PROJECT MANUAL

VOLUME #3 of 3

PAYNEVILLE ELEMENTARY SCHOOL RENOVATION AND ADDITION

Payneville, Kentucky

SCB 1569/ BG #18-283

July 10, 2019

OWNER

Meade County Board of Education
Brandenburg, Kentucky

SUPERINTENDENT – Dr. John Millay

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DIVISION 20 – MECHANICAL

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PART 1 – GENERAL:

1.1 The Advertisement for Bid, Instructions to Bidders, Bidding Requirements, General, Special and Supplementary Conditions, and all other Contract Documents shall apply to the Contractor's work as well as to each of their Sub-Contractor's work.

1.2 All manufacturers, suppliers, fabricators, contractors, etc. submitting proposals for any part of the work, services, materials or equipment to be used on or applied to this project are hereby directed to familiarize themselves with the Contract Documents. In case of conflict between these General Provisions and the General and/or Special Conditions, the Contractor shall contact the Engineer for clarification and final determination prior to the Bid.

1.3 The work included in this Division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Mechanical Systems indicated or specified in the Contract Documents.

1.4 Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete any part of the Mechanical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the Plans and/or Specifications, shall be included in the Bid as part of this Contract.

1.5 It is not the intent of this Section of the Specifications to make any Contractor, other than the General Contractor, responsible to the Owner. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect, then to the Engineer. Also, this Section of the Specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

1.6 The Architect and Engineer do not define the scope of individual trades, subcontractors, material suppliers and vendors. Any sheet numbering system or specification numbering system used which identifies disciplines is solely for the Architect and Engineer’s convenience and is not intended to define a subcontractor’s scope of work. Information regarding individual trades, subcontractors, material suppliers and vendors may be detailed, described and indicated at different locations throughout the Contract Documents. No consideration will be given to requests for change orders for failure to obtain and review the complete set of Contract Documents when preparing Bids, prices and quotations. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

1.7 It is the intent of the Contract Documents to deliver to the Owner a new, complete and operational project once the work is complete. Although Plans and Specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

1.8 In general, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owner at least forty-eight (48) hours prior to the interruption of any services (gas, domestic water, heating, etc.). The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with

this requirement may result in complete work stoppage for the Contractors involved until a complete schedule of interruptions can be developed.

1.9 Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of Bidder/Proposer's own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner.

1.10 Each Bidder/Proposer shall also be governed by any unit prices and Addenda insofar as they may affect part of their work or services.

1.11 Definitions and Abbreviations:

- Contractor - Any Contractor whether bidding, proposing or working independently or under the supervision of a General Contractor, Prime Contractor, Construction Manager and who installs any type of Mechanical Work as specified in the Contract Documents or, the General Contractor.
- Engineer - The Consulting Mechanical-Electrical Engineer either consulting to the Owner, Architect, or Other, etc. In this case: CMTA, Inc., Consulting Engineers.
- Architect - The Architect of Record for the project.
- Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owner, etc.
- Bidder/Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.
- The Project - All of the work required under this Contract.
- Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.
- Provide - Furnish and install complete, tested and ready for operation.
- Install - Receive and place in satisfactory operation.
- Indicated - Listed in the Specifications, shown on the Plans or Addenda thereto.
- Typical or Typ.- Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.
- ADA - Americans with Disabilities Act.
- AGA - American Gas Association.
- ANSI - American National Standards Institute.
- ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.
- ASME - American Society of Mechanical Engineers.
- IBC - International Building Code.
- NEC - National Electrical Code.
- NEMA - National Electrical Manufacturers Association.
- NFPA - National Fire Protection Association.
- OSHA - Office of Safety and Health Administration.
- SMACNA - Sheet Metal and Air Conditioning Contractors National Association.
- UL - Underwriters Laboratories.

PART 2 – INTENT AND INTERPRETATION:

2.1 It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.

2.2 All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer's installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer's installation requirements whether specifically detailed or not within the Plans and Specifications.

2.3 Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

2.4 The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer / Architect. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.

2.5 The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

PART 3 – INDEMNIFICATION:

3.1 The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

PART 4 – PLANS AND SPECIFICATIONS:

4.1 The Plans are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The Plans are not intended to show every item which may be necessary to complete the systems. All Bidder/Proposers shall anticipate that additional items may be required and submit their Bid accordingly.

4.2 The Plans and Specifications are intended to supplement each other. No Bidder/Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.

4.3 The Plans and Specifications shall be considered to be cooperative and anything appearing in the Specifications which may not be indicated on the Plans or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

4.4 Contractor shall make all of their own measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

4.5 The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.

4.6 Should conflict, overlap or duplication of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under their branch until instructions in writing are received from the Engineer.

4.7 Unless dimensioned, the Plans only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the Plans shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to insure no conflict with other work.

4.8 Each Bidder/Proposer shall review all Plans in the Contract Documents to insure that the work they intend to provide does not create a conflict with or affect the work of others in any way. Where such effect does occur it shall be the Bidder/Proposer's responsibility to satisfactorily eliminate any such conflict or effect prior to the submission of their proposal. Each Bidder/Proposer shall in particular insure that there is adequate space to install their equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the Bidder/Proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to insure adequate spaces.

4.9 Where on the Plans a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

4.10 Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

4.11 Where within the Contract Documents the word “typical” or “typ.” is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

4.12 Each Contractor shall evaluate ceiling heights specified on Architectural Plans. Where the location of equipment or systems may interfere with ceiling heights or maintenance and access of equipment or systems, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Do not install equipment or systems in the affected area until the conflict is resolved. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work or cost incurred on the part of the Contractor or unduly delay the work.

4.13 The Contractor shall provide a layout confirmation of equipment rooms to verify that all of the equipment submitted and approved will in fact fit into the proposed space and have adequate clearance for service.

PART 5 – EXAMINATION OF SITE AND CONDITIONS:

5.1 Each Bidder/Proposer shall inform themselves of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work.

5.2 Each Bidder/Proposer shall also fully acquaint themselves with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. A proposal shall cover all expenses or disbursements in connection with such matters and conditions. No allowance will be made for lack of knowledge concerning such conditions after Bids are accepted.

PART 6 – EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS:

6.1 When any Contractor requests approval of materials and/or equipment of different physical size, weight, capacity, function, color, access, that the design allows for it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, etc. from that indicated, electrical service, etc. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall compensate them for all necessary changes in their work. Any Plans, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineer does not in any way absolve the Contractor of this responsibility.

6.2 Notwithstanding any reference in the Specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the provisions of this Part are met. Requested substitutions shall be submitted to the Engineer a minimum of ten (10) days prior to Bid. If this procedure is not followed, the substitution will be rejected. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

6.3 Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineer.

6.4 Each Bidder/Proposer shall furnish along with their proposal a list of specified equipment and materials which is to be provided. Where several makes are mentioned in the Specifications and the Contractor fails to state which they propose to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not insure that the Engineer will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings are satisfactorily comparable to the items specified and/or indicated.

6.5 Ten (10) days prior to the submission of a proposal, each Bidder/Proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Bidder/Proposers signify that they have included the cost of all required items in the proposal and that the Bidder/Proposer will be responsible for the safe and satisfactory operation of the entire system.

6.6 Coordinate kitchen equipment selection by the General Contractor prior to Bid. Any deviations and/or conflicts for any kitchen equipment shall be the Contractor's responsibility.

PART 7 – CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.:

7.1 The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, etc. in connection with their work. They shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. They shall also obtain all required certificates of inspection for their work and deliver same to the Engineer before request for acceptance and final payment for the work.

7.2 Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall also be versed in all Codes, Rules and Regulations pertinent to their part of the work prior to submission of a proposal.

7.3 The Contractor shall include in their work, without extra cost, any labor, materials, services, apparatus and Plans in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

7.4 All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

7.5 All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable.

7.6 All plumbing work is to be constructed and installed in accordance with applicable codes, Plans and Specifications which have been approved in their entirety and/or reflect any changes requested by the State Department of Health. Plumbing work shall not commence until such Plans are in the possession of the Plumbing Contractor.

7.7 All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the Building Code and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association.

7.8 The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.

7.9 Where minimum code requirements are exceeded in the Design, the Design shall govern.

7.10 The Contractor shall insure that their work is accomplished in accord with the OSHA Standards and that they conduct their work and the work of their personnel in accord with same.

7.11 All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction and the American Disabilities Act.

7.12 All pressure vessel installations shall comply with the State, and/or Federal Code applicable. A Certificate of Final Boiler Inspection shall be required.

7.13 Work in elevators, elevator shafts and elevator equipment rooms shall comply with the Elevator Code enforced by the Authority Having Jurisdiction.

7.14 All work in conjunction with a natural gas installation shall, in addition to all other Codes, Rules, Regulations, Standards, etc., comply with the requirements of the local gas supplier and/or standards and recommendations of the American Gas Association.

7.15 All work in relation to domestic water systems shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the requirements of the local water utility company.

7.16 All work in relation to the installation of sanitary or storm sewers shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the local agency governing such installations.

7.17 Discharge of any toxic, odorous or otherwise noxious materials into the atmosphere or any system shall be subject to regulations of the Environmental Protection Agency (EPA) and/or the air pollution control commission. If in doubt, contact the State Department for Environmental Protection.

7.18 Where conflict arises between any code and the Plans and/or Specifications, the code shall apply except in the instance where the Plans and Specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten (10) days prior to bid date, otherwise the Contractor shall make the required changes at their own expense.

PART 8 – QUALIFICATIONS OF CONTRACTOR/WORKERS:

8.1 All Mechanical Contractors and their subcontractors bidding this project must have been a licensed company for a minimum of three (3) years to qualify to Bid this project. Individual employee experience does not supercede this requirement.

8.2 All mechanical subcontractors bidding the mechanical work must have completed one project of 70% this subcontract cost size and two projects of 50% this subcontract cost size.

8.3 All mechanical work shall be accomplished by qualified workers competent in the area of work for which they are responsible. Untrained and incompetent workers, as evidenced by their workmanship, shall be summarily relieved of their responsibilities in areas of incompetency. The Engineer shall reserve the right to determine the quality of workmanship of any workers and unqualified or incompetent workers shall refrain from work in areas not deemed satisfactory. Requests for relief of a workers shall be made through the normal channels of Architect, Contractor, etc.

8.4 The Contractor shall hold all required licenses in the State which the work is to be performed.

8.5 All plumbing work shall be accomplished by Journeymen Plumbers under the direct supervision of a Master Plumber as defined under State Plumbing Law Regulations and Code. Proof and Certification may be requested by the Engineer.

8.6 The installation of all Heating, Ventilating and Air-Conditioning Systems (HVAC) by any Contractor, whether in existing or new building construction shall be performed by a Licensed Master HVAC Contractor. This includes any Contractor installing HVAC systems, piping and ductwork.

8.7 All sheet metal, insulation and pipe fitting work shall be installed by workers normally engaged in this type work.

8.8 All automatic control systems shall be installed by workers normally engaged or employed in this type work.

8.9 All special systems (Automatic Sprinkler Equipment, etc.) shall be installed only by workers normally engaged in such services. Exception to this specification may only be made in writing by the Engineer.

8.10 All electrical work shall be accomplished by Licensed Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

PART 9 – SUPERVISION OF WORK:

9.1 The Contractor shall personally supervise the work for which they are responsible or have a competent superintendent, approved by the Engineer, on the work at all times during progress with full authority to act on behalf of the Contractor.

PART 10 – CONDUCT OF WORKERS:

10.1 The Contractor shall be responsible for the conduct of all workers under their supervision. Misconduct on the part of any worker to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that worker. The consumption of alcoholic beverages or other intoxicants, narcotics, barbiturates, hallucinogens or dehabilitating drugs on the job site is strictly forbidden.

PART 11 – COOPERATION AND COORDINATION WITH OTHER TRADES:

11.1 The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay.

11.2 Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than ¼" = 1'-0", clearly indicating how their work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. Make the necessary changes in the work to correct the condition without extra charge.

11.3 The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

PART 12 – GUARANTEES AND WARRANTIES:

12.1 The Contractor shall guarantee all equipment, apparatus, materials, and workmanship entering into their Contract to the best of its respective kind and shall replace all parts at their own expense, which are proven defective within the time frame outlined in the General Conditions of the Contract. The effective date of completion of the work shall be the date of the Architect's/Engineer's Statement of Substantial Completion. Items of equipment which have longer guarantees, as called for in these Specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Engineer shall then submit these warranties, etc. to the Owner. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of their

operator or other employees. Refer to other sections for any special or extra warranty requirements.

12.2 All compressors shall have five year warranty. (1st year parts and labor, 2nd thru 5th year compressor only).

12.3 All VFD's shall have a two year warranty.

12.4 Provide all warranty certificates to Owner. All warranties begin starting at the substantial completion date, submit warranty certificates accordingly.

PART 13 – COST BREAKDOWNS (SCHEDULE OF VALUES):

13.1 Within thirty (30) days after acceptance of the Contract, the Contractor shall furnish to the Engineer, one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made in a format approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted.

13.2 The breakdown shall be minimally as follows. Material and labor shall be listed separately. Pay special attention to required withholding percentages for startup, testing, documentation, acceptance, owner training, etc.:

- Mechanical Shop Drawings
- Motor Load Coordination with other subcontractors
- Mechanical Record Drawings & Acceptance
- Mechanical O&M Manuals & Acceptance
- Mechanical Owner Training & Acceptance
- Mechanical Identification Materials & Labor
- HVAC Piping Materials & Labor
- HVAC Piping Testing, Cleaning, Documentation, Acceptance, etc.
- HVAC Piping Purging, Flushing, Cleaning
- Insulation (Piping) Materials & Labor
- Insulation (Ductwork) Materials & Labor
- Plumbing Fixtures and Equipment
- Plumbing Materials, Piping & Labor
- Plumbing Shop Fabrication
- Domestic Water Heater Equipment & Labor
- Domestic Water Heater Startup, Testing, Documentation, Training, Acceptance, etc.
- Fire Protection Shop Drawings
- Fire Protection Materials & Labor
- Fire Protection Record Drawings & Acceptance
- Sheetmetal Equipment
- Sheetmetal Materials & Labor
- Sheetmetal Shop Fabrication
- Filters and Racks Materials & Labor
- Heat Pump Equipment & Labor
- Heat Pump Startup, Testing, Documentation, Training, Acceptance, etc.
- Air Handling Unit Equipment & Labor
- Air Handling Unit Startup, Testing, Documentation, Training, Acceptance, etc.
- Other HVAC Equipment & Labor
- Other HVAC Equipment Startup, Testing, Documentation, Training, Acceptance, etc.
- Chemical Treatment Materials & Labor
- Chemical Treatment Startup, Testing, Documentation, Training, Acceptance, etc.
- Controls Shop Drawings
- Controls Materials & Labor

- Controls Graphics
- Controls Record Drawings
- Controls Startup, Commissioning, Testing, Documentation, etc.
- Controls Training and Acceptance
- Test and Balance Materials & Labor
- Test and Balance Initial Report, Final Report and Acceptance

PART 14 – CHANGES IN MECHANICAL WORK:

14.1 REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 15 – CLAIMS FOR EXTRA COST:

15.1 REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 16 – MATERIALS AND WORKMANSHIP:

16.1 All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Bidder/Proposer shall determine that the materials and/or equipment they propose to furnish can be brought into the building(s) and installed within the space available. In certain cases, it may be necessary to remove and replace walls, floors and/or ceilings and/or disassemble/reassemble the materials and equipment and this work shall be the responsibility of the Contractor, whether specifically initiated or not. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of fans, motors, coils, filters, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s). Insure, through coordination that no other Contractor seals off access to space required for equipment materials, etc.

16.2 Materials and equipment shall bear Underwriters' Laboratories label where such a standard has been established, where applicable.

16.3 Use extreme care in the selection of equipment and its installation to insure that noise and vibration are kept at a minimum. The Engineer's determination shall be final and corrections to such discrepancies shall be made at the cost of the Contractor.

16.4 Each length of pipe, fitting, trap, fixture and device used in the plumbing or drainage systems shall be stamped or indelibly marked with the weight or quality thereof and with the manufacturer's mark or name.

16.5 All equipment shall bear the manufacturer's name and address. All electrically operated equipment shall bear a name plate indicating required horsepower, voltage, phase and ampacity. Pumps and fans shall have a data plate indicating horsepower, pressure and flow rate.

PART 17 – HAZARDOUS MATERIALS:

17.1 The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building or site.

17.2 Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work, insure that their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

17.3 CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

17.4 If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise them immediately.

17.5 The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

17.6 No asbestos or mercury containing materials shall be installed in this project.

PART 18 – COORDINATION DRAWINGS:

18.1 Detailed electronic coordination drawings shall be required for this project. A specific line-item shall be included on the schedule of values by each Trade for “preparation of coordination drawings”. This line-item value shall be approved by the Engineer. The Engineer and the Engineer’s Field Inspector shall closely monitor progress and quality of the preparation of the electronic coordination drawings and may withhold pay requests as deemed appropriate.

18.2 Coordination Drawings shall be provided on this project by each Trade (Mechanical, Fire Protection, Electrical). Drawings shall be 30x42 sheet size and shall be at ¼” scale and shall match the drawing setup as included in the Architectural Drawings. Drawings shall be prepared in electronic format. The Architect and Engineer will supply electronic drawings files (REVIT models) of the Contract Documents upon the Contractor’s request and release.

18.3 The basis for the Coordination Drawings shall be the sheet metal ductwork fabrication shop drawings, all electrical feeder conduits and other conduits 2” and larger. The Coordination Drawings shall be prepared by the Mechanical Contractor. The Coordination Drawings shall indicate (1) systems above ceilings in finished areas, (2) systems supported from the structure in finished areas without ceilings, (3) systems in the mechanical rooms, and (4) all wall, roof, floor penetrations. These drawings shall indicate all ductwork as double lined with bottom elevations noted.

18.4 The sheet metal fabrication shop drawings shall be completed in a timely manner so as not to conflict with construction schedule and phasing plan. At the Contractor’s discretion, these drawings shall be completed in phases to correspond with the project construction work sequencing. The Mechanical Contractor shall furnish an electronic copy of these ductwork shop drawings to all other Trades, specifically the Fire Protection and Electrical and other Contractors as requested by the General Contractor for the purpose of including other trades work on the Coordination Drawings.

18.5 Pre-Coordination Meetings with all necessary trades shall occur. During these meetings, the Contractors shall discuss locations/elevations where piping, conduits, cable path, etc will be installed with respect to the sheetmetal fabrication drawings and other trades. The sheetmetal ductwork and gravity piping systems shall be given the first priority. Within 30 days of the meeting, each Trade shall provide the Mechanical Contractor electronic drawings of all of their systems (with elevation noted), coordinated with the ductwork and other trades for them to incorporate into the Coordination Drawings. Coordination Meetings shall then occur so that all

conflicts can be resolved between Trades. All conflicts shall be resolved between all Trades at these Coordination Meetings and the Mechanical Contractor shall then amend the Drawings to include the Final Coordinated Work.

18.6 It is realized that not all systems can be completely detailed. The coordination drawings shall include the following at a minimum:

- All supply/return/exhaust ductwork.
- All above slab sanitary and roof drainage piping.
- HVAC, fire protection and domestic water piping which are 2" in size and greater, excluding insulation.
- Electrical conduits which are 1.5" in size and greater.
- Cable tray and bridal ring paths.
- Multiple smaller piping/conduits hung on a common trapeze hanger.
- All wall, roof, floor penetrations.

18.7 After completion of the Final Coordination Drawings, a Final Review with the all Trades shall occur to provide any final comments and approval by all Trades. Other interim coordination meeting will be required to insure successful coordination drawings. Any additional coordination items will be updated by the Mechanical Contractor. The Final Approved Coordination Drawings shall distributed to each Trade by the Mechanical Contractor. The Mechanical Contractor shall also furnish a complete 30x42 paper set of drawings to the jobsite main office and shall utilize them for updates of field conditions/deviations that occur during construction. Final Approved Coordination Drawings shall also be distributed to the Contractor, Owner, Architect and Engineer for their Records. This process shall be completed prior to starting any work.

18.8 Each Contractor shall insure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on Coordination Drawings kept at the jobsite. Upon completion of a particular phase, the Mechanical Contractor shall incorporate all field deviations into the Coordination Drawings to be utilized as Record Drawings. The Engineer shall review the Record Documents from time to time to insure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. The Record Drawings shall be distributed electronically (on CD) to the Contractor, Owner, Architect and Engineer for their Records.

18.9 The mechanical contractor is responsible to the general contractor for the shop drawing layout of the following rooms and details:

- Concrete pads and foundations
- Equipment room layouts with actual equipment
- Roof layouts
- Trench locations and sizes
- Dimensioned floor drain locations
- Congested areas above ceilings adjacent to mechanical and electrical room
- Dimensioned ductwork shop drawings

18.10 The electrical contractor is responsible to the general contractor for the shop drawing layout of the following rooms and details:

- Concrete pads and foundations
- Equipment room layouts with actual equipment
- Routes of feeders conduits and all other conduits 1.5" and larger
- Bridle ring cabling paths
- Trench locations and size
- Congested areas above ceilings adjacent to mechanical and electrical rooms

PART 19 – TEMPORARY SERVICES:

19.1 The Contractor shall arrange any temporary water, electrical and other services which may be required to accomplish the work. Refer also to General and Special Conditions.

19.2 All temporary services shall be removed by Contractor prior to completion of work.

PART 20 – SURVEY, MEASUREMENTS AND GRADE:

20.1 The Contractor shall lay out their work and be responsible for all necessary lines, levels, inverts, elevations and measurements. The Contractor must verify the figures shown on the Plans before laying out the work and will be held responsible for any error resulting from failure to do so.

20.2 The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

20.3 Should the Contractor discover any discrepancy between actual measurements and those indicated which prevents following good practice or the intent of the contract documents, the Contractor shall promptly notify the Engineer and shall not proceed with this work until the Contractor has received instructions from the Engineer on the disposition of the work.

PART 21 – PROTECTION OF EQUIPMENT:

21.1 The Contractor shall be entirely responsible for all material and equipment they furnish in connection with their work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All piping, etc., shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at their expense. All ductwork with open ends shall be covered with plastic during construction.

PART 22 – REQUIRED CLEARANCES FOR ELECTRICAL EQUIPMENT:

22.1 The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost. Coordinate with the Electrical Contractor prior to any work.

PART 23 – EQUIPMENT SUPPORT:

23.1 Each piece of equipment, apparatus, piping, or conduit suspended from the ceiling or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc. Do not support items from roof/floor deck or bridging.

PART 24 – DUCT AND PIPE MOUNTING HEIGHTS:

24.1 All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure. Refer to Plans for minimum heights of ducts and piping above ceiling.

PART 25 – BROKEN LINES AND PROTECTION AGAINST FREEZING:

25.1 No conduits, piping, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. Do not install piping across or near openings to the outside whether or not they are carrying static or moving fluids. Insulation on piping does not necessarily insure that freezing will not occur. If in doubt, contact the Engineer.

PART 26 – WEATHERPROOFING:

26.1 Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as specified and approved by the Architect and Engineer before work is performed. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

26.2 Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

PART 27 – FINAL CONNECTIONS TO EQUIPMENT:

27.1 The Contractor shall finally connect mechanical services (water, sanitary, gas, air, etc.), to any terminal equipment, appliances, kitchen equipment, etc., provided under this and/or other divisions of the work. Various equipment connections indicated are based upon “basis of design” equipment selections. Should alternate equipment be purchased by the General Contractor, then this Contractor shall make the necessary provisions in the Bid for any and all differences. Change Orders shall not be considered for any differences due to alternate equipment purchase. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer’s recommendations. If in doubt, contact the Engineer prior to installation.

PART 28 – ACCESSIBILITY:

28.1 The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and ceilings for the proper installation of their work. They shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.

28.2 The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, controls, coils, etc.

28.3 Whether shown on the Plans or not, the Contractor shall provide in the Bid access panels for each concealed shut-off valve, motorized control damper, manual air damper or other device requiring service as shown on Engineer's Plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. Change orders for access panels will not be accepted.

PART 29 – SCAFFOLDING, RIGGING AND HOISTING:

29.1 The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

PART 30 – CONCRETE WORK:

30.1 The Contractor shall be responsible for the provisions of all concrete work required for the installation of any of their systems or equipment. The Contractor may, at their option, arrange with the others to provide the work. This option, however, will not relieve the Contractor of their responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete Specifications, all concrete related to Mechanical work shall be 3500 psi minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy equipment shall not be installed on pads for at least seven (7) days after pour. Insert 6-inch steel dowel rods into new and existing floors to anchor pads.

30.2 All concrete pads shall be complete with all pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18" in width shall be reinforced with ½" deformed round bars on 6" centers both ways. Bars shall be approximately 2" above the bottom of the pad. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms, all surfaces shall be rubbed to a smooth surface. Chamfer all vertical edges ¾" and tool horizontal edges with ¾" radius.

30.3 In general, concrete pads for equipment shall be 4" thick, extend six (6) inches beyond the equipment's base dimensions. Where necessary, extend pads 30 inches beyond base or overall dimensions to allow walking and servicing space.

PART 31 – RESTORATION OF NEW OR EXISTING LANDSCAPING, PAVING, SURFACES, ETC.:

31.1 The Contractor shall at their expense restore to their original conditions all paving, curbing, surfaces, drainage ditches, structures, fences, landscaping, existing or new building surfaces and appurtenances, and any other items damaged or removed by their operations. Replacement and repairs shall be in accordance with good construction practice; by qualified tradesman, and shall match materials employed in the original construction of the item and shall be to the satisfaction of the Owner and/or Engineer.

PART 32 – MAINTENANCE OF EXISTING UTILITIES AND LINES:

32.1 The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that comes within the contract construction site, shall be subject to continuous uninterrupted service with no other exception than the Owner of the utilities permission to interrupt same temporarily. Provide a seven (7) day written notice to Engineer, Architect and Owner prior to interrupting any utility service or line.

32.2 Known utilities and lines as available to the Engineer are shown on the Plans. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain and mark all utilities or lines that would be endangered by the excavation. Hand dig if required to locate. Contractor shall bear costs of repairing damaged utilities.

32.3 If utilities or lines occur in the earth within the construction site, the Contractor shall probe and locate the lines prior to machine excavation in the respective area. Hand dig if required to locate.

32.4 Cutting into existing utilities and services shall be performed in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore

service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.

32.5 The Contractor shall repair to the satisfaction of the Owner and Engineer, any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

32.6 Machine excavation shall not be permitted with ten feet of gas lines, fuel lines, electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only in accord with utility company, agency or other applicable laws, standards or regulations.

32.7 Protect all new or existing lines from damage by traffic, etc. during construction. Repairs or replacement of such damage shall be at the sole expense of the party responsible.

32.8 Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

PART 33 – CLEANING:

33.1 The Contractor shall, at all times, keep the area of their work presentable to the public and clear from rubbish and debris caused by their operations; and at the completion of the work, they shall remove all rubbish, debris, all of their tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of their rubbish or debris.

33.2 After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

33.3 Ductwork and piping shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4” above the floor and shall be completely covered in plastic. Installed ductwork shall be protected with plastic. Do not install the ductwork or insulation (pipe or duct) if the building is not “dried-in”. If this is required, the entire lengths of duct shall be covered in plastic to protect. The Owner/Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing a NADCA certified Contractor.

PART 34 – TEMPORARY USE OF EQUIPMENT:

34.1 The permanent heating and plumbing equipment, when installed, may be used for temporary services, with the consent of the Engineer. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.

34.2 Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

34.3 Warranties shall begin at substantial completion regardless of their temporary use or not.

34.4 A pre-start-up conference shall be held with the Architect, Owner, General Contractor and the Mechanical Contractor. Equipment shall not be started until after this meeting.

34.5 For Heat Pump Units during all phases of construction:

- At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.
- On the outside of all return and exhaust air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the "construction" filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.
- At substantial completion of the project the entire unit shall be cleaned to present a like "new" unit for the Owner and all filters shall be replaced with new.

34.6 For Outside Air Units during all phases of construction:

- These units shall not be used for temporary heating and cooling by the Contractor. They shall, however, be made operational, tested, etc. as specified during construction by the Contractor. Three complete sets of filters are required for each unit. In each unit, install one set of filters during construction. In each unit, install one set of filters at substantial completion. For each unit, leave third set of filters in boxes in appropriate mechanical room as a spare set for the Owner. Dispose of all construction filters.
- At substantial completion of the project the entire unit shall be cleaned to present a like "new" unit for the Owner and all filters shall be replaced with new.

PART 35 – NOISE, VIBRATION OR OSCILLATION:

35.1 All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at their expense.

35.2 All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means. Unitary equipment, such as room units, exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.

35.3 The Contractor shall provide supports for all equipment they furnish. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineer.

PART 36 – EQUIPMENT/CONTROLS STARTUP & VERIFICATION:

36.1 The Contractor and their Subcontractors shall include in the bid to provide equipment and controls startup and verification for ALL Mechanical Systems specified for this project.

36.2 A pre-start-up conference shall be held with the Architect, Engineer, Owner, General Contractor, Mechanical Contractor, Electrical Contractor, Controls Contractor, Test and Balance Contractor, and the Manufacturer's providing startup services. The purpose of this meeting will be discuss the goals, procedures, etc. for start-up.

36.3 Specific line-items shall be included on the schedule of values by each Trade for "equipment and controls startup". These line-item values shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspector(s) shall closely monitor progress and quality of the equipment and controls startup and may withhold pay requests as deemed appropriate until satisfactorily completed.

36.4 Specific startup/verification specifications are included throughout the Mechanical Specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians, not third party contractors, and shall complete and submit start-up reports/checklists. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner. Where factory start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up. All information shall be completed by the Contractor and submitted to the Owner/Engineer prior to acceptance of the equipment.

36.5 The Contractor shall be responsible for completion of System Verification Checklists/Manufacturer's Checklists. Factory startup is required for all HVAC equipment noted. Unless noted otherwise, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. The contractor shall utilize checklists provided by the Facility Commissioning Group (FCG). These requirements shall include the following equipment and systems:

- Heat Pumps
- Water-to-Water Heat Pump Units
- Outside Air Units
- Variable Frequency Drives
- Water Flow Meters/BTUH Meters
- Make Up Air Units and Exhaust Fans

36.6 Except for the specific equipment specified in this Specification Section, the manufacturer's recommended startup procedures and checklists will be acceptable for use in the project. Where "manufacturer" startup is not specified, then this Contractor shall perform startup services in strict accordance with manufacturer's instructions. All startup/verification process shall be thoroughly documented by the Contractor and shall include the time and date when performed.

36.7 The Contractor shall "zip-tie" a start-up report to each piece of equipment in a clear plastic cover. Once start-up completion is verified by the Engineer the Contractor shall remove all reports and consolidate them into close-out documentation. The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists.

PART 37 – <u>INSPECTION, APPROVALS AND TESTS:</u>

37.1 Before requesting a final review of the installation from the Architect and/or Engineer, each Contractor shall thoroughly inspect their installations to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineer for unnecessary and undue work on their part.

37.2 The Contractor shall provide as a part of this Contract any required Agency inspection, licensed and qualified to provide such services. All costs incidental to the provisions of inspections shall be borne by the Contractor.

37.3 The Contractor shall advise each Inspecting Agency in writing, with an informational copy of the correspondence to the Architect and/or Engineer, when they anticipate commencing the work. Inspections shall be scheduled for rough-in as well as finished work. The rough-in inspections shall be divided into as many inspections as may be necessary to cover all rough-in without fail. Failure of the Inspecting Agency to inspect the work in a timely manner and submit the related reports may result in the Contractor having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

37.4 Approval by an Agency Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these Plans and Specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

37.5 Before final acceptance, the Contractor shall furnish the original and three (3) copies of the certificates of final approval by the Agency Inspector to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

PART 38 - ABOVE-CEILING AND FINAL PUNCH LISTS:

38.1 The Contractor shall review each area and prepare and complete their own punch list for each of the subcontractors as required for the Project Schedule.

38.2 Seven (7) days notice shall be given to the Engineer for review of above ceiling work that will be concealed by tile or other materials. Seven (7) days notice shall be given to the Engineer for review of below ceiling work and final inspection.

38.3 When all work from the Contractor's punch list is complete at each of the major Project Stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven (7) days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review. The Contractor’s representative may be requested at the inspections.

38.4 If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due net 10 days from date of each additional visit) at a rate of $125.00 per hour plus travel expense for extra trips required to complete either of the above ceiling, below ceiling or final punch lists.

PART 39 – OPERATING INSTRUCTIONS:

39.1 Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a period of three (3) days of eight (8) hours each, or as otherwise specified. Refer to Section HVAC EQUIPMENT for additional requirements. During this period, instruct the Owner or their representatives fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least seven (7) days written notice to the Owner, Architect and Engineer in advance of this training period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representatives that were present.

39.2 Each Contractor shall furnish three complete bound sets for approval to the Engineer instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft form, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Refer to Specification Section SHOP DRAWINGS for additional detail.

39.3 Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

PART 40 – RECORD DRAWINGS:

40.1 The Contractor shall insure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to insure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose and deliver to the Engineer upon completion of the work.

DIVISION 20 - MECHANICAL

SECTION 200200 - SCOPE OF THE MECHANICAL WORK

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS – MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Mechanical work for this Contract shall include all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner the complete mechanical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not necessarily limited to the following paragraphs.

1.3 All applicable services and work specified in GENERAL PROVISIONS - MECHANICAL.

1.4 Installation of all equipment per the manufacturer’s instruction, whether specifically detailed or not.

1.5 Provide all required motor starters, etc. not provided under the electrical sections.

1.6 Thorough instruction of the Owner’s maintenance personnel in the operation and maintenance of all mechanical equipment.

1.7 Thorough coordination of the installation of all piping, ductwork, equipment and any other material with other trades to insure that no conflict in installation.

1.8 Approved supervision of the mechanical work.

1.9 Procurement of all required inspections, including fees for all inspection services and submission of final certificates of inspection to the Engineers.

1.10 Excavation, backfilling, cutting, patching, sleeving, concrete work, etc., required to construct the mechanical systems.

1.11 Equipment and controls start-up, verification and documentation as specified.

1.12 Coordination drawings, record drawings, final inspection certificates, test results, O & M documentation, warranty certification, spare parts and other specified closeout documentation.

1.13 Required schedule of values breakdown.

1.14 Pipe, duct and equipment identifications.

1.15 Preinstallation meetings and equipment mockups.

1.16 Complete sanitary sewer service including the grease trap. Refer to Civil Drawings/Specifications for additional requirements.

1.17 Complete storm sewer service. Refer to Civil Drawings/Specifications for additional requirements.

1.18 Complete natural gas service. Refer to Civil Drawings/Specifications for additional requirements.

1.19 Complete interior and exterior heat pump system and required test results.

1.20 Domestic hot, cold and recirculating hot water system.

1.21 Soil, waste and vent systems.

1.22 Roof drainage systems.

1.23 All plumbing equipment, fixtures and fittings.

1.24 100% automatic sprinkler systems.

1.25 Complete heating, ventilation and air conditioning systems.

1.26 All mechanical exhaust systems.

1.27 All insulation associated with mechanical systems.

1.28 Condensate drainage systems.

1.29 All required pressure testing, flushing, purging, pressure and flow testing requirements.

1.30 Final coordination and connection of all mechanical equipment furnished by others (e.g., kitchen equipment, appliances).

1.31 Complete natural gas piping systems.

1.32 All required controls, including self checkout and commissioning.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 200300 - SHOP DRAWINGS, MAINTENANCE MANUALS AND PARTS LISTS

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS – MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Contractor shall prepare and submit to the Engineer, through the Prime Contractor and the Architect within thirty (30) days after the date of the Contract, required copies of all shop drawings, certified equipment drawings, installation, operating and maintenance instructions, samples, wiring diagrams, etc. on all items of equipment specified hereinafter. Refer to Division 1 requirements for shop drawing submittal requirements.

1.3 Provide all shops in electronic/PDF format. The Engineer's comments will be returned in electronic format.

1.4 Each shop drawing and/or manufacturers descriptive literature shall have the proper notation indicated on it and shall be clearly referenced to the specifications, schedules, fixture numbers, etc., so that the Engineer may readily determine what the Contractor proposes to furnish. All data and information schedules indicated or specified shall be noted on each copy of each submittal.

1.5 Submittal data shall include specification data including metal gauges, finishes, accessories, etc. Also, the submittal data shall include certified performance data, wiring diagrams, dimensional data, and a spare parts list. Submittal data shall be reviewed by the Engineer before any equipment or materials is ordered or any work is begun in the area requiring the equipment.

1.6 All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the Prime Contractor and the Architect to show that the drawings have been reviewed by the Contractor. Any drawings submitted without these stamps of approval may not be considered and will be returned for proper resubmission.

1.7 The Contractor shall make any corrections or changes required by the Engineer and shall re-submit for final review as outlined above.

1.8 It shall be noted that review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the Contract Documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located. The Contractor shall also coordinate piping side connections.

1.9 The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for adaptability of the item to the project; compliance with applicable codes, rules, regulations and information that pertains to fabrication and installation; dimensions. weight and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project.

1.10 Prior to ordering any materials or rough-in of any kind, the Mechanical Contractor shall be responsible for final coordination of all electrical requirements (i.e. voltage, phase, circuit breaker, wire sizing, etc.) with the Electrical Contractor. There will be no change in the Contract Amount for any discrepancies. A final coordination meeting shall be held with the Architect, Owner,

Engineer, Prime Contractor, Mechanical Contractor, Electrical Contractor and their sub-contractors.

1.11 Equipment shall not be ordered and no final rough-in connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractor. It shall be the Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. The Contractor shall coordinate with all the other trades having any connections, roughing-in, etc. to the equipment.

1.12 If the Contractor fails to comply with the requirements set forth above, the Engineer shall have the option of selecting any or all items listed in the Specifications or on the Drawings; and the Contractor shall be required to furnish all materials in accordance with this list.

1.13 Colors for equipment in other than mechanical spaces shall be selected from the Manufacturer's standard and factory optional colors unless noted otherwise on the Plans. Color samples shall be furnished with the shop drawing submission for such equipment.

1.14 All submittals for mechanical equipment shall include all information specified and scheduled. This shall include air and water pressure drops, RPM, noise data, face velocities, horsepower, voltage motor type, steel or aluminum construction, and all accessories clearly marked.

1.15 All items listed in the schedules shall be submitted for review in a tabular form similar to the equipment schedule. All items submitted shall be designated with the same identifying tag as specified on each sheet.

1.16 Any submittals received in an unorganized manner without options to be provided specifically noted and with incomplete data will be returned for resubmittal.

PART 2 – <u>SHOP DRAWINGS:</u>

2.1 Shop Drawings, descriptive literature, technical data and required schedules shall be submitted on the following:

Access Doors
Air Filters and Racks
Chemical Treatment and Test Reports
Double Wall Ductwork
Ductwork Accessories/Volume Dampers
Exhaust Fans
Fire Protection Sprinkler System (2.2.3)
Firestopping (2.2.5)
Floor Drains
Heat Pump Units
Insulation
Outside Air Handling Units
Plumbing Equipment
Plumbing Fixtures, Fittings and Trim
Pumps and Hydronic Specialties
Register, Grilles, Diffusers and Louvers
Roof Drains
System Verification Check Lists
Temperature Controls & Components (2.2.2)
Valves
Variable Frequency Drives
Water Heaters

(Refer to the corresponding Special Notes.)

2.2 Special Notes:

2.2.1 For all items above, upon substantial completion of the project, the Contractor shall deliver to the Engineer (in addition to the required Shop Drawings) three (3) complete copies of operation and maintenance instructions and parts lists for each item above. Where available, documents shall include at least:

- Detailed operating instructions
- Detailed maintenance instructions including preventive maintenance schedules.
- Addresses and phone numbers indicating where parts may be purchased.
- Expanded parts drawings, parts lists, service manuals, schematics, wiring diagrams.
- Master air filter list including equipment identification, filter size, filter quantity, and supplier contact information.
- Start up reports, service records and test reports.

2.2.2 Shop drawings for the Temperature Control Systems shall include detailed, scaled plans and schematic diagrams indicating the function and operation of the system. Refer to Specification Section – CONTROLS for additional requirements.

2.2.3 Shop drawings for the Building Fire Protection System shall be prepared and stamped by a Certified Contractor and shall meet the criteria of the authority having jurisdiction and submitted to the Engineer. After the Engineer's review, they shall be submitted by the Contractor to the proper state authorities along with the required agency review fee. Refer to Specification Section – FIRE PROTECTION for additional requirements.

2.2.4 The Contractor shall submit shop drawings for the kitchen range hood system(s) along with all required supporting documentation agency and review fees to the authority having jurisdiction and receive approval prior to submittal to the Engineer. Refer to Specification Section – HVAC EQUIPMENT and Specification Section SHEETMETAL for additional requirements.

2.2.5 The Contractor shall submit project specific UL listed firestopping installation drawings to the authority having jurisdiction where required for their approval as required.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 200400 - DEMOLITION AND SALVAGE

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

2.1 It is the intent of this Section to completely remove all components of any existing mechanical system indicated in the mechanical drawings and items associated with the required architectural demolition specified in the Contract Documents. Also, any mechanical systems that will be open to view, or will interfere with the operations of the completed building, or which will, in any way, interfere with project construction shall be removed. The Contractor shall field verify existing conditions prior to bid.

PART 2 – PLUMBING DEMOLITION:

2.1 The general scope of the plumbing system demolition is indicated on the drawings. Where plumbing fixtures, equipment, etc. are removed, also remove all associated branch piping, hangers, insulation, concrete pads, controls, etc. Where plumbing fixtures are removed, all piping and services shall be removed in accordance with the current Building Code.

2.2 Refer to the demolition drawings for piping which shall be demolished or shall remain. If other piping is found during construction which is not indicated on the drawings, the fixtures the piping serves must be identified. If it serves fixtures which are being demolished, the piping shall be removed back to the nearest mains and capped. Verify this work with the Engineer prior to demolition.

2.3 The Contractor shall be responsible for the removal and/or relocation of any plumbing equipment, concrete pads, piping, drain lines, vent lines, valves, fittings, etc., which may in the course of construction, interfere with the installation of any new and/or relocated Architectural, Mechanical or Electrical Systems specified in the Contract Documents. This work shall be performed at no increase in the contract price.

2.4 Unless otherwise indicated, the Contractor shall be responsible for patching and repairing all holes, etc. in the ceilings, walls, roof and floors where plumbing equipment is removed by qualified tradesmen.

2.5 All underslab sanitary pipes abandoned in place shall be made safe in compliance with the Plumbing Code. No other piping is allowed to be abandoned.

2.6 All plumbing equipment not indicated to be reused shall be removed.

PART 3 – HVAC DEMOLITION:

3.1 The general scope of the HVAC system demolition is indicated on the drawings. Where HVAC units are removed, also remove all associated ductwork, branch piping, hangers, insulation, concrete pads, controls, etc.

3.2 Refer to the demolition drawings for equipment piping and ductwork to be demolished or which shall remain. If other equipment, piping or ductwork is found during construction which is not indicated on the drawings, it must be determined if these systems serve other areas not being

renovated. If the equipment piping and ductwork serve only renovated areas, the system shall be demolished. Verify this work with the Engineer prior to demolition.

3.3 Remove all temperature controls, panels, accessories, etc. that are accessible or become accessible during construction that serves demolished systems. Cap airtight any pneumatic control tubing at nearest main.

3.4 The Contractor shall be responsible for the removal and/or relocation of any HVAC piping, equipment, fittings, valves, etc. which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Structural, Mechanical or Electrical Systems specified in the Contract Documents at no increase in the contract price.

3.5 Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall, roof and floors where HVAC equipment is removed by qualified tradesmen.

3.6 Where piping and ductwork systems are partially demolished, cap systems air and water tight and insulate. All capping of duct systems shall be done with 22 gauge sheet metal and insulated. Seal with duct sealant.

PART 4 – SALVAGE:

4.1 It is the intent of this section to deliver to the Owner all components which may be economically reused by them. The Contractor shall make every effort to remove reusable components without damage.

4.2 Components to be delivered to the Owner shall be specifically identified by the Owner's representative prior to beginning the demolition. The Contractor shall prepare a letter of transmittal of all salvaged items and obtain the Owner's signature and date of receipt.

4.3 Other items become the property of the Contractor and are to be removed from the site and disposed of properly.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 201100 - SLEEVING, CUTTING, PATCHING, REPAIRING AND FIRESTOPPING

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS – MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Contractor shall be responsible for all openings, sleeves, trenches, etc., that may be required in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the General Contractor, any openings which they are to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the Contractor.

1.3 The Contractor shall plan their work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to route through; however, when this is not coordinated, the Contractor shall then do all cutting and patching required for the installation of their work, or pay other trades for doing this work when so directed by the Engineer. Any damage caused to the building by this Contractor shall be corrected or rectified at their expense.

1.4 The Contractor shall notify other trades in due time where they will require openings or chases in new concrete, masonry, etc. Set all concrete inserts and sleeves for their work. Failing to coordinate, Contractor shall cut openings for the work and patch same as required at their expense with qualified tradesman.

1.5 The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly corrected to the satisfaction of the Engineer.

1.6 All work improperly performed or not performed as required in this section, shall be corrected by the General Contractor at the responsible Contractor’s expense.

PART 2 – SLEEVES:

2.1 Cast iron or Schedule 40 steel sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking between pipe and sleeve for water proofing. Horizontal sleeves passing through exterior walls or where there is a possibility of water leakage and damage shall be caulked watertight. Utilize “Link-Seal” at these locations.

2.2 In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter plus insulation. Sleeves through walls and floors shall be cut off flush with inside surface unless otherwise indicated.

2.3 Vertical sleeves in roofs shall be flashed and counterflashed with lead (4 lb.) or 16 oz. copper and welded or soldered to piping, lapped over sleeve and properly weather sealed. Where sleeves pass through roof construction, sleeves shall extend minimum of 12" above the roof.

PART 3 – CUTTING:

3.1 All openings in plaster, gypsum board or similar materials, shall be framed by means of plaster frames, casing beads, or angle members as required. The intent of this requirement is to provide smooth, even termination of wall, floor and ceiling finishes as well as to provide a fastening means for devices, etc.

3.2 The Mechanical Contractor shall coordinate all openings in masonry walls with the General Contractor; and, unless otherwise indicated in the Contract Documents, shall provide lintels for all openings required for the mechanical work such as louvers, exhaust fans, etc. Prime paint all lintels. Lintels shall be sized as follows:

3.2.1 New Openings under 48" in width: Provide one 3½"x3½"x3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on each end.

3.2.2 New Openings over 48" in width: Consult with Structural Engineer.

3.3 No cutting shall be performed at location that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

3.4 Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe-cut with a masonry saw.

PART 4 – PATCHING, REPAIRING AND FINISHING:

4.1 Patching and repairing made necessary by work performed under this Division shall be included as a part of the work and shall be done by skilled workers of the trade. The work shall be performed in strict accordance with the provisions herein before specified to match adjacent surfaces and in a manner acceptable to the Engineer.

4.2 Where portions of existing sites, lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced back to original or better condition to the satisfaction of the Engineer.

4.3 Piping and ductwork passing through floors, ceilings and walls in finished areas shall be fitted with chrome plated brass escutcheon trim pieces of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe/duct around which it is installed.

4.4 Flanged metal collars shall be provided around all ducts, flues, pipes, etc. at all wall penetrations; both sides. Penetrations through any wall will require the installation of flanged collars. Openings shall not be any larger than 2” in any direction than the piping/duct passing through the wall. Openings larger than this requirement shall also be infilled to match adjacent construction. Fill void with insulation for sound reduction.

PART 5 – FIRESTOPPING:

5.1 The Contractor shall submit project specific UL listed firestopping installation drawings to the local NKAPC building inspectors for their approval as required.

5.2 All mechanical pipes and ducts penetrating fire rated floors and walls shall be firestopped by this Contractor. All firestopping products and assemblies installed shall be UL listed.

5.3 Where the installation of conduit, ducts, piping, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with

an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

5.4 Where the installation of ductwork requires the penetration of non-rated floors, the space around the duct or pipe shall be tightly filled with an approved non-combustible material.

5.5 The manufacturer of the firestopping materials shall provide on site training for the installing Contractor. The training session shall demonstrate to the Contractor the proper installation techniques for all the firestopping materials.

5.6 Firestopping materials include (but are not limited to) wraps, strips, caulks, moldable putties, restricting collars with steel hose clamps, damming materials, composite sheets, fire dam caulks, steel sleeves, etc.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 201200 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Contractor shall include all excavating, filling, grading, and related items required to complete their work as shown on the drawings and specified herein or as required to complete, connect and place all mechanical systems in satisfactory operation.

PART 2 – EARTHWORK CLASSIFICATION:

2.1 Without regard to the materials encountered, all excavation and materials excavated shall be unclassified. Materials to be excavated shall include earth, rock, concrete or any other obstructions encountered in excavation and/or trenching to install underground utility pipes, tanks, vaults or other equipment.

2.2 Include all costs for rock removal, including mass rock and trench rock in the bids. No adjustment in the contract sum will be made on account of the presence or absence of rock, shale, debris, obstructions or other materials encountered in the excavating. The Contractor shall be responsible for the removal of all materials encountered as required for the installation of the work.

2.3 It shall be distinctly understood that references to rock, earth, topsoil or any other excavated or non-excavated material or other material on the construction plans, cross section, contract documents, technical specification or provisions, whether in numbers, words, letters, lines or graphically shown, is solely for information for the Engineer and Owner. This information shall not be taken as an indication of the classification of the material to be excavated, bored or removed by any method, including drilling and blasting, or materials not removed. This information shall not be taken as to the quantity of either rock, earth, topsoil, or any other material involved, or the quality of the material such as hardness, wetness, workability or suitability of the material either during excavation and construction or as a material to be reused during construction.

2.4 The Contractor shall draw their own conclusions as to the surface and sub-surface conditions to be encountered during construction of this project. The Engineer and Owner do not give any guarantee or warranty as to the accuracy of the data shown and no claim will be considered for additional compensation when the materials encountered are not in accord with the information shown.

2.5 Refer to Specification Division EARTHWORK located in the Site Work portions of the Specifications and Civil Drawings for additional information. Also refer to the GEOTECHNICAL report included in the Front End of the Specifications.

PART 3 – EXCAVATION:

3.1 Unless otherwise shown or required, provide separate trenches for sewers, water lines and other underground raceways, with a minimum of 10 feet measured from outside diameter between pipes. In locations, such as close to buildings where separate trenches for sewers and water

lines are impractical, lay the water pipe on a solid shelf at least 2'-0" above the top of the sewer and 2'-0" to the side.

3.2 Water lines crossing under sewer lines, or crossing less than 2 feet above sewer lines, must be concrete encased for a distance not less than 5 feet on either side of the point of crossover.

3.3 Excavate trenches of sufficient width for proper installation of the work. Excavate to 6" below the bottom of new pipes for installation of compacted fill.

3.4 Sheet and brace trenches as necessary to protect workers and adjacent structures. Comply with local regulations or, in the absence thereof, with the latest version of "Manual of Accident Prevention in Construction" by the Associated General Contractors of America and current OSHA Standards. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and/or equipment and prevent injurious caving. Where removal of sheeting and/or bracing is hazardous, leave in place. Cut off such sheeting not to be removed at least 3 feet below finished grade.

3.5 Rules and regulations governing the respective utilities shall be observed in executing all work under this Division. Active utilities discovered in the course of excavation shall be protected or relocated in accordance with written instructions from the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed and abandoned with ends plugged or capped in accord with current codes and safe practice. If in doubt, contact Engineer.

3.6 Machine excavation shall not be allowed within ten (10) feet of electric lines, natural gas lines or other lines carrying combustible materials. Use only hand tools.

3.7 The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted. Any damage to existing structures, exterior services, or rock intended for bearing, shall be corrected at the responsible Contractor's expense.

3.8 Perform final grading of trench bottoms by hand tools; carry machine excavation only to such depth that soil bearing for pipes and raceways will not be disturbed. Grade the bottom of trenches evenly to insure uniform bearing for all piping and raceways. Cut bell holes as necessary for joints and jointmaking. Except as hereinafter specified, bottom of trenches for bell and spigot pipe, flanged pipe, etc. shall be shaped to the lower quadrant of pipe with additional excavation for bell or flange. Piping installed where it rests on bell or flange and/or is supported with blocks or wedges will not be accepted.

3.9 Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtenances in water. Pump or bail water from bell holes to permit proper joining of pipe. Any dewatering from this Contractor's trenches which is required during construction, shall be included in this Contract.

3.10 In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, utility lines, landscaping to remain, etc. The Contractor shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage or any other damage incurred in the course of excavation shall be at the responsible Contractor's expense.

3.11 Use surveyor's level to establish elevations and grades.

3.12 Machine excavation shall be held a sufficient distance from foundations and footings to insure no damage to same. Contractor shall accept full responsibility and pay for repairs and/or replacement of structural members, footings, etc.

3.13 The Contractor shall accept the site as it is and remove all trash, rubbish and material from the site prior to starting excavation work.

3.14 The Contractor shall provide and maintain barricades and temporary bridges around excavations as required for safety. Temporary bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these bridges in a safe and passable condition for all traffic until removal. Refer to OSHA Standards for such installations and comply with same in all details.

3.15 Pay particular attention to existing utilities and lines to avoid damage. The locations of existing lines which are indicated on the plans were taken unconfirmed from drawings prepared for previous construction and locations are approximate only. Also, certain water, gas, electric, storm and sanitary sewer lines and other underground appurtenances, active or abandoned, may not appear on the drawings. It shall be each Contractor's responsibility to ascertain the location of all lines and excavate with caution in their area.

3.16 Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor’s expense.

3.17 Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.

PART 4 – BACKFILL, COMPACTION AND SURFACE REPAIR:

4.1 Backfilling for Mechanical Work shall include all trenches, manhole pits, tanks and/or any other earth and/or rock openings which are excavated under this Contract. Backfilling shall be carefully performed and the surface restored to its original level to receive new finish. Wherever trenches and earth openings have not been properly filled and/or settlement occurs, they shall be re-excavated, re-filled and properly compacted, smoothed off and finally made to conform to the level of the original ground surface.

4.2 All trenches shall be backfilled with 6" of manufactured sand or #8 crushed stone after finished excavation. Install the new pipe on the compacted fill material. Install tracer wire on pipe. Apply any special coatings to the pipe. Also perform all required pressure tests and check the grade of the pipe to ensure that it is correct and free of swags, bows or bends. Once coatings and testing are complete, backfill the pipe bed to 12" above the top of the pipe with specified compacted fill material. Backfill the remainder of the trench with earth (rock and debris free) tamped at 6" intervals. Water settling of backfill is permitted only as an aid to mechanical compacting.

4.3 Backfill and compact beneath areas to be seeded or sodded within six (6) inches of finished grade. The remaining six (6) inches shall be backfilled with clean top soil.

4.4 Backfill and compact beneath concrete slabs, paved areas, walks, etc. shall be brought to proper grade to receive the sub-base and paving. No concrete or paving shall be placed on uncompacted fill or unstable soil.

4.5 Wherever, in the opinion of the Engineer, the soil at or below the requisite pipe grade is unsuitable for supporting piping, special support shall be provided as directed by the Engineer.

4.6 Backfill and compaction for natural gas lines shall be in strict accordance with the local utility company or local municipality’s requirements. If in doubt, contact the utility company or local municipality.

4.7 Unsuitable material and surplus excavated material not required for backfill shall be removed from the site. The location of dump and length of haul shall be the affected Contractor's responsibility.

4.8 Provide and place any additional fill material from off the site as may be required for backfill. Fill obtained from off site shall be of kind and quality as specified for backfill and the source approved by the Engineer and shall be brought to the site by the Contractor requiring the fill.

4.9 If not specified or indicated elsewhere in the Contract Documents to be performed by Others, the Contractor shall lay new sod over their excavation work for existing disturbed grassy areas. Level, with adjacent surface, compact and water in accord with sound sodding practice.

4.10 Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated as follows.

4.11 At a minimum, fill in grass areas shall be compacted to 90% Standard Proctor Density, ASTM D-698, at moisture content between 2 percent below to a 3 percent above the optimum moisture content or as specified in Specification Division EARTHWORK; whichever is most stringent.

4.12 At a minimum, fill in concrete or asphalt area shall compacted to 98% Standard Proctor Density, ASTM D-698, at moisture content between 2 percent below to a 3 percent above the optimum moisture content or as specified in Specification Division EARTHWORK; whichever is most stringent.

4.13 Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

4.14 All materials used for backfill around structures shall be of a quality acceptable to the Engineer and shall be free from large or frozen lumps, large rocks, wood, and other extraneous material. All spaces excavated and not occupied by footings, foundations, walls or other permanent work shall be refilled with earth up to the surface of the surrounding ground, unless otherwise specified, with sufficient allowance for settlement.

4.15 In making the fills and terraces around the structures, the fill shall be placed in layers not exceeding 8 inches in depth and shall be kept smooth as the work progresses. Each layer of the fill shall be compacted. Sections of the fill immediately adjacent to buildings or structures shall be thoroughly compacted by means of mechanical tamping or hand tamping as may be required by the conditions encountered. All fills shall be placed so as to load structure symmetrically.

4.16 Rough grading shall be held below finished grade and then the topsoil which has been stockpiled shall be evenly spread over the surface. The grading shall be brought to the levels as specified. Final dressing shall be accomplished by hand work or machine work, or a combination of these methods as may be necessary to produce a uniform and smooth finish to all parts of the regrade. The surface shall be free from clods greater than one inch in diameter. Excavated rock (1” and smaller) may be placed in the fills, but is shall be thoroughly covered. Rock placed in fills shall not be closer than 24 inches from finished grade. Refer to Specification Division EARTHWORK.

4.17 Maintenance Settling: Where settling is measurable or observable at excavated areas during Project Warranty Period, remove surface (pavement, concrete or any other surface or finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration.

4.18 Disposal of Excess Non-organic Soil and Rock: Any excess excavated waste material shall become the property of the Contractor and shall be disposed of by the Contractor off site at no additional cost to the Owner.

4.19 Unless otherwise directed by the Owner during construction, excess topsoil and subsoil suitable for fill shall be disposed of by the Contractor off site at no additional cost to the Owner.

PART 5 – MINIMUM DEPTHS OF BURY TO TOP OF PIPE:

5.1 In the absence of other indication, the following shall be the minimum depth of bury to top of pipe of exterior utility lines. Check drawings for variations.

5.1.1 Fire and Domestic Water Lines 36 inches.

5.1.2 Geothermal Piping 36 inches.

END OF SECTION.

DIVISION 20 – MECHANICAL

SECTION 201300 - PIPE, PIPE FITTINGS AND PIPE SUPPORT

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 Each Contractor's attention is also directed to Specification Section HANGERS, CLAMPS, ATTACHMENTS, ETC.

1.3 Unless otherwise indicated, all materials shall be new and of the best grade and quality for the type specified. Materials shall comply with the “Buy American Act”.

1.4 Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineer prior to submission of the bid.

1.5 All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.

1.6 The piping indicated shall be installed complete and shall be of the size indicated. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineer. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project.

1.7 All piping shall be installed straight and true, parallel or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.

1.8 All pipes shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. Spacing of pipe supports shall not exceed eight (8) foot intervals for pipes 3” and smaller and ten (10) foot intervals on all other piping. Small vertical pipes (1” and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants.

1.9 Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation. Refer to Specification Section INSULATION - MECHANICAL.

1.10 The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted.

1.11 In metal buildings or buildings with light gauge trusses, support piping with standard pipe hangers with C-clamp connection to main structural members (not perlins), use angle steel cross pieces between main structural members where required to provide rigid support.

1.12 Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.)

or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation. This includes temporary support required during Construction.

1.13 In general, piping shall be installed concealed except in mechanical rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur they shall be kept as close to walls as possible.

1.14 Pipe shall be cut accurately to measurements established at the building by the Contractor and worked into place without springing or forcing. All pipes shall be reamed to full pipe diameter before joining and before assembling. All lengths of pipe shall be set vertically and tapped with a hammer to remove scale and dust and inspected to ensure that no foreign matter is lodged therein.

1.15 All hot and cold water piping shall be kept a sufficient distance apart so as to prevent heat transfer between them. Cold water piping shall also be kept apart from refrigerant hot gas lines.

1.16 Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing. If in doubt, consult Engineer.

1.17 Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If in doubt, consult Engineer.

1.18 Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case shall be accomplished without use of insulating unions and permission of the Engineers.

1.19 Dielectric couplings or through ways shall be provided at all connections of dissimilar materials.

1.20 Nipples shall be of the same material, composition and weight classification as pipe with which installed.

1.21 Apply approved pipe dope for service intended to all male threaded joints. The dope shall be listed for intended use.

1.22 Eccentric reducers shall be used where required to permit proper drainage and venting of pipe lines; bushings shall not be permitted.

1.23 High points of closed loop hydronic systems shall have manual air vents as required unless automatic air vents are specifically indicated. Pipe to suitable drainage point.

1.24 Installation of pipe shall be in such a manner as to provide complete drainage of the system, whether detailed or not on plans. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be ½" size ball valves with 3/4" hose thread end and vacuum breaker. Label each drain valve.

1.25 Where plastic piping penetrates a fire rated assembly, it shall be replaced with a threaded metal adapter and metal pipe or whatever means necessary to maintain the separation rating in accordance with local plumbing and fire codes.

1.26 Plastic piping or any material with a flame and smoke spread rating not approved for plenum use shall not be permitted in supply, return, relief or exhaust plenums.

1.27 All increases in vent size at roof shall be by means of service weight cast iron increasers.

1.28 Non-metallic piping shall be installed in strict accordance with the manufacturer's instructions. If no such instructions are available, consult Engineer.

1.29 When running any type of pipe below a footing, perpendicular to the footing, the area underneath the footing and in the zone of influence shall be backfilled with concrete. The zone of influence is the area within a 45 degree angle projecting down from the top edge of footing on all sides of the footing.

1.30 When running any type of pipe below a footing, parallel to the footing, the area underneath the zone of influence shall be backfilled with 4" of crushed stone or sand bedding under the pipe. Each pipe section shall be anchored into unexcavated earth on both ends with deadman anchor system. The remainder of the trench in the zone of influence shall be backfilled with cementitious flowable fill. The zone of influence is the area within a 45 degree angle projecting down from the top edge of the footing on all sides of the footing.

1.31 Piping for all drainage systems shall be installed to permit flow, trapping, and venting in accord with current codes and best practice.

1.32 Install all gas piping per NFPA54. Union or valves shall not be installed in an air plenum. Piping below slab must be sleeved and vented. Piping installed in contained non-vented areas shall not have mechanical joints.

1.33 The entire domestic hot, cold and recirculating hot water piping system shall be sterilized in strict accord with requirements of the Department of Health Codes, Rules and Regulations for the State in which the work is being accomplished.

1.34 Site water piping utilized for domestic service shall be filled, cleaned and disinfected. Disinfection shall utilize chlorine per the local water company standards or approved equal. Hyper-chlorinated water shall be discharged and diluted at the end of the pipeline into the sanitary sewers per local utility regulations.

1.35 The entire sanitary waste and vent piping system within the building shall be air-tight. If any sewer gases are present within the building, it shall be the Contractor's responsibility to locate and correct any leaks and retest as required. Any sewer odor issues that occur during the Warranty Period shall be corrected by the Contractor.

1.36 Refrigerant piping must be installed to meet the HVAC equipment manufacturer's requirements. A refrigerant piping schematic shall be obtained from the equipment manufacturer which indicates pipe sizes, valves, traps, sight glasses and other required refrigerant specialties. While installing or soldering refrigerant lines, the piping system must be continuously purged with nitrogen. After the piping system is installed, the refrigerant system must be evacuated to 25 microns for eight hours. Contact Engineer 36 hours prior to installation of refrigerant lines or evacuation of refrigerant system.

1.37 When connecting to an existing hydronic water system (chilled, hot, geothermal, etc.) or domestic water system, the Contractor shall include cost to drain the existing piping system and refill with water/closed loop chemicals to match existing fluid. If the building is occupied, and the drain down will affect services to these occupied areas, then the systems shall be drained and refilled over a weekend at a time acceptable to the Owner. Refer to Specification Section PIPE FILLING, CLEANING, FLUSHING, PURGING AND CHEMICAL TREATMENT.

PART 2 – UNIONS, FLANGES AND WELDED TEES:

2.1 Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves and piping accessories from the piping system. Keep adequate clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.

2.2 Dielectric insulating couplings or though ways shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.

2.3 Tee connections for welded pipe shall be assembled with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller. Weld-o-let and thread-o-let branch connections are acceptable.

PART 3 – SPECIFICATIONS STANDARDS:

3.1 All piping and material shall be new, comply with the “Buy American Act” and shall conform to the following minimum applicable standards:

- Steel pipe; Schedule 40; ASTM A-53.
- Copper tube; Type K, L, M; ASTM B88-62; Type DWV ASTM B306-62.
- Cast iron soil pipe; ASA A-40.l and CS 188-59.
- Cast iron drainage fittings; ASA B16.12.
- Cast iron screwed fittings; ASA B16.4.
- Welding fittings; ASA B16.9.
- Cast brass and wrought copper fittings; ASA B16.18.
- Cast brass drainage fittings; ASA B16.23.
- PVC pipe; Schedule 40; ASTM D-1785.
- PVC pipe; Schedule 40; ASTM D2665 and D1784. Piping must be installed in compliance to the manufacturer’s recommendations which shall be made available to the plumbing inspector.

PART 4 – PIPE TESTING AND CLEANING:

4.1 Piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.

4.2 Water piping systems shall be subjected to a hydrostatic test of 150 psi. The system shall be proven tight after a twenty-four (24) hour test.

4.3 The house drain line, interior storm sewers, interior rain water conductors, and all soil, waste and vent piping shall be subjected to a hydrostatic test of not less than a 10-foot head or an air test of not less than 5 psi and shall hold for 15 minutes.

4.4 Exterior sewer lines to the termination point outside the building shall be subject to a ten-foot hydrostatic test or an approved smoke test. These lines shall be subjected to a second test after 2 feet of backfill has been properly installed.

4.5 After fixtures have been installed, the entire plumbing system, exclusive of the house sewer, shall be subjected to an air pressure test equivalent to one inch water column and proven tight. The Contractor responsible shall furnish and install all of the test tees required, including those for isolating any portion of the system for tests.

4.6 The Contractor shall perform all additional tests that may be required by the Department of Health or other governing agency.

4.7 Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.

4.8 The natural gas service shall be tested in accordance with requirements and/or recommendations of the local gas company.

4.9 Natural gas piping downstream of the meter assembly shall be tested per the local gas company requirements or the following (whichever is stricter):

- Low Pressure (up to 14" wc) – Test to 10 psi for 24 hours.
- Elevated Pressure (up to 2 psi) – Test to 50 psi for 24 hours.
- Medium pressure (up to 60 psi) – Test to 100 psi for 24 hours.

4.10 Contractor shall notify TAB Agency in writing that the domestic water system has been flushed, cleaned and ready for sterilization or sanitizing. No chemicals are to be added to this system until all balancing has been completed for risk of contamination. The TAB firm is to properly notify all parties in writing when they have completed this portion of testing. If not properly coordinated, then the system will require additional sterilization and sanitizing at the Contractor's expense. Refer to TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS Specification Section.

PART 5 - PITCH OF PIPING:

5.1 All piping systems shall be installed so as to drain to a low point. Certain minimum pitches shall be required for this drainage. For proper flow and/or for proper operation, the following pitches shall be required:

5.2 Interior Soil, Waste and Vent Piping: ¼ inch per foot in direction of flow where possible but in no case less than 1/8" per foot.

5.3 Exterior Sanitary Lines: Not less than one (1) percent fall in direction of flow and no greater than indicated.

5.4 Roof Leaders: 1/8 inch per foot where possible. Where not possible, run dead level.

5.5 Condensate Drain Lines From Cooling Equipment: Not less than ¼ inch per foot in direction of flow.

5.6 All Other Lines: Provide ample pitch to a low point to allow 100 percent drainage of the system.

PART 6 – APPLICATIONS:

6.1 Soil, Waste and Vent Piping (Below Slab)

6.1.1 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Kentucky Plumbing Code.

6.2 Soil, Waste and Vent Piping (Above Slab)

6.2.1 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Kentucky Plumbing code.

6.3 Domestic Hot, Cold and Recirculating Water Piping (Above Slab)

6.3.1 Type "L" hard copper tubing with wrought copper fittings with lead free solder equivalent in performance to 95/5. (Maximum lead content of solder and flux is 2%).

6.3.2 "Pex" Domestic Water Piping:

6.3.2.1 "Pex" piping may be utilized for pipe runouts to individual plumbing fixtures. "Pex" may not be utilized for piping serving multiple fixtures.

6.3.2.2 Manufactured by Zurn PEX, Inc. and conforms to ASTM F877 cross-linked polyethylene (PEX) tubing hot and cold water distribution systems, ASTM F876 cross-linked polyethylene (PEX) tube, ASTM F1807 fittings and ASTM F2159 fittings. Comply with manufacture's product data, including product technical bulletins, technical memo's, installation instructions and design drawings, including; Zurn PEX Plumbing Installation Guide. Store PEX tubing indoors, in cartons or under cover to avoid dirt or foreign material from entering the tubing. Do not expose PEX tubing to direct sunlight for more than six months. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

6.3.2.3 Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity and possesses the skills and knowledge to install a PEX potable water distribution system. Installer will utilize skilled workers holding a trade qualification license or equivalent or apprentices under the supervision of a licensed tradesperson.

6.3.2.4 Tubing: Cross-linked polyethylene (PEX) manufactured by the Silane method. Non-barrier type shall have a pressure and temperature rating of 160 PSI at 73°F, 100 PSI at 180°F and 80 PSI at 200°F.

6.3.2.5 Fittings: Fittings shall be manufactured by Zurn PEX Inc, identified by the letters "Q" or "Z". Manufactured in accordance with ASTM F1807 or ASTM F2159 and/or comply with ASTM F877 system standard as identified on the fitting.

6.3.2.6 Crimp Systems: Qickclamp: Listed to ASTM F877, identified as a Zurn PEX Inc, Qickclamp by the "Qickclamp" and "Q" marking. Copper Crimp Ring: Listed to ASTM F1807 and/or ASTM F877, black in color and identified as a Zurn PEX Inc, ring by the letter "Q".

6.3.2.7 Tools: Qickclamp tools shall be supplied by the PEX tubing manufacturer, identified by the name "Zurn" on the tool. Copper Crimp Ring tools shall be supplied by the PEX tubing manufacturer or approved by the PEX tubing manufacturer for use.

6.3.2.8 Valves Shall be of the plastic or metal type, meeting the requirements of ASTM F877, identified as such with the appropriate mark on the product

6.4 DOMESTIC COLD, HOT AND RECIRCULATING HOT WATER PIPING (BELOW SLAB): Type "K" hard or soft copper tubing with wrought copper fittings and brazed joints. There shall be no joints beneath slabs.

6.5 Geothermal Piping

6.5.1 Polyethylene pipe manufactured by Driscoplex "5300 Climate Guard" or Vanguard Polyethylene "Geo-Black". Piping shall be listed for closed-loop ground source geothermal application.

6.5.2 The pipe and fittings of the system shall be warranted by the manufacturer for ground source heat pump service.

6.5.3 Specifications for the polyethylene pipe and fittings:

6.5.3.1 All pipe and heat fused materials shall be manufactured from a virgin polyethylene extrusion compound material in accordance with ASTM D-2513, Sections 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness, and respective tolerances as specified in ASTM D-3035 or D-2447. Fittings shall be manufactured to diameters, wall thicknesses, and respective tolerances as specified in ASTM D-2683 for socket fittings and ASTM F-1055 for electrofusion fittings.

6.5.4 The material shall maintain a 1600 psi hydrostatic design basis at 73.4 degrees F per ASTM D-2837, and shall be listed in PPI TR4 as a PE3408 piping formulation. The material shall be high density, polyethylene extrusion compound having a cell classification of PE345434C or PE355434C as specified in ASTM D-3350 with the following exception: this material shall exhibit zero failures (F0) when tested for 192 or more hours under ASTM D-1693, condition C, as required in ASTM D-3350.

5.4.5 Dimensions

5.4.5.1 Pipe with a diameter of ¾", 1" and 1¼" (nominal sizes) shall be manufactured in accordance with ASTM D-3035 with a dimension ratio of 11.

5.4.5.2 Pipe with diameter of 1½" and 2" (nominal sizes) shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 15.5 (or Schedule 40).

5.4.5.3 Pipe 3" (nominal) and larger shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 17.

5.4.6 Runouts to Heat Pumps 2" and Smaller: Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

5.4.7 Runouts to Heat Pumps 2½" and Larger: Type "L" hard copper piping with wrought copper fittings and 95/5 solder may be installed.

5.4.8 Warranty

5.4.8.1 Manufacturer shall supply a written warranty of 25 years or greater, specifying material replacement and labor allowance.

5.4.9 Certification

5.4.9.1 Manufacturer shall supply a notarized document confirming compliance with the above standards.

5.4.10 Pipe Joining Methods:

5.4.10.1 The only acceptable method for joining buried pipe systems is by a heat fusion process.

6.5.5 When PVC pipe is connected to steel or copper piping, a brass threaded male/female connection shall be used to transition materials. Provide appropriate dielectric union to a black steel pipe where applicable. This shall be a manufactured fitting. No metal threads shall be inserted into PVC piping or PVC threads into metal piping.

6.6 Air Vent Discharge Lines

6.6.1 Type "L" soft copper; wrought copper fittings, 95/5 solder.

6.7 Condensate Drain Lines

6.7.1 Type "M" copper tubing with sweat fittings and 95/5 solder.

6.8 Water Heater Relief Line

6.8.1 Type "M" copper tubing with sweat fittings and 95/5 solder.

6.9 Dual Temperature Hot/Chilled Water Heating Piping

6.9.1 2" and Smaller: Schedule 40 black steel pipe with screwed fittings or Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

6.9.2 2½" and Larger: Schedule 40 black steel pipe with 125# welded or flanged joints. Weldolets may be used for branch line connections to pipe mains. Type "L" hard copper piping with wrought copper fittings and 95/5 solder may be installed.

6.9.3 Schedule 40 black steel mechanical grooved pipe couplings and fittings with 125# rating manufactured by Victaulic or equal. Install gaskets as recommended by the manufacturer. Piping system shall be rated for minimum of 220 degrees F water temperature. Mechanical grooved piping may not be used if system water temperature exceeds 220ºF.

PART 7 – EXTERIOR APPLICATIONS (SITE WORK):

7.1 SITE SANITARY SEWER:

7.1.1 Sanitary pipe shall be schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Plumbing Code.

7.2 SITE STORM SEWER:

7.2.1 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Plumbing Code.

7.3 SITE DOMESTIC WATER PIPING (PIPE SIZE 4" AND GREATER):

7.3.1 The site water main piping shall be PVC and shall conform, as a minimum, to the latest revision of ASTM Specifications D-2241 “Standard Specifications for Poly Vinyl Chloride (PVC) Plastic Pipe (SDR-PR)”, and shall be pressure Class 200. The pipe furnished under ASTM A-2241 shall have a standard dimension ratio not to exceed SDR 21, and shall be rated to a working pressure of at least 200 psi at 73.4 degree F.

7.3.2 Joints shall be of the push-on type conforming to ASTM D3139 “Standard Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals” and ASTM F477 “Standard Specifications for Elastomeric Seals (Gaskets) for Joint Plastic Pipe” requirements for elastomeric-gasket joints. All jointing material and lubricants shall be non-toxic.

7.4 SITE DOMESTIC WATER PIPING (PIPE SIZE 3” AND LESS):

7.4.1 SDR 21 PVC pressure-rated conforming to ASTM D1784 and ASTM D2241 with a cell classification of 12454 (specific gravity – 1.4, tensile strength – 7,000 psi, tensile modulus – 400,000 psi, 1ZOD impact strength – 0.65 lb./in.), with integral bell to utilize gasketing system for sealing and meeting specification defined in ASTM F477. Pipe shall be rated for 200 psi and shall be NSF listed. Diamond Plastics Corporation Pressure Rated PVC Pipe or equal.

7.5 SITE FIRE PROTECTION: - Refer to the Specification Section – FIRE PROTECTION.

PART 8 – PLUMBING PIPING APPLICATIONS:

PVC is not permitted in KY if the vertical stack height is greater than 45 feet (page PC-60-2 Section 10.6). This is from the vent termination to the base of the gravity stack).

Cast iron piping must be used for waste water temperatures over 140º F. for at least 50' from the equipment from which it serves. (IE: dishwasher waste, floor drains adjacent to boilers, floor drains for sterilizer equipment, etc.)

Do not use PVC above slab where HVAC return air plenums are utilized.

8.1 SOIL, WASTE AND VENT PIPING (BELOW SLAB):

8.1.1 Kitchen and Mechanical Room pipe serving boiler and water heater drains shall be service weight cast iron hub and spigot piping with compression gasket joints for 50'-0"

8.1.2 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Plumbing Code (ASTM – D2665 & D1784). PVC pipe shall not be installed where waste water applications exceed 140 deg F.

8.1.3 Piping below slab shall be a minimum of 2" in size.

8.2 SOIL, WASTE AND VENT PIPING (ABOVE SLAB):

8.2.1 Type DWV copper drainage piping with cast bronze drainage pattern fittings with solder joints.

8.2.2 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Plumbing Code (ASTM – D2665 & D1784).

8.3 ROOF LEADERS AND STORM LINES (BELOW SLAB):

8.3.1 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Plumbing Code (ASTM – D2665 & D1784).

8.4 ROOF LEADERS AND STORM LINES (ABOVE SLAB):

8.4.1 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Plumbing Code (ASTM – D2665 & D1784).

8.5 DOMESTIC COLD, HOT AND RECIRCULATING HOT WATER PIPING (ABOVE SLAB):

8.5.1 Type "L" hard copper tubing with wrought copper fittings with lead free solder equivalent in performance to 95/5. (Maximum lead content of solder and flux is 2%).

8.6 DOMESTIC COLD, HOT AND RECIRCULATING HOT WATER PIPING (BELOW SLAB):

8.6.1 Type "K" hard or soft copper tubing with wrought copper fittings and brazed joints. There shall be no joints beneath slabs.

8.7 WATER HEATER RELIEF LINE:

8.7.1 Type "M" copper tubing with sweat fittings and 95/5 solder.

8.8 FIRE PROTECTION: - Refer to Specification Section – FIRE PROTECTION.

PART 9 – ABOVE CEILING PIPING RELOCATION

9.1 Include in this project, the relocation of the following piping systems:

- Offset (2), 3/4” domestic water pipes, with (4) elbows, insulated and 20 feet total length.
- Offset (6), 1” domestic water pipes, with (4) elbows, insulated and 20 feet total length.
- Offset (6), 1-1/2” domestic water pipes, with (4) elbows, insulated and 20 feet total length.
- Offset (6), 1” domestic water pipes, with (4) elbows, insulated and 20 feet total length.
- Offset (6), 1” domestic water pipes, with (4) elbows, insulated and 20 feet total length.
- Offset (2), 3” hydronic hot (condenser) water pipes, with (4) elbows, insulated and 20 feet total length.
- Offset (2), 4” hydronic hot (condenser) water pipes, with (4) elbows, insulated and 20 feet total length.
- Offset (2), 6” hydronic hot (condenser) water pipes, with (4) elbows, insulated and 20 feet total length.

9.2 During Construction, the Contract Sum shall be increased OR decreased based on Contract unit prices for each of the above.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 201305 - GEOTHERMAL LOOP PIPING SYSTEM, CLOSED LOOP GROUND HEAT EXCHANGER & HEAT TRANSFER FLUID

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

PART 2 - INSTALLATION PERSONNEL AND TRAINING REQUIREMENTS:

2.1 The loop installer/contractor shall have a current International Ground Source Heat Pump Association (IGSHPA) certification, having completed an IGSHPA training course in the fundamentals of design, installation, and operation of ground source systems, and having passed the IGSHPA certification examination.

2.2 Ground heat exchanger fabricators shall have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of a IGSHPA Certified Heat Fusion Technician. The Fusion Technician shall be thoroughly familiar with heat fusion procedures, and have had formal training at a heat fusion school under direct supervision of an IGSHPA certified instructor.

2.3 Local and state laws, ordinances, and regulations as they pertain to buried pipe systems shall be strictly followed.

PART 3 - GROUND HEAT EXCHANGER PIPING MATERIALS:

3.1 Acceptable pipe materials for the underground buried portion of the ground heat exchanger are polyethylene as specified in this section.

3.2 Piping shall be Driscoplex “5300 Climate Guard” or Vanguard Polyethylene “Geo-Black”. Piping shall be listed for closed-loop ground source geothermal application.

3.3 The pipe and fittings of the buried system shall be warranted by the manufacturer for ground source heat pump service.

3.4 Specifications for the polyethylene heat exchanger as follows:

3.4.1 All pipe and heat fused materials shall be manufactured from a virgin polyethylene extrusion compound material in accordance with ASTM D-2513, Sections 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness, and respective tolerances as specified in ASTM D-3035 or D-2447. Fittings shall be manufactured to diameters, wall thicknesses, and respective tolerances as specified in ASTM D-2683 for socket fittings and ASTM F-1055 for electrofusion fittings.

3.4.2 The material shall maintain a 1600 psi hydrostatic design basis at 73.4 degrees F per ASTM D-2837, and shall be listed in PPI TR4 as a PE3408 piping formulation. The material shall be high density, polyethylene extrusion compound having a cell classification of PE345434C or PE355434C as specified in ASTM D-3350 with the following exception: this material shall exhibit zero failures (F0) when tested for 192 or more hours under ASTM D-1693, condition C, as required in ASTM D-3350.

3.4.3 Dimensions

3.4.3.1 Pipe with a diameter of ¾", 1" and 1¼" (nominal sizes) shall be manufactured in accordance with ASTM D-3035 with a dimension ratio of 11.

3.4.3.2 Pipe with diameter of 1½" and 2" (nominal sizes) shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 15.5 (or Schedule 40).

3.4.3.3 Pipe 3" (nominal) and larger shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 17.

3.4.4 Markings

3.4.4.1 Sufficient information shall be permanently marked on the length of the pipe as defined by the appropriate ASTM pipe standard.

3.4.4.2 Piping shall also have permanent factory length markings.

3.4.5 Warranty

3.4.5.1 Manufacturer shall supply a written warranty of 25 years or greater, specifying material replacement and labor allowance.

3.4.6 Certification

3.4.6.1 Manufacturer shall supply a notarized document confirming compliance with the above standards.

PART 4 - PIPE JOINING METHODS:

4.1 The only acceptable method for joining buried pipe systems is by a heat fusion process.

4.2 Polyethylene pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures.

4.3 "U" bends fittings shall be used at bottom of the vertical bores. "U" bend fitting shall be manufactured by manufacturer of piping materials.

PART 5 - FLUSHING, PURGING, PRESSURE AND FLOW TESTING:

5.1 Successful flushing and purging is critical and shall be accomplished and documented. Notify Engineer prior to flushing and purging.

5.2 Coordinate this with the cleaning and flushing listed in Section 230200 - HVAC Equipment and 203100 – Test and Balance.

5.3 Vertical loops shall be pressure tested before installation, and all horizontal components of the ground heat exchanger will be flushed, pressure and flow tested prior to backfilling.

5.4 Heat exchangers shall be tested hydrostatically at 150% of the pipe design rating or 300% of the system operating pressure (whichever is greater).

5.5 No leaks shall occur within a 30 minute period.

5.6 All fusion joints and loop lengths shall be checked to verify that no leaks have occurred due to fusion joining or shipping damage.

5.7 Flow rates shall be compared to calculated values to assure that there is no blockage or kinking of any pipe. Submit written verification of compliance.

5.8 A minimum velocity of 2 ft/sec in each piping section must be maintained until all air is removed. The system shall also be forward and reversed to remove all debris. Purging of one wellfield row shall be witnessed by the Engineer, Owner, Mechanical Contractor, General Contractor and the Test and Balance Contractor. The Test and Balance Contractor shall confirm the minimum velocities are obtained during the purging process and shall also measure supply and return pressures. The Contractor shall provide P/T plugs as required by the Test and Balance Contractor. The Contractor shall provide all means and methods necessary to insure minimum velocities are obtained. After one test is confirmed, the other wellfield rows shall be tested utilizing the same procedure.

5.9 Final purging of air from the entire building and loop field shall be performed by the well field installer so that air in building piping will not be transferred to the well field.

PART 6 - HORIZONTAL PIPING SYSTEMS:

6.1 Sharp bending of pipe around trench corners shall be prevented by using a shovel to round corners, or by installing an appropriate elbow fitting. Manufacturer's procedures shall be followed.

6.2 Backfilling procedure will include prevention of any sharp-edged rocks from coming into contact with the pipe by removal of the rocks before backfilling, backfill with #9 rock. Provide a minimum of 6” cover over pipe with back filled material. Clods resulting from use of a backhoe must be broken up so as not to form air pockets around the pipe which will reduce heat conduction between the earth and the pipe. The flow of backfill soil must be controlled to prevent bridging and the formation of air pockets. Several slow passes with an angled backfill blade are required. Flooding is required to assure removal or air pockets. Backfill load bearing capacity shall meet the Architect's specification. Minimum burry depth of piping shall be 36” to top of pipe.

6.3 Horizontal return bends must be backfilled by hand to properly support the pipes and prevent kinking.

PART 7 - BORE HOLE AND GROUTING:

7.1 The Contractor shall bore wells of a sufficient diameter to allow installation of the piping and U-bend and a 1" (minimum) HDPE tremie pipe (for grout application), but shall be no less than 4-1/2".

7.2 Bore holes shall be grouted as recommended by IGSHPA to ensure good heat transfer. Local and state laws and regulations as to backfilling requirements shall be followed. See IGSHPA Grouting Procedures Manual for detailed grouting procedures.

7.3 Vertical bores shall be drilled to sufficient depths to ensure that the entire length of U-tube is inserted. This may require the bore to be drilled several feed deeper than the U-tube length.

7.4 All U-tube joints shall be visually inspected for integrity as specified by the pipe manufacturer (alignment of joints, proper bead roll-back) before insertion into the bore hole.

7.5 The bore hole annulus shall be completely grouted to ensure there are no air voids and to ensure there is consistent contact between the vertical piping and the bore hole formation. This will require the bore annulus to be filled with grout from the bottom to the top with a "tremie" tube.

7.6 The entire bore shall be grouted with a thermally enhanced grout mixture with a thermal conductivity of 1.00 Btu/hr-ft-°F. Grout shall be GeoPro Thermal Grout Lite 100 bentonite mixture or approved equal. Mixture shall be field mixed in strict accordance with manufacturer's recommendations. Grout mixture shall be mechanically pumped with a positive displacement pump into bore hole from bottom to top utilizing a tremie tube. Through the course of the project, three sample grout specimens shall be taken of the mixed grouting material by this contractor. An analysis shall be performed by the grout manufacturer to verify proper thermal performance and grout mixture. This contractor shall submit these reports to the Owner, Architect and Engineer to verify compliance with the installation specifications.

7.7 The Contractor shall accept the site as-is and is responsible for any and all required casings. If an area of voids is encountered, the Contractor shall either fill or re-drill wells in an approved area and extend piping to them.

7.8 No night drilling will be allowed.

PART 8 – GEOTHERMAL WELLFIELD DISTRIBUTION VAULT:

8.1 The vault shall pre-engineered and factory assembled and tested prior to shipping to jobsite. The vault shall be manufactured by Atlantis Vaults, ISLD Pipe or equal. Other

manufacturers/systems require written approval by Engineer 7 days prior to bid day via a substitution request. Concrete vaults are not allowed.

8.2 External Shell: Shall be constructed of high density polyethylene flat stock having a cell classification of 345444 with a UV stabilizer of C. All materials used shall have a minimum thickness of 1". Internal and external seams are heat welded using High Density Polyethylene welding rods having a cell classification of 345444C. All seams are nitrogen tested. Walls shall be 72" high (minimum), with a 30" manhole with ladder. The manhole lid is connected with 8-3/8" stainless steel counter sunk bolts. Lid to have 5000 pound traffic load bearing capacity.

8.3 Internal Bracing: Shall be spaced at a maximum of 30" and constructed of a minimum of 1" thick high density polyethylene flat stock heat welded to the external shell with high density polyethylene welding rods.

8.4 Internal Piping: Shall be as previously specified. The vault piping shall be constructed in an offset, over and under, model for supply and return lines. All joints shall be heat fused. The entire piping system shall be tested using 150 psi nitrogen. The main supply and return pipe shall be shipped with cap butt welded to pipe. All pipe penetrating the vault walls shall be DR 11 and shall be heat welded to the external shell.

8.5 Fittings:

8.5.1 P/T Plugs: Shall be constructed of solid brass and have a dual seal core of Nordel, with a 350°F rating for water. Plugs shall be rated zero leakage for vacuum to 1000 psig and shall be capable of receiving a pressure or temperature probe.

8.5.2 Butterfly Valve: Shall be constructed of a cast iron body, 416 stainless steel stem with a lever shut off system.

8.5.3 90° Elbows: Shall be molded out of high density polyethylene resins in accordance with the requirements of ASTM 3261.

8.5.4 Branch and Service Saddles: Shall be molded out of high density polyethylene resins in accordance with the requirements of ASTM 3261.

8.6 Installation: The vault shall be lowered into a pit 105" deep with a 6" bed of #57 gravel. Once the vault is in place, concrete is poured 36" deep and 12" thick around the vault to balance buoyancy pressure and allow for anchoring.

PART 9 – WARRANTY:

9.1 The entire ground loop system and backfill from a point 5' inside the building shall be warranted for five years from date of substantial completion against any leakage or failure.

PART 10 – SUBMITTALS:

10.1 Submit manufacturer's specification sheets and installation instruction for each component of the system, showing manufacturer, pipe or tube weight, pressure rating, fitting type and joint type for each piping system.

10.2 Submit manufacturer's data for geothermal vault and components**.**

10.3 Submit manufacturer’s data for the grout mixture. Submit details on grouting procedures, methods and equipment.

10.4 Submit a dimensioned drawing indicating the system layout and pipe sizes.

10.5 Provide a copy of the contractor’s certification as required in Part 2 of this specification.

10.6 Submit manufacturer’s data sheets to the Engineer for review and final volume of fluid required to obtain freeze point specified.

PART 11 - TEST BORES:

11.1 The Contractor may visit the site prior to bid and perform their own test boring if additional information is required. This shall be coordinated with the Owner.

END OF SECTION.

DIVISION 20 – MECHANICAL

SECTION 201310 – PIPE FILLING, CLEANING, FLUSHING, PURGING AND CHEMICAL TREATMENT

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 Review the Specification Section – REQUIRED SHOP DRAWINGS, ETC., and provide all documentations called for therein.

1.3 Through coordination with other Contractors, Vendors and Suppliers associated with this Project, this Contractor shall insure a complete, 100% functional, tested, inspected and approved systems. Claims for additional cost or change orders will immediately be rejected.

1.4 A pre-installation meeting shall be held with the Owner, Architect, Engineer, General Contractor, Mechanical Contractor, Pipe Fitter Foreman and Chemical Treatment Contractor to discuss goals and expectations for cleaning, flushing, purging and chemical treatment.

1.5 Chemicals, equipment, testing services, and chemical application shall be supplied by a single water treatment company for undivided responsibility. The water treatment company shall be a recognized specialist, active in the field of commercial/industrial water treatment for at least 5 years. The water treatment company shall have regional water analysis laboratories, service department, and full time representatives located within the trading area of the job site or facility.

1.6 Prior to any construction, the Contractor shall sample the existing closed loop chemicals for the existing chilled water system in the high school and the hot water and heap pump systems in the middle school and provide chemical treatment water quality analysis. Provide levels for all items noted in paragraph “Water Quality Minimum Performance Requirements for Closed Loops”. Provide a report to the Engineer.

1.7 Furnish initial supply of the closed loop chemicals for each system including the existing chilled water system in the high school and the hot water and heap pump systems in the middle school. This contractor shall retest the systems after 3, 6, 9 and 12 months upon substantial completion to verify the proper dosage is in each system. Provide all closed loop chemicals for the first year. The Contractor shall determine the appropriate chemical volumes for each system. Each system’s water shall be tested for proper chemical parameters, clarity, and biological activity. If needed, provide chemical addition, including anti-freeze. Provide any laboratory and technical assistance required to achieve a successful program.

1.8 As a condition of acceptance and project closeout, a summary of water quality and treatment shall be provided in writing to the Owner and/or Engineer after the water treatment services have been completed. The closeout documentation shall include dates for warranty testing.

1.9 Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

1.10 Water Quality Minimum Performance Requirements for Closed Loops:

- Closed hydronic systems shall maintain a pH value within 9 – 10.5 pH for iron and copper piping loops.
- Total Anaerobic Plate Count - Maintain a maximum value of 100 organisms/ml.
- Nitrate Reducers (Denitrifying Bacteria) - Maintain below a maximum value of 10,000 organisms/ml.
- Sulfate Reducers - Maintain below a maximum value of 200 organisms/ml.
- Iron Bacteria - Maintain below a maximum value of 100 organisms/ml.
- Slime Bacteria - Maintain below a maximum value of 1,000 organisms/ml.

PART 2 – CLEANING AND FLUSHING OF HYDRONIC PIPING:

2.1 This project consists of the following Hydronic Piping Loops:
- Heat Pump Water

2.2 There are several precautions which must be observed during its installation. This contractor is advised to read all of the manufacturer's instructions prior to commencing the installation. This cleaning and flushing of the systems must be accomplished.

2.3 All water circulating systems for the project shall be thoroughly cleaned before placing in operation to rid the system of dirt, piping compound, mill scale, oil and any and all other material foreign to the water. During construction, extreme care shall be exercised to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.

2.4 After the piping is complete:
(1) the Contractor shall first fill the piping loops and all runouts with clear water. The loop water shall be circulated for one hour with make-up water open and boiler drain open to accomplish initial flushing of the system.
(2) After initial flushing, the individual terminal devices and coils shall be connected permanently to the supply and return runouts conditions and then add trisodium phosphate in an aqueous solution to the system at the proportion of one pound per fifty gallons of water in the system.
(3) After the system is filled with this solution, the loop shall be allowed to circulate for 24 hours.
(4) The Chemical Treatment Contractor shall be given notice by the Contractor of scheduling this cleaning and, if the Engineer's representative deems it necessary, the operation shall be repeated.
(5) After the system has been completely cleaned as specified herein, it shall be tested by litmus paper or other dependable method and shall be left on the slightly alkaline side.
(6) If the system is found to be still on the acid side, the cleaning by use of Trisodium Phosphate shall be repeated.
(7) After the cleaning and flushing is complete, and approved by CMTA, the Contractor shall provide the proper water treatment for the system.

2.5 After the heat pump loop is complete:
(1) the Contractor shall first close the WSHP isolation valves and open the WSHP bypass valves.
(2) Fill the piping loops and all runouts with clear water. The loop water shall be circulated for one hour with make-up water open and boiler drain open to accomplish initial flushing of the system.
(3) After initial flushing, the Contractor shall open the WSHP isolation valves and close the WSHP bypass valves and then add trisodium phosphate in an aqueous solution to the system at the proportion of one pound per fifty gallons of water in the system.
(4) After the system is filled with this solution, the loop shall be allowed to circulate for 24 hours.

(5) The Chemical Treatment Contractor shall be given notice by the Contractor of scheduling this cleaning and, if the Engineer's representative deems it necessary, the operation shall be repeated.
(6) After the system has been completely cleaned as specified herein, it shall be tested by litmus paper or other dependable method and shall be left on the slightly alkaline side.
(7) If the system is found to be still on the acid side, the cleaning by use of Trisodium Phosphate shall be repeated.
(8) After the cleaning and flushing is complete, and approved by CMTA, the Contractor shall provide the proper water treatment for the system.

PART 3 – CLOSED LOOP CHEMICAL TREATMENT:

3.1 Provide a 3/4" valved and capped port for injection of the closed loop chemicals into the system.

3.2 Provide 30% propylene glycol with rust inhibitors **in the 2-pipe hydronic loop**. The Contractor shall determine the appropriate chemical volumes for each system.

3.3 After the system is complete it shall be thoroughly cleaned before placing in operation to rid the system of dirt, biological contamination, piping compound, loose mill scale, oil, and any and all other material foreign to the water as previously specified.

3.4 Before chemical cleaning and sterilization of the entire system, the field and hydronic loop and mains shall be individually flushed and purged until free of dirt, debris, and air. During the flushing/purging and chemical cleaning processes the supply and return run-outs shall be temporarily placed in bypass operation. See SYSTEM FILLING & PURGING PLAN for additional information.

3.5 After chemical cleaning, the entire system shall be sterilized with a biocide added at recommended dosage to effectively kill any present microorganisms. Add glutaraldehyde to achieve 60 – 200 ppm of active ingredient or isothiazoline to achieve 10 – 13 ppm active. Do not flush biocide from system. Corrosion inhibitors shall be installed in closed loop systems containing metal piping, fittings, accessories, etc.

3.6 A bacteria analysis shall be performed to ascertain biological cleanliness of system. If bacteria counts are above set parameters then sterilization process shall be repeated until bacteria counts are at or below acceptable levels. Microbiological limits are listed under "Water Quality Minimum Performance Requirements" elsewhere in this Specification Section.

3.7 Within 48 hours of the completion of the sterilization and confirmation that bio-levels are within the specified parameters, implement a water treatment program to passivate all metal surfaces.

PART 4 – SYSTEM FILLING & PURGING PLAN:

4.1 Refer to drawings.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202100 - VALVES

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 Each Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include, but may not be limited to all valves of all types including balancing valves, air vents, drain valves, check valves, special valves for special systems, etc., for all Mechanical Systems.

1.3 ACCEPTABLE MANUFACTURERS: Lunkenheimer, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Bell & Gossett, Apollo.

1.4 The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.

1.5 Each type of valve shall be of one manufacturer, i.e., ball valves, one manufacturer, butterfly valves, one manufacturer, check valves, one manufacturer, etc.

1.6 All valves shall comply with current Federal, State and Local Codes. All valves shall be new and of first quality. All valves shall be designed and rated for the service to which they are applied. Zinc, plastic, fiber or non-metallic valves shall not be acceptable.

1.7 Contractor shall provide colored tape on ceiling tile where valves are located above ceiling. Provide access panels where valves are located above hard ceiling.

PART 2 – DOMESTIC WATER APPLICATIONS:

2.1 Gate Valve (2" and under): Use ball valves as specified.

2.2 Gate Valve (4” and larger): Gate valve shall have bronze body, bonnet and solid wedge. Gate valve shall be rising stem with bolted bonnet and solid wedge. Valve shall have rated for 150 psi working pressure. Gate valve shall be Nibco T-134 for threaded ends or Nibco S-134 for solder ends.

2.3 Globe Valves (2" and under): Globe Valves shall have bronze body, bonnet and disc holder. Globe valve shall have union bonnet, integral seat, teflon or stainless steel renewable disc and be rated for 150 psi working pressure. Globe valve shall be Nibco T-235 for threaded ends or Nibco S-235 for solder ends.

2.4 Check Valve (2" and under): Check valve shall have bronze body, disc and hinge. check valve shall be Y-pattern type, horizontal swing, renewable disc and rated for 150 psi working pressure. Check valve shall be Nibco T-413 for threaded ends or Nibco S-413 for solder ends.

2.5 Two Piece Ball Valve (2" and under): Ball valve shall have bronze body, ball and reinforced, water tight seat. Valve shall be two piece construction. Valve shall be "full-port" type. Valve handle shall only require quarter turn to go from full open to full close. The handle shall be removable with vinyl grip. Valve shall be rated for 180 degrees F water temperature and 150 psi working pressure. Ball valve shall be Nibco T-585 for threaded ends and Nibco S-585 for solder ends.

2.6 Ball Valves (2½"-3"): Ball valve shall have bronze body, ball and reinforced, watertight seat. Valve shall be "full port" type. Valve handle shall only require quarter turn to go from full open to full close. The handle shall be removable with vinyl grip. Valve shall be rated for 250 degrees F water temperature and 200 psi working pressure. Ball valve shall be Nibco S-FP-600 for threaded ends and Nibco T-FP-600 for solder ends. Provide extended handles for all ball valves installed in a chilled water system.

2.7 Strainers (2" and under): Watts 77S Series "Y" type strainer with cast iron body and threaded ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with cleanout plug and be rated for 200 psi working pressure.

2.8 Strainers (2½" and larger): Watts 77F Series "Y" type strainer with semi-steel body and flanged ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with bolted cleanout and be rated for 200 psi working pressure.

2.9 Pressure Reducing Valves: Watts #U5B water pressure reading valve with bronze body, bolted bonnet, integral stainless steel strainer and outlet water pressure gauge. Internal disc, diaphragm and stainless steel seat shall all be removable. Valve shall be rated for inlet water pressures up to 300 psi. Water pressure reducing valves shall be provided for all equipment where water pressure exceeds the equipment manufacturer's ratings.

2.10 Vacuum Breakers: Watts #288A atmospheric type vacuum breaker with brass body. Vacuum breaker shall be rated for 210 degrees F and 125 psi working pressure and shall meet ASSE Standard 1001.

2.11 Double Check Valve: Double check valve shall have bronze body construction and be provided with inlet strainer, two (2) gate valves for isolation and three (3) test ports. Assembly shall be rated for 110 degrees F water temperature and 175 psi water pressure. Assembly must meet requirements of AWWA Standard C506. For sizes 2" and less, provide Watts #900 (or equal) with threaded ends. For sizes 2½" and larger, provide Watts #709 (or equal) with flange ends.

2.12 Reduced Pressure Backflow Preventers: Reduced pressure backflow preventers shall be provided with inlet strainer, two (2) gate valves for isolation, three (3) test ports and air gap fitting. Assembly shall be rated for 110 degrees F water temperature and 175 psi water pressure. RPBP shall be UL listed and meet AWWA C511 standards. Watts #909 or equal by Wilkins or Conbraco. All valves 3" and less in size shall bronze body construction, over 3" in size shall have epoxy coated cast iron bodies. Assemblies 2" and under in size shall have threaded ends, over 2" in size shall have flange ends. Perform backflow preventer test and provide results with closeout documentation.

2.13 Balancing Valve: Bell & Gossett "Circuit Setter" Model CB or equal balancing valve. All valves to be of bronze body/brass ball construction with glass and carbon filled TFE seat rings. Valves to have differential pressure read-out ports across valve seat area. Read-out ports to be fitted with internal EPT inserts and check valves. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. All valves to have calibrated nameplates to assure specific valve settings. Valves shall be designed for positive shut-off.

PART 3 – HVAC APPLICATIONS:

3.1 Gate Valve (2" and under): Use ball valves as specified.

3.2 Check Valves (2" and less): Check valve shall have bronze body, disc and hinge. Check valve shall be Y-pattern type horizontal swing, renewable disc and rated for 200 psi working pressure. Check valve shall be Nibco T-413 for threaded ends or Nibco S-413 for solder ends.

3.3 Check Valves (2½" and larger): Check valve shall have cast iron body and cast iron bolted bonnet the disc and seat ring shall be bronze. Check valve shall be horizontal swing with renewable seat and disc. Valve shall be rated for 200 psi working pressure. Check valve shall be Nibco F-918 for flanged ends and Nibco T-918 for threaded ends. Threaded ends valve allowed for sizes 3" and less only.

3.4 Two Piece Ball Valves (2" and under): Ball valve shall have bronze body, ball and reinforced, watertight seat. Valve shall be two piece construction. Valve shall be "full port" type. Valve handle shall only require quarter turn to go from full open to full close. The handle shall be removable with vinyl grip. Valve shall be rated for 250 degrees F water temperature and 200 psi working pressure. Ball valve shall be Nibco T-585 for threaded ends and Nibco S-585 for solder ends. Provide extended handles for all ball valves installed in insulated piping systems.

3.5 Ball Valves (2½"-3"): Ball valve shall have bronze body, ball and reinforced, watertight seat. Valve shall be "full port" type. Valve handle shall only require quarter turn to go from full open to full close. The handle shall be removable with vinyl grip. Valve shall be rated for 250 degrees F water temperature and 200 psi working pressure. Ball valve shall be Nibco S-FP-600 for threaded ends and Nibco T-FP-600 for solder ends. Provide extended handles for all ball valves installed in insulated piping systems.

3.6 Butterfly Valve (4" and larger): Butterfly valve shall have cast iron body with bronze disc. Valve to have extended neck to allow for insulation and be "lug" type configuration. Interior liner shall be made of EPDM. Lever handle shall be lock type with 10 position settings. Valve to be rated for 200 psi working and have positive shut-off equal to Hammond 6411 Series.

3.7 Strainers (2" and under): Watts 77S Series "Y" type strainer with cast iron body and threaded ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with cleanout plug and be rated for 200 psi working pressure.

3.8 Strainers (2½" and larger): Watts 77F Series "Y" type strainer with semi-steel body and flanged ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with bolted cleanout and be rated for 200 psi working pressure.

3.9 Balancing Valve (4" and less): Balancing valve shall have bronze or cast iron body. Valves to have differential pressure readout ports across valve seat area with integral check valves. Valve shall be equipped with memory stop. Valves to have threaded ends for sizes 3" and less, flanged ends for larger sizes. Valve to be provided with performed molded insulation casing. Design working pressure and temperature to be 200 psi at 250 degrees F balancing valve shall be similar to Bell & Gossett Model CB.

3.10 Flexible Connection: Pumpsaver SMP or equal braided stainless steel pump connector(s). Construction to be of annular corrugated stainless steel close-pitch hose with stainless steel overbraid. The corrugated metal hose, braid(s), and a stainless steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full-penetration TIG weld. End fittings shall be flat-face plate steel flanges with 150# ANSI drilling and outside diameter. Fittings must be attached using a 100% circumferential TIG weld. Braided stainless steel pump connector(s) must be suitable for operating temperatures up to 850 degrees F. The rated working pressure of the braided metal hose must have a minimum 4:1 safety factor. Each braided stainless steel pump connector shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure. Flanged pump connectors shall be prepared for shipment using cut-to-length spacers, securely positioned between the flanges to prevent axial compression damage and maintain the manufactured length. Spacers must be removed prior to system start up.

3.11 Automatic Air Vent: Armstrong Model 79 automatic air vent for vertical mounting with brass body

and polypropylene float. Vent to be rated for 150 psi working pressure and 240 degrees F working temperature. Pipe discharge to nearest floor drain.

3.12 Manual Air Vent: Armstrong Model 505A manual air vent with brass body. Install with 12" length of 1/4" soft copper discharge piping.

PART 4 – NATURAL GAS APPLICATIONS:

4.1 Gas Ball Valve (2" and less): Nibco TFP600N gas ball valve. Valve shall forged two-piece brass, CSA/CGA CR 91-002 certified, 5 psig rating, lever handle, full port ball valve, lubricated shaft, PTFE seats, blowout proof stem and threaded ends.

4.2 Gas Lubricated Plug Valve, (2½" and greater): Homestead lubricated industrial plug valve, Model 611/612, 100% round port, leak-proof, spring loaded ball and lubricant sealed check valve. Provide with threaded ends and lever handle.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202200 - INSULATION - MECHANICAL

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

1.2 Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.

1.3 Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

PART 2 – MANUFACTURERS:

2.1 Insulation shall be as manufactured by Manville, Keene Corp., Knauf, Owens-Corning, Armstrong, World Industries or other approved equivalent. Insulation sundries and adhesives shall be as made by Benjamin Foster, Childers, Vimasco or approved equivalent.

PART 3 - FIRE RATINGS AND STANDARDS:

3.1 Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50 and Fuel Contributed 50.

3.2 Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.

3.3 All products and their packaging shall bear a label indicating above requirements are not exceeded.

3.4 Duct linings shall meet the Erosion Test Method in compliance with UL Publication No. 181.

PART 4 - GENERAL APPLICATION REQUIREMENTS:

4.1 Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping, ductwork or equipment until tested, inspected and released for insulation.

4.2 Where more than one thickness of insulation is required, joints (both longitudinal and transverse) shall be staggered.

4.3 All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe and ductwork is to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full thickness of insulation specified. If necessary, extra fittings and pipe are to be used. No noticeable deformation of insulation or discontinuity of vapor seal, where required, will be accepted. Coordinate work with plumbers, pipe fitters, etc. to assure hanger locations agree with location of insulation inserts.

4.4 “Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

4.5 Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.

4.6 Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!

4.7 All insulation shall be installed with joints butted firmly together.

4.8 The Contractor shall insure that all insulation (piping, ductwork, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

PART 5 - PIPING SYSTEMS:

5.1 GENERAL

5.1.1 Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.

5.1.2 Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to insure no condensation drip or collection.

5.1.3 Valves, flanges and unions shall only be insulated when installed on piping whose surface temperature will be at or below the dew point temperature of the ambient air.

5.1.4 Insulation shall not extend through fire and smoke walls. Pack sleeve at fire and smoke wall with approved fire retardant packing similar to mineral wool.

5.2 INSULATION SHIELDS

5.2.1 Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180 ° arc. Insulation shields shall be the following size:

PIPE SIZE	SHIELD GAUGE	SHIELD LENGTH
2" AND LESS	20	12"
2 1/2" TO 4"	18	12"
5" TO 10"	16	18"
12" AND GREATER	14	24"

5.3 PREMOLDED INSULATION FITTING COVERS

5.3.1 Provide Zeston 2000 or equal PVC insulated fitting covers on all pipe fittings, flanges, valves and pipe terminations. Fittings shall be insulated by applying the proper factory precut insulation insert to the pipe fitting. The ends of the insulation insert shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe insulation tufted and tucked in, fully insulating the pipe fitting. The proper thickness of insulation must be applied to keep the jacket temperature less than 150°F. An approved vapor retarder mastic compatible with the PVC shall be applied around the edges of the adjoining pipe insulation and on the fitting cover throat overlap seam. The PVC fitting cover shall then be applied and secured with pressure sensitive tape along the circumferential edges. The tape shall extend over the adjacent pipe insulation and have an overlap on itself at least 2" on the downward side. On fittings where the operating temperature is below 50°F, two or more layers of the insulation inserts shall be applied with the first layer being secured with a few wrappings of fiber glass yarn to eliminate voids. One addition insert shall be used for each additional 1" of pipe insulation above 1-1/2".

5.4 INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .22 at 75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket. The jacket shall have an inside foil surface with self sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturer's recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

5.4.1 Domestic Cold Water - 1" thick

5.4.2 Hydronic System Fill Lines From Domestic Cold Water - 1" thick.

5.4.3 Domestic 110°F Hot Water and 110°F Recirculating Hot Water - 1" thick.

5.4.4 Dual Temperature Chilled/Hot Water Hydronic – 2" thick.

5.4.5 Storm Water Piping, Primary and Overflow – 1" thick.

5.4.6 Condensate Piping – ½" thick.

5.4.7 Geothermal Heat Pump Piping – 1" thick on on HDPE piping (not required for HDPE piping above lay-in ceiling; or exposed piping in mechanical rooms (with floor drain and concrete floor). Any piping above or over a non-accessible ceiling (drywall) or concealed (chases, etc) shall be insulated. Any piping within 25 feet of exit doors shall be insulated. Piping in the kitchen and receiving area shall be insulated (including piping above lay-in ceiling).

PART 6 - DUCTWORK SYSTEMS:

6.1 GENERAL

6.1.1 Duct sizes indicated are the net free area inside clear dimensions; where ducts are internally lined, overall dimensions shall be increased accordingly.

6.1.2 Duct insulation shall extend completely to all registers, grilles, diffusers, and louver outlets, etc., to insure no condensation drip or collection.

6.1.3 Outside air ductwork downstream of Energy Recovery Units (OAU-1/ERU-1/2) does not require insulation.

6.2 EXTERNAL INSULATION (FOR SUPPLY AND UNCONDITIONED OUTSIDE AIR DUCTWORK)

6.2.1 Owens/Corning, "Faced Duct Wrap - Type 100" or approved equivalent, 1-½" thick fiberglass duct wrap, factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. The R value shall be 4.5. Flame spread 24, smoke developed 50, vapor barrier performance 0.02 perms per inch.

6.3 EXPOSED EXTERNALLY INSULATION (FOR SUPPLY AND UNCONDITIONED OUTSIDE AIR DUCTWORK IN THE MECHANICAL ROOMS)

6.3.1 1" rigid fiberglass industrial board with foil scrim kraft vapor barrier facing, 1.5 PCF density, K=.22 @ 75°F. For round or oval ductwork, use semi-rigid fiberglass duct board. Owens/Corning or approved equivalent industrial insulation type 705. Provide 6oz. canvas jacket with fire retardant lagging. Use semi-rigid type 703 insulation for round ducts.

PART 7 – MECHANICAL EQUIPMENT:

7.1 ROOF DRAIN SUMPS: Knauf "Pipe and Tank Insulation" or approved equivalent rigid board insulation with exterior vapor barrier jacket formed to bottom of sump basin. Insulation shall have a K factor of 0.26 at 100°F. mean temperature. Insulation shall be 1" thick. Insulation shall be formed to roof drain sump. Vapor barrier shall remain continuous.

7.2 AIR SEPARATOR, HEAT EXCHANGER AND HOT WATER STORAGE TANKS: Knauf "Elevated Temperature Blanket 1000°F" or approved equivalent. Insulation shall be constructed of non-combustible, inorganic glass mineral wool. Insulation shall be 2" thick. K = 0.28 Btu in/hr.fr² °F @ 100°F. Insulation shall be attached in strict accordance with the manufacturer's recommendations. All insulation shall be jacketed with 6 oz. canvas with fire retardant lagging.

END OF SECTION.

DIVISION 20 – MECHANICAL

SECTION 202300 – THERMOMETERS, PRESSURE GAUGES AND OTHER MONITORING INSTRUMENTS

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Contractor shall include all thermometers, pressure gauges and/or compound gauges at the locations indicated. All pressure gauges and/or compound gauges shall be provided with ¼ turn ball valves to allow the gauge to be removed and replaced without shutting down system.

PART 2 – THERMOMETERS AND PRESSURE GAUGES:

2.1 Gauges and thermometers shall be Miljoco, Marsh, Trerice, or Weksler.

2.2 All thermometers and pressure gauges shall be readable from a standing position on the floor. Mount thermometers in approved wells. Do not make direct contact of base with fluid in pipe. Pressure gauges and thermometers subject to vibration shall be mounted remotely away from vibrating pipe surface, etc. with flexible tubing.

2.3 Digital thermometers shall be solar powered industrial thermometer. The range shall be -50°F/300°F with an accuracy of 1% or 1°, whichever is greater. The display shall be a 3/8” LCD digit. Use where specifically indicated on the drawings.

2.4 Pressure gauges shall be Bourdon Type, circular, 4-1/2" face, black letters on white face graduated in 2 PSI or less and shall be manufactured for service intended. Provide with pig tail connectors and gauge cocks. Accuracy to be plus or minus 1%. Water pressure shall have 0 to 100 PSI range.

PART 3 – PRESSURE/TEMPERATURE PORT (PETE’S PLUG – P/T PLUG):

3.1 Provide 1/4" NPT fitting to receive either a temperature or pressure probe, 1/8" OD. Fitting shall be solid brass with two valve cores. Valve core material to be neoprene for temperatures up to 200ºF and Nordel for temperatures up to 275ºF. Pete’s Plugs to have 3" length when installed on insulated pipes and 1-1/2" length for uninsulated pipes. Pete’s Plug to be fitted with a cap and gasket, and shall be rated at 1000 PSIG at 140ºF.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202400 - IDENTIFICATIONS, TAGS, CHARTS, ETC.

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

PART 2 – TAGS AND CHARTS:

2.1 Provide and install on each valve 1” in size or greater for all mechanical systems a 1.5" diameter circular bronze or baked phenolic tag fitted to each valve so that it cannot be removed. Each tag shall be embossed consecutively with sequential number identifiers. Number identifiers shall be determined by the Contractor sequentially.

2.2 Provide typewritten valve charts indicating each valve identifier, the valves service, normal position and its location. Also furnish one electronic copy on CD in “*.xls” format. One (1) copy of this chart shall be mounted in suitable frame(s) with clear plastic covers in a conspicuous location in each of the major mechanical rooms. Repeat only main valves which are to be operated in conjunction with operations of more than single mechanical room.

2.3 All emergency shutoff valves shall be identified with a permanent engraved tag hung from the valve with 1-inch high lettering. Emergency shutoff valves shall be identified as any valve whose closure could create an emergency condition in the facility (i.e. natural gas, water, domestic hot water, main HVAC valves, etc.).

2.4 Label all control panels and disconnect switches with service and equipment served.

PART 3 – PIPING AND DUCTWORK IDENTIFICATION:

3.1 All piping and ductwork installed shall be identified according to the chart hereinafter specified. Provide stenciled markers and arrows indicating direction of flow on all piping and ductwork installed under this contract. Markers and arrows shall be painted using machine cut stencils. All letters shall be sprayed using fast drying lacquer paint. All markers and arrows shall be properly oriented so that descriptive name may be easily read from the floor. Piping and ductwork shall be identified on twelve (12) foot centers. All piping and ductwork shall be minimally identified once above all room ceilings and where it passes thru walls or floors. At the Contractor's option, Setmark or equivalent manufactured marking system may be substituted for field marking.

3.2 The following table describes the size of the color field and size of the identification letters which shall be used for pipes of different outside pipe diameters.

Outside Diameter	Label Length	Letter Size
¾” – 1 ¼”	8”	½”
1 ½” – 2”	8”	¾”
2 ½” – 6”	12”	1 ¼”
8” – 10”	24”	2 ½

3.3 The following chart describes the pipe service and label identification which shall be used for various pipes:

PIPE	ABBREVIATION
Geothermal Supply	G.S.
Geothermal Return	G.R.
Chilled Water Supply	C.H.S.
Chilled Water Return	C.H.R.
Domestic Cold Water	D.C.W.
Domestic Hot Water	D.H.W.
Recirculated Hot Water	R.H.W.
Fire Protection	SPRINKLER
Sanitary Sewer Piping	SAN
Sanitary Vent Piping	VENT
Storm Sewer Piping	STORM

PART 5 – EQUIPMENT IDENTIFICATION:

5.1 Unless otherwise specified, all equipment shall be identified. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. In finished rooms and mechanical rooms, equipment shall be identified neatly and conspicuously with engraved black lamacoid plates (or equivalent) with 1" high white letters on the front of each piece of equipment.

5.2 All mechanical equipment and associated starters/disconnects shall have the electrical panel number and circuit number identified on a lamacoid plate. Coordinate with the Electrical Contractor.

PART 6 – DUCTWORK IDENTIFICATION:

6.1 All ductwork shall be identified as to the service of the duct and direction of flow. Include equipment designator on SA & RA ductwork. The letters shall be at least two inches high and the flow arrow shall be at least six inches long. The letters and flow arrow shall be made by precut stencils and black oil base paint with aerosol can. Concealed ducts also need to be identified.

6.2

DUCTWORK	ABBREVIATION
Supply Air Ductwork	SA + Equipment Identifier
Return Air Ductwork	RA + Equipment Identifier
Exhaust Air Ductwork	EA + Equipment Identifier
Outside Air Ductwork	OA + Equipment Identifier

PART 7 – ACCESS THROUGH LAY-IN CEILINGS:

7.1 Mark each lay-in ceiling panel which is nearest access to equipment, valves, dampers, filters, duct heaters, etc., with colored tape labels located on the ceiling grid.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202500 - HANGERS, CLAMPS, ATTACHMENTS, ETC.

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 Each Contractor's attention is also directed to Specification Section PIPE, PIPE FITTINGS AND SUPPORT.

1.3 This section includes, but is not limited to, furnishing and installing supports, anchors, and accessories for piping, ductwork, equipment, etc. Furnishing and installing shall be by each trade for the completion of their work as directed in this Section.

PART 2 – MATERIALS AND EQUIPMENT:

2.1 Hangers, Clamps, Attachments Schedule:

- ACCEPTABLE MANUFACTURERS: Grinnell, Elcen, Fee & Mason.
- All hangers, clamps and attachments shall be manufactured products.
- Pipe Rings (2” pipe and smaller) – adjustable swivel split ring or split pipe ring.
- Pipe Clevis (2.5” pipe and larger) – adjustable wrought clevis type.
- Pipe Clevis (All pipe sizes) – steel clevis for insulated pipe.
- Riser Clamps (All pipe sizes) – extension pipe or riser clamp.
- Beam Clamps (All pipe sizes) – malleable beam clamp with extension piece.
- Brackets (All pipe sizes) – medium weight steel brackets.
- Concrete Inserts (All pipe sizes) – wrought or wedge type inserts.
- Concrete Fasteners (All pipe sizes) – self-drilling concrete inserts.
- Rod Attachments (All pipe sizes) – extension piece, rod coupling, forged steel turnbuckle
- U-bolts (All pipe sizes) – standard u-bolt.
- Welded Pipe Saddles (All pipe sizes) – pipe covering protection saddle sized for thickness of insulation.
- Pipe Roll (All pipe sizes) – adjustable swivel pipe roll.
- Protection Saddle (All pipe sizes) – 180 degree coverage, sheet metal pipe protection saddle.
- Hanger Rods (All pipe sizes) – Steel, diameter of hanger threading.
- Concrete Channel Inserts (All pipe sizes) – continuous heavy duty slot inserts unistrut.
- Adjustable Spot Inserts (All pipe sizes) – continuous heavy duty spot insert unistrut.
- Miscellaneous steel such as steel angles, rods, bars, channels, etc used in framing for supports, fabricated brackets, anchors, etc. shall confirm to ASTM-A-7.

PART 3 – INSTALLATION:

3.1 Supporting and hanging shall be done so that excessive load will not be placed on any one hanger so as to allow for proper pitch and expansion of piping.

3.2 Hangers and supports shall be placed as near as possible to joints, turns and branches.

3.3 For concrete construction, utilize adjustable concrete inserts for fasteners. Expansion anchors and power driven devices may be used when approved in writing by the Architect/Engineer.

3.4 Utilize beam clamps for fastening to steel joists and beams. Expansion anchors in masonry construction. Do not support piping or ductwork from bridging or metal decking.

3.5 When piping is routed in joists, piping shall be top mounted on trapeze type hangers with each pipe individually clamped to trapeze hanger. Do not support piping or ductwork from bridging angles.

3.6 Trapeze hangers are not allowed, unless specifically approved by the Engineer.

3.7 Install all miscellaneous steel other than designed building structural members as required to provide means of securing hangers, supports, etc., where piping does not pass directly below or cross structural elements.

3.8 Piping shall not be supported by the equipment to which it is connected. Support all piping so as to remove any load or stress from the equipment.

3.9 Where piping, etc., is routed vertically, approved riser clamps, brackets or other means shall be utilized at approximately 10'-0" center to center minimum. An approved adjustable base stand or fitting on concrete support base shall be utilized at the base of the vertical run.

3.10 Where piping is routed along walls, knee braced angle frames, etc. pipe brackets with saddles, clamps, and rollers mounted on structural brackets fastened to walls or columns shall be used.

3.11 Support all ceiling hung equipment with approved vibration isolators.

3.12 Where copper tubing is specified, hangers shall be of copper clad type when piping is uninsulated.

3.13 Uninsulated piping hung from above shall be supported with ring and clevis type pipe hangers. Uninsulated piping mounted on trapeze (when allowed) and wall bracket type support shall be held in place with U-bolts. U-bolts shall allow for axial movement in the piping.

3.14 All insulated piping shall be supported with clevis type and pipe roll hangers. Hangers shall be sized to allow the pipe insulation to pass through the hangers. Install insulation protection saddles at all hanger locations. Welded pipe saddles shall be installed at all hangers on piping 5" and larger. The pipe saddles shall be sized for the thickness of insulation used. Hangers shall fit snugly around outside of insulation saddles.

3.15 Under no conditions will perforated band iron or steel wire driven hangers be permitted.

3.16 Support steel and copper piping at a minimum of eight (8) foot intervals for piping 3" and smaller and ten (10) foot intervals for larger piping. Provide additional support at end of the branches and change of direction.

3.17 Where fireproofing is dislodged/damaged from the building structure due to Contractor’s installation of hangers, clamps, etc., it shall be the Contractor’s responsibility to repair all dislodged/damaged fireproofing to original fireproofing rating. This shall also include all work performed by their contractors sub-contractors.

3.18 Insure that all bolts and nuts are tightened.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 203100 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Engineer, or authorized representative, shall be notified by the Contractor twenty-four (24) hours in advance of any tests called for in these Specifications or required by others.

1.3 Only after written approval, signed by the Engineer, shall the Contractor apply insulation or paint or allow the work to be furred-in. This written approval, however, does not relieve the Contractor of the responsibilities for any failure during the guarantee period. The expense of all tests shall be borne by the Contractor, along with all temporary equipment, materials, gauges, etc. required for tests.

PART 2 - HEATING, VENTILATING AND AIR CONDITIONING TESTING:

2.1 The test and balance of this system shall be by a Contractor who employs only the services of a certified AABC or independent NEBB firm whose sole business is to perform test and balance services. The Test and Balance contractor shall report all deficiencies to the Engineer.

2.2 The test and balance contractor shall bid directly to the Owner.

2.3 Mechanical Contractor shall provide all start-up documents to Test and Balance Contractor prior to any test and balance services.

2.4 The Mechanical Contractor shall test all piping before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory. Water piping systems shall be subjected to a hydrostatic test as specified and shall be proven tight after a twenty-four (24) hour test.

2.5 All motors, bearings, etc. shall be checked and lubricated as required during start-up procedures. All automatic, pressure regulating and control valves shall be adjusted. Excessive noise or vibration shall be eliminated.

2.6 System balancing, where required, shall be performed only by persons skilled in this work. The system shall be balanced as often as necessary to obtain desired system operation and results.

2.7 All fan belts shall be adjusted for proper operation of fans.

2.8 Testing shall occur after completion of the ceiling systems installation.

2.9 All deficiencies observed by the Test and Balance Contractor shall be reported immediately to the Engineer and Mechanical Contractor.

2.10 Refer to Specification Section – CONTROLS – DIRECT DIGITAL for additional requirements.

2.11 Refer to Specification Section – GENERAL PROVISIONS – MECHANICAL for startup requirements.

2.12 Provide a preliminary test report to the Engineer immediately after the system is air balanced, or any initial phases are balanced. This report may be hand written. Any systems that are not found to operate within the design tolerances by the Test and Balance Contractor shall be immediately be reported to the Engineer via telephone call to attempt to determine a resolution while the Test and Balance Contractor is still on site. Additional compensation will not be accepted for additional trips.

2.13 Anticipate visiting the site again after the Engineer has reviewed the report. The Engineer may request up to two (2) additional site visits for onsite troubleshooting where additional measurements may be required.

2.14 For the purpose of placing the Heating, Ventilating and Air Conditioning systems in operation according to design conditions and certifying same, final testing and balancing shall be performed in complete accordance with AABC Standards for Total System Balance, Volume Six (2002), for air and hydronic systems as published by the Associated Air Balance Council.

2.15 Large units provided with pump VFD's, setting shall be field determined with TAB contractor. To determine the setting all system pumps shall be ON and adjust the VFDs to maintain HP flow per the schedules. Record flow at all heat pumps with the TAB contractor. Turn all system pumps off and record flow at each heat pump with a VFD for engineering review.

2.16 The following systems shall be tested and balanced:

- The supply, return, outside and exhaust air duct systems associated with all OA units and heat pumps. Provide static pressure profiles thru each system. Static pressure profiles shall include all sections from the return duct inlet and supply duct outlet of the heat pump unit. Show accurate representation of return, relief, outdoor and economizer damper locations. On units equipped with exhaust air fans; show location and profile of the exhaust fan.
- Outside and exhaust air in each room to within 5% of design air flow rate.
- Heat pump total air flow and discharge and inlet pressures.
- Hydronic and domestic pumps total water flow.
- Balance heat pump water loop, circulating pumps and associated coil water flows. (minimum & maximum)
- Verify calibrations of the duct static pressure and water pressure sensors for all systems.
- Balance each heat pump unit and adjust ECM motor to design airflow. Record inlet and outlet static pressure, including filters. Measure outside air flow at each heat pump.
- Balance all supply and return air grilles to within 10% of design air flow rate.
- Balance all exhaust air fans and record inlet static pressure.
- Balance the kitchen rangehood supply/exhaust air system.

2.17 Balance the water flow rate of each domestic hot water recirculating pump. Set the flow rate for each balancing valve in the recirculating hot water system. If flow rates are not indicated, contact the engineer for each balance valve GPM.

2.18 Instruments used for testing and balancing of air and hydronic systems shall have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.

2.19 Test and Balance agency shall provide sizing of fan or motor sheaves required for proper balance. The Mechanical Contractor shall purchase and install all sheaves and belts as required. This includes new and existing equipment.

2.20 Three (3) copies of the complete test reports shall be submitted to the Consulting Engineer prior to final acceptance of the project. Preliminary test reports shall be submitted when requested.

2.21 The Contractor shall provide and coordinate work to provide sufficient time before final completion date so that tests and balancing can be accomplished and provide immediate labor and tools to make corrections when required without undue delay.

2.22 The Contractor shall put all heating, ventilating and air conditioning systems and equipment and rangehood system into full operation and shall continue the operation of same during each working day of testing and balancing.

2.23 The Test and Balance Contractor shall be present during the Engineer's final inspection of the building, or a separate project review date. The Engineer may request confirmation of the air balance report by asking for new measurements to be taken at that time. Any information in the test and balance report may be asked to be reconfirmed.

END OF SECTION.

DIVISION 23 - HVAC

SECTION 230800 - HVAC COMMISSIONING

PART 1 - GENERAL

1.1 RELATED WORK

1.1.1 Division 22 – Plumbing

1.1.2 Division 26 – Electrical

1.2 REFERENCES

1.2.1 Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

1.2.2 ASHRAE Guideline 1-1996

1.2.3 ASHRAE Guideline 0-2005

1.2.4 ACG Commissioning Guideline – 2005

1.3 DESCRIPTION OF WORK

1.3.1 The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

1.3.2 The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 ROLES OF THE COMMISSIONING AGENCY

3.1.1 The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of HVAC systems within the facility.

3.1.2 The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and

functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

3.1.3 Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

3.1.4 The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

3.1.5 The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

3.1.6 The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

3.1.7 The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

3.1.8 The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

3.1.9 The CA will review operating and maintenance materials for HVAC systems.

3.1.10 The CA will review phasing plans as provided by the CM relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.2 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

Boilers
Fluid Coolers
Heat Pumps
OA Units
Energy Recovery Units
Pumps
Exhaust Fans
DDC Control System

3.3 HVAC COMMISSIONING PLAN

3.3.1 Commissioning Team: The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:

Program Manager (PrM)
Facilities Management Division (FMD)
Commissioning Agent (CA)
Design Team (DT)
General Contractor (GC)

Mechanical Contractor (MC)
Controls Contractor (CC)
Test and Balance Contractor (TABC)
Electrical Contractor (EC)

3.3.2 Basis of Design Document

- The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
- The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

3.3.3 Commissioning Meetings: Commissioning meetings will be held in conjunction with progress meetings as necessary. The CA will be on site for the CX meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

3.3.4 Resolution Tracking Forms (RTF)

- The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
- The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

3.3.5 System Verification Checklists (SVC) / Manufacturers' Checklists

- The MC will provide SVC's based on manufacturers start-up procedures. These tests should be provided for all systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS*. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
- The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
- The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

3.3.6 Start-Up

- Start-up of major HVAC systems will be witnessed the CA. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting HVAC equipment.
- CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on

site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

3.3.7 Controls Monitoring: Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

3.3.8 TAB Monitoring

- The preliminary TAB report set-up will be reviewed prior to HVAC equipment start-up, in order to assure that the final TAB report format and content is acceptable.
- TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.
- A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

3.3.9 Functional Performance Tests (FPT)

- The CA will write FPT's based on the respective sequence of operations. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS* above.
- Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
- The Functional Performance Tests shall include HVAC and related equipment.
  - Units will be tested in designed operating modes. Proper operation will be verified at automatic control, and other modes, if necessary, to achieve BOD conformance.
  - DDC control systems will be tested as necessary.
  - HVAC systems will be tested to assure that the building as an integrated system operates properly.
  - Trend verification of systems and subsystems shall be completed prior to start of functional performance testing. CA will provide trend format to CC and discuss trend requirements in CX meetings throughout the construction phase of project.
- Deferred Testing
  - If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
  - Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.
- Rescheduled Functional Performance Test
  - During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, their time will be billed to the contractor as an additional fee.

- If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed for the commissioning personnel's return trip.

- Building Turn-Over / Owner Orientation / User Training
  - The CA will oversee contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
  - The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
  - Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going HVAC related problems are being addressed and corrected in a timely and efficient manner.
  - The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.4 RESPONSIBILITIES OF TEAM MEMBERS

3.4.1 General Contractor (GC)

- Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the HVAC commissioning process.
- Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
- Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
- Coordinate inclusion of commissioning activities in the construction schedule.
- Facilitate resolution of deficiencies identified by observation or performance testing.
- Assist the CA in monitoring the duct leakage testing.

3.4.2 Mechanical Contractor (MC)

- Each contractor in this division shall include in their quote the cost of participating in the commissioning process.
- Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
- Assure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.
- Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.
- Attend commissioning meetings scheduled by the CA.
- Assist the CA in system verification and performance testing.
- Prepare preliminary schedule for HVAC system inspections, O & M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CA. Update schedule as appropriate throughout the construction period.
- Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
- Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
- Notify the CA a minimum of two weeks in advance of scheduled system start-up.
- Update drawings to as-built condition and review with the CA throughout the construction process.

- Schedule vendor and subcontractor provided training sessions as required by project specifications.
- Provide written notification that the following work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent.
  - HVAC equipment including fans, AC units, fan coil units, ductwork, dampers, terminal devices, etc.
  - Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.
  - That BAS is functioning in accordance with design intent.
- Participate in the Functional Performance Tests.
- Participate in the off-season mode testing.
- Participate in O&M Training as required by project specifications.
- Provide a complete set of as-built drawings and O & M manuals for review. The CA shall review the as-built drawings and O&M manuals concurrently with the design team.

3.4.3 Test and Balance Contractor (TABC)

- Include cost for commissioning requirements (participation) in the contract price.
- Attend commissioning meetings scheduled by the CA.
- Submit the TAB procedures and preliminary TAB report to the CA for review at least two weeks prior to beginning TAB work.
- Notify the CA a minimum of two weeks in advance of scheduled TAB work.
- Provide partial, preliminary TAB Reports by phase, by building section, by system, or as required by the CA.
- Assist the CA in system verification and performance testing.
- Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
- Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the CA for verification or diagnostic purposes.
- Participate in the Functional Performance Tests as required to achieve design intent.
- Provide sound and vibration where required to assist in diagnosis of areas exhibiting unacceptable levels of noise or vibration.
- Participate in the off-season mode testing as required to achieve design intent.
- Participate in O&M Training as required by project specifications.

3.4.4 Temperature Control Contractor (TCC)

- Include cost for commissioning requirements in the contract price.
- Review control sequence and component selection for conformance with design intent.
  - Attend a submittal review meeting with the CA and Engineer to ensure clear understanding of scope of work and expectations.
  - Verify that specified safeties and interlocks have been selected.
  - Verify proper selection of control valves and actuators based on design parameters.
  - Verify proper selection of control dampers and actuators based on design parameters.
  - Verify that sensor selection conforms to design intent.
- Attend commissioning meetings scheduled by the CA.
- Provide the following submittals to the CA:
  - Hardware and software submittals.
  - Control panel construction shop drawings.
  - Narrative description of control sequences for each HVAC system and subsystem.
  - Schematics showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access.
  - A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.

    - A complete listing of all software routines employed in operating the control system. Also provide a program narrative that describes the logic flow of the software and the functions of each routine and sub-routine. The narrative should also explain individual math or logic operations that are not clear from reading the software listing.
    - Hardware operation and maintenance manuals.
    - Application software and project applications code manuals.
    - Panel and equipment insert documents.
    - Assist CA with remote monitoring capabilities. Supply any software and/or hardware needed.
- Verify that specified interfaces provided by others are compatible with BAS hardware and software.
- Coordinate installation and programming of BAS with construction and commissioning schedules.
- Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
- Provide control system technician to assist during equipment startup.
- Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
- Participate in the Functional Performance Tests as required by the project specifications.
- Provide a control system technician to assist during verification and performance testing.
- Provide system modifications to achieve system operation as defined by the design intent.
- Provide support and coordination for TAB contractor. Provide all devices, such as portable operator terminals and all software for the TAB to use in completing TAB procedures.
- Provide written notification that the TCC scope of work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent, and that BAS is functioning in accordance with design intent.
- Participate in the Functional Performance Tests as required to achieve design intent.
- Participate in the off-season mode testing as required to achieve design intent.
- Participate in O&M Training as required by project specifications. Include training on hardware operations and programming

END OF SECTION

DIVISION 21 – MECHANICAL

SECTION 210100 - FIRE PROTECTION SYSTEM

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 No Contractor, other than those regularly engaged in the installation of approved and franchised automatic sprinkler systems will be considered or approved for the work under this Specification Section. The Contractor shall have not less than five (5) years experience in the fabrication and erection of fire protection systems as specified. The Contractor shall have completed five (5) installations similar and equivalent in scope to the systems specified.

1.3 Before submitting bid, examine the Contract Documents, visit the site (if necessary) and become acquainted with all conditions that may, in any way whatsoever, affect the execution of this work. The Contractor shall take their own measurements and be responsible for exact size and location of all openings required for installation of this work. Figured dimensions where indicated are reasonably accurate and should govern in setting out work. Detailed method of installation is not indicated. Where variations exist between described work and approved practice, the Engineer shall be consulted for directive.

1.4 It is the intent of the Plans and Specifications to provide a general layout only and locate major equipment, components, piping, etc. Variations in head locations, pipe routing, etc., shall be anticipated by the Contractor and shall be coordinated with all other trades and indicated on the drawings and descriptive literature called for hereinafter. It shall be the express responsibility of the Contractor to provide all required design, materials and equipment and perform all work required to install a complete and approved installation.

1.5 All materials and methods shall be in accordance with applicable codes, regulations and/or ordinances and meet approval of local inspection authority and the State Fire Marshal. Also, all work shall comply with the latest editions of the National Board of Fire Underwriters, National Fire Protection Association, OHSA Regulations, the International Building Code, the Life Safety Code, International Mechanical Code and governing building codes. All materials and equipment installed as a part of this work shall be listed by the Underwriters Laboratories, Inc. as approved for fire protection installations.

1.6 Where flow and pressure data are available, they are indicated on the project drawings. The Contractor shall independently verify all such information and notify the Engineer of any discrepancies discovered prior to beginning the work. Where no flow information is indicated on the project drawings, the Contractor shall obtain the data and indicate it on the shop drawing submittal. All flow information obtained shall be less than six (6) months old. Piping systems shall be hydraulically sized based on the most conservative flow information obtained. No adjustments in the contract amount will be allowed for failure of the Contractor to obtain adequate flow information.

1.7 The Owner’s local insuring agency may review plans prepared and submitted by the Contractor but shall have no authority to make changes once work has begun. Coordinate with the Owner prior to construction.

1.8 All work performed under this section shall be accomplished in close harmony with all other trades. All work not so coordinated shall be removed and reinstalled at the expense of the Contractor.

1.9 The Contractor shall list the following cost breakdowns, material and labor, on the official project schedule of values:

- Fire Protection Shop Drawings and Approvals
- Fire Protection Materials & Labor
- Fire Protection Record Drawings & Acceptance

PART 2 – SCOPE OF WORK:

2.1 Furnish all material, labor, tools, equipment and supervision required for installation of a complete and new fire protection system as indicated on the project drawings and within these specifications. Include all necessary piping, sprinkler heads, test connections, valves, drains, etc.

2.2 The Contractor shall provide flushing and sterilization of all water lines in accordance with current Codes, Rules and Regulations and shall make connection to domestic water mains in accord with current rules and regulations of the State Department of Sanitary Engineering and Division of Water.

2.3 The Contractor shall obtain and pay for all necessary state, municipal, county, city and other permits and fees and pay all State taxes which are applicable.

2.4 All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, for a period of one year from substantial completion.

2.5 Upon completion, the Contractor shall submit to the Engineer, a properly completed "Sprinkler Contractor's Certificate Covering Materials and Tests" form.

2.6 Upon completion of this work all debris, material, and equipment shall be removed from the building and premises; all piping shall be cleaned ready for finish painting. Do not remove rust inhibitive primer specified hereinafter.

PART 3 – SHOP DRAWINGS:

3.1 The Contractor shall prepare and submit to the Engineer, shop drawings including design calculations, detailed catalog cutsheets and layout drawings indicating the proposed automatic sprinkler system. All layouts and drawings shall be closely coordinated by the Contractor with the work of ALL other trades. The shop drawings shall indicate the following items:

- Name and address of Owner, Architect and Engineer.
- Sprinkler heads including temperature rating.
- Fire Department Connection (FDC)
- Post Indicator Valve (PIV)
- Detector check valves.
- Water motor gong.
- Wet pipe alarm valves and wet system specialties.
- Flanged gate and check valves.
- Pipe hangers
- Supervised OS&Y valve
- Fire Pump, starter/controller and electrical characteristics
- Make & type of jockey pump and electrical characteristics
- The pressure sensing switch
- The post indicator supervisory switch (coordinated with the Fire Alarm Contractor)
- The main gate valve supervisory switch (coordinated with the Fire Alarm Contractor).

- The flow switch (coordinated with the Fire Alarm Contractor).

3.2 On a set of drawings to the same scale as the drawings accompanying these specifications, indicate:
- Each head location coordinated with lights, diffusers and other ceiling mounted device.
- Location of all risers, mains, runout lines, etc.
- Size of all risers, mains, runout lines, etc.
- Location and type of pipe hangers.
- All other information required by the Authority Having Jurisdiction providing approval.

3.3 The Contractor shall submit these shop drawings to the Engineer through the General Contractor and Architect for their review and approval. The Contractor shall submit the reviewed drawings to the Authority Having Jurisdiction for their review and approval. The Contractor shall incorporate all review comments from the Engineer and the Authority Having Jurisdiction. No work shall be performed onsite until all review processes are complete and updated drawings are on the job site.

PART 4 – EQUIPMENT AND MATERIALS:

4.1 EXTERIOR PIPE & FITTINGS: Class 200 PVC piping for exterior fire protection piping. Piping shall meet AWWA C900 requirements, be UL listed, Factory Mutual approved and NSF approved. Joints shall have spigot pipe ends with a flexible elastomeric ring seated in a groove to provide water tight seal. Minimum burst pressure to be 900 psi when tested in accordance with ASTM D1599. No. 8 copper wire (tracer wire) shall parallel all piping.

4.2 POST INDICATOR VALVE: Furnish and install a post indicator valve as required by the local authority. It shall be listed and approved by Underwriters Laboratories and Associated Factory Mutual Laboratories; Marked SV-FM; vertical; non-adjustable; with electric supervisory switch, handle, view window, brass padlock with two (2) keys; gate valve to meet gate valve specifications, except to have non-rising stem and mechanical joint ends; equivalent to Mueller, Scott or Lunkenheimer.

4.3 DETECTOR CHECK VALVE: Furnish and install detector check valve as required by the local authority. It shall be listed and approved by Underwriter Laboratories and Associated Factory Mutual Laboratories; 175# working pressure; IBBM; flanged; with tapped bosses each side for by-pass meter trimming; equivalent to Viking, Badger or Grinnell.

4.4 The Contractor shall contact the servicing water company and ascertain their policy pertaining to the bypass water meter. If not furnished by water company, the Contractor shall furnish and install the bypass meter and trimming as detailed on the drawings.

4.5 FIRE DEPARTMENT CONNECTION: Furnish and install a fire department connections with threads as approved by the local fire department; cast brass polished and chromium plated; with connection sizes and lettering as directed by the local authority having jurisdiction; Viking, Automatic Sprinkler Corporation, or approved equivalent.

4.5.1 At the low point near each fire department connection, install a 90-degree elbow with drain connection to allow for localized system drainage to prevent freezing. Basis of Design: Victaulic #10-DR.

4.6 WET ALARM VALVES: All alarm valves must be UL and FM approved. Alarm valve shall have a grooved seat design with retarding chamber. Valve shall be rated for 175 PSI working pressure. Valve shall be provided with external bypass line and drain valve. Reliable, Gem, Grinnell, Star, Viking or approved equal.

4.7 FLOW INDICATOR SWITCHES: Furnish and install flow indicator switches as required by NFPA 13. All flow indicator switches shall be UL approved. Coordinate with Fire Alarm System supplier/installer.

4.8 TAMPER SWITCHES FOR WATER SHUT-OFF VALVES: Furnish and install tamper switches where required by NFPA 13. All tamper switches shall be UL approved. Coordinate with Fire Alarm System supplier/installer. All tamper switches located in fire protection pits shall be waterproof, capable of operating beneath water and be NFPA approved.

4.9 GATE VALVES: 2½" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; OS&Y; flanged; cast iron discs; bronze seat rings; four point wedging mechanism; equivalent to Mueller, Scott or Lunkenheimer. 2" and under; 150# working pressure; bronze; rising stem; screwed; bronze discs; bronze seat rings; two point wedging mechanism; equivalent to Jenkins, Scott or Lunkenheimer.

4.10 CHECK VALVES: 2½" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; flanged; equivalent to Mueller, Scott or Lunkenheimer. 2" and under; 150# working pressure; bronze; screwed; equivalent to Jenkins, Scott or Lunkenheimer.

4.11 INTERIOR PIPE & FITTINGS: Up to 2" Schedule 40 ASTM A-53 black steel; 125# cast iron screwed fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings. 2½" and larger: Schedule 40 black steel with flanged, welded or victaulic (or similar) type approved fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.

4.11.1 Grooved joint couplings consisting of two ductile iron housing segments to ASTM A536, grade 65-45-12; pressure responsive elastomer gasket; and ASTM A449 compliant bolts and nuts.

- Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support and hanging in accordance with NFPA-13, fully installed at visual pad-to-pad offset contact. (Couplings that require exact gapping at specific torque ratings are not permitted.) Installation-Ready for complete installation without field disassembly. Basis of Design: Victaulic Style 107N and 009-EZ.
- Flexible Type: For use in locations where vibration attenuation and stress relief are required: Basis of Design: Victaulic Installation-Ready Style 177 or Style 77.

4.12 Do not route sprinkler piping (including drops) directly above any light fixtures. Do not route sprinkler piping near ceiling; hold tight to structure. Where large volumes occur above ceiling route pipe at least 36” above ceiling. The Sprinkler Contractor shall coordinate during design of sprinkler systems to ensure these requirements are met.

4.13 Do not route sprinkler piping (including drops) directly above any light fixtures. Do not route sprinkler piping near ceiling; hold tight to structure. Where large volumes occur above ceiling route pipe at least 36” above ceiling. The Sprinkler Contractor shall coordinate during design of sprinkler systems to insure these requirements are met.

4.14 SPRINKLER HEADS: Tyco, Viking, Victaulic, Reliable: All sprinkler heads shall be fed in a reverse bend arrangement. Sprinkler head degree ratings shall be determined by the area serviced in accord with current Codes and Standard Practices. Types of sprinkler heads shall be as follows:

- Semi-Recessed, Quick Response – Reliable (or equal) Model F1FR-300 or Victaulic model V27, semi-recessed automatic sprinkler head. Escutcheon and head shall be white.
- Upright, Quick Response – Reliable (or equal) Model F1FR or Victaulic model V27, Vertical Upright automatic sprinkler head.

4.15 At the Contractor’s option, extended coverage sprinkler heads may be used where appropriate.

4.16 When working in existing facilities, sprinkler heads style and color shall match existing.

4.17 Where sprinkler heads are installed in a tile ceiling, they shall be installed in the middle of the tiles, at half or quarter points along the length of the tiles.

4.18 Coordinate sprinkler head locations in kitchen freezer/cooler units with light fixtures and other ceiling mounted devices to insure proper coverage is maintained. Provide these heads with cages. Seal freezer/cooler panels where pipe penetrations occur.

4.19 CLAMPS AND ANCHORS: Furnish and install approved clamps, as required, at all (45 degree) l/8 bends, (90 degree) ¼ bends and flange and spigot pieces to the straight pipe to insure permanent anchorage of all fire lines. Fittings, clamps, clamp rods, nuts, washers, and glands shall be factory zinc-coated.

4.20 HANGERS: All piping shall be adequately and permanently supported in an approved manner on approved hangers. Minimally support piping on 8 foot intervals for pipe 3” and smaller; 10 foot intervals for larger piping. Also support within 24” of changes in direction and end of runs.

4.21 SLEEVES AND ESCUTCHEON PLATES: Furnish and install sleeves for pipes where piping penetrates masonry walls; exterior wall sleeves to be watertight. Fire and smoke stop all penetrations through fire and smoke walls and coordinate with General Contractor for locations. Furnish and install cast brass chrome plated split ring type escutcheons where piping penetrates walls, ceilings and floors, whether in finished areas or not.

4.22 INSPECTION TEST CONNECTIONS & PRESSURE GAUGES: A 1" inspection test connection as required by the Building Code. Discharge shall run to open air. Control valve for test connection shall be installed not over 7' above the floor. A pressure gauge at the inspection. Test connection at each location indicated on the Plans. Pressure gauges shall be 2½" diameter and readable from the floor.

4.23 SIGNS: Appropriate code approved and required signs shall be installed on all control valves, drains, inspector's test, etc., indicating the function, installation, etc. Signs shall be neatly affixed with rust inhibitive screws, rivets or where hung from piping; with stainless steel No. 14 AWG wire.

4.24 SPRINKLER HEAD CABINET: Furnish and install a cabinet, clearly labeled, with four (4) sprinklers of each type complete with required wrenches. Locate as directed by Engineer. Label "Sprinkler Heads".

PART 5 – SYSTEM DRAINAGE:

5.1 The entire System except that part which is below grade and will not freeze shall be installed so as to allow 100% drainage.

5.2 All sprinkler branch piping shall be installed so as to drain back to the main riser.

5.3 Approved 2" drawoff piping shall be provided on sprinkler risers with discharge piping running to nearest floor drain or open air.

5.4 Where sprinkler piping is trapped, an approved auxiliary draw-off shall be provided and neatly installed.

5.5 All draw-offs shall have a metal tag labeled "Sprinkler Drain".

PART 6 – INSPECTIONS AND TESTS:

6.1 Furnish all labor, equipment and conduct all required tests in the presence of the Owner and Engineer or designated representative if requested. Coordinate with Owner and Engineer prior to testing.

6.2 All interior and exterior piping and devices comprising the fire protection system shall be tested under hydrostatic pressure of not less than 200 PSI and maintained for not less than two (2) hours. Any leaks or cracks developing as a result of these tests shall be repaired to the satisfaction of the Owner.

6.3 Upon completion of their work, the Contractor shall submit a written and signed certificate to the Engineer indicating that they performed the above prescribed tests and rectified all malfunctions arising therefrom.

PART 7 – FIRE PUMP, JOCKEY PUMP AND CONTROLS

7.1 APPROVED MANUFACTURERS: Aurora, Peerless, ITT XYLEM AC,

7.2 The pump furnished for fire protection service shall be supplied with the specified electric motor, controls and pump accessory items by the pump manufacturer. The pump, motor and control shall be UL listed and FM approved for fire protection service. The pumping equipment shall be installed as recommended in the National Fire Protection Association (NFPA) Standard 20, Standard for the Installation of Centrifugal Fire Pumps. The fire pump shall also be capable of delivering not less than 150% of rated flow at not less than 65% rated head. The pump shall be furnished with drive, controls and accessories as indicated. Pump manufacturer shall have unit responsibility for the proper operation of the complete unit assembly as indicated by field acceptance tests.

7.3 Each individual pump shall be hydrostatically tested and run tested at the factory prior to shipment. The pump shall be hydrostatically tested at a pressure of not less than one and one-half times the no flow (shut off) head of the pump's maximum diameter impeller plus the maximum allowable suction head but in no case less than 250 PSIG.

7.4 A field acceptance performance test shall be conducted upon completion of pump installation. The test shall be made by flowing water through calibrated nozzles, approved flow meters or other such accurate devices as may be selected by the authority having jurisdiction. The test shall be conducted as recommended in NFPA Standard 20 by the installing contractor in the presence of the authority having jurisdiction and with that authority's final approval and acceptance. Failure to submit documentation of factory and field tests will be just cause for equipment rejection.

7.5 VERTICAL TURBINE PUMP: The fire pump shall be of a vertical turbine single stage construction specifically labeled for fire service. The pump shall be connected to the fire protection (sprinkler) system. The suction supply for the fire pump shall be from a underground storage tank infrastructure system. The pump casing shall be cast iron with 125 pound rating suction and 250 PSI pound rating discharge flanges. The flanges shall be machined to American National Standards Institute (ANSI) dimensions.

7.6 FITTINGS: The pump manufacturer shall furnish piping accessory items for the pump installation which will adapt the pump connections to the fire protection system and test connection as follows. Fittings subjected to pump discharge pressure shall be ANSI 250 pound rating. The following fittings subjected to suction pressure shall be ANSI 125 pound rating.

- Eccentric tapered suction reducer.
- Concentric tapered discharge increaser.
- Hose valve test head.
- Hose valves with caps and chains.

- Pump casing relief valve.
- Automatic air release valve.
- Ball drip valve.
- Suction and discharge pressure gauges.
- Low suction control valve.

7.7 ELECTRIC MOTORS: The pump driver shall be horizontal foot mounted ball bearing induction motor. The size of the motor is scheduled on the drawings. The motor locked rotor current shall not exceed the values stated in NFPA Pamphlet 20. The motor shall be mounted on a steel base common to the pump and shall be connected to the pump with a flexible coupling protected by a suitable guard. The fire pump manufacturer shall accurately align the pump and motor shaft prior to shipment. After field installation but prior to grouting the base, a millwright or similarly qualified person shall check and verify or correct the shaft alignment. The fire pump shall be provided with a SOFT START.

7.8 ELECTRIC MOTOR CONTROLLERS: The automatic electric motor controller shall be UL listed and FM approved specifically for fire pump service. Provide fire pump controller with integral open transition type transfer switch to comply with NFPA-20 & NFPA 70. Provide with integral over-current protection and disconnecting means for normal and emergency power feeds to transfer switch. Over-current protection shall be sized per NFPA-20 & NFPA-70. Controller and all components shall be service entrance rated. Controller shall have second utility option for emergency power feed.

7.9 JOCKEY PUMP: The jockey pump shall have a capacity as scheduled on the drawings. The motor enclosure shall be built to NEMA 56 frame standards. The pump shall have a cast iron frame and adapter fits to maintain axial alignment. The pump shall have threaded suction and discharge connection. The pump shall have mechanical seals. The pump shall be provided with a casing relief per NFPA 20.

7.10 FIRE PUMP TEST CONNECTION: Crocker 6800 Series with pipe size/number of inlets to match the fire pump capacity. Each outlet shall have a cast brass gate valve with cap and chain. Unit body shall be cast brass. Entire unit shall have a polish chrome finish.

PART 8 – ABOVE CEILING PIPING RELOCATION

8.1 Include in this project, the relocation of the following piping systems:
- Offset (__), 1” fire protection pipes, with (4) elbows and 20 feet total length.
- Offset (__), 1-1/4” fire protection pipes, with (4) elbows and 20 feet total length.

8.2 During Construction, the Contract Sum shall be increased OR decreased based on Contract unit prices for each of the above.

END OF SECTION.

DIVISION 22 – PLUMBING

SECTION 220100 - PLUMBING SPECIALTIES

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Contractor shall provide all equipment and specialties complete with trim required and connect in a manner conforming to the State Plumbing Code.

1.3 The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of the rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

1.4 All equipment and specialties shall be new. All equipment and specialties shall be installed as recommended by the manufacturer.

1.5 Prior to final inspection, test by operation at least twice, all equipment. Also, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from equipment and specialties and thoroughly clean same.

1.6 All equipment and specialties shall be installed in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost.

1.7 Provide all drainage specialties indicated, specified and/or required to provide complete and acceptable removal of all storm, sanitary, waste, laboratory waste, etc. from the building and into approved receptors. Drainage specialties shall be on non-electrolytic conduction to the material to which they are connected. Drainage specialties shall be installed in a manner so as to insure no leakage of toxic or odorous gases or liquids and shall have traps and/or backflow preventers where required. Nor shall they allow backflow into other or existing systems.

PART 2 - CLEANOUTS:

2.1 Cleanouts: In addition to cleanouts indicated on the drawings, provide cleanouts in soil and waste piping and storm drainage at the following minimum locations:

- At base of each stack.
- At fifty (50) foot maximum intervals in horizontal lines.
- At each change of direction of a horizontal line.
- As required to permit rodding of entire system.
- As required by current State Plumbing/Building Codes.

2.2 Water closets, mop sinks/basins and other fixtures with fixed traps shall not be accepted as cleanouts.

2.3 Cleanouts and/or test tees concealed in inaccessible pipe spaces, walls and other locations shall have an eight (8) inch by eight (8) inch (minimum) access panel or cover plates shall be set flush with finished floors and walls and shall be key or screw driver operable.

2.4 Access panels for cleanouts shall be of the Zurn 1460 series or equivalent by Josam or Wade. Where they are not to receive paint, they shall be polished bronze unless otherwise indicated where they are to receive paint or other finishes.

2.5 Cleanouts and access panels shall be sized so as to permit the entry of a full sized rodding head capable of one hundred percent circumferential coverage of the line served.

2.6 Provide a non-hardening mixture of graphite and grease on threads of all screwed cleanouts during installation.

2.7 Do not install cleanouts against walls, partitions, etc. where rodding will be difficult or impossible. Extend past the obstruction.

2.8 In finished walls, floors, etc., insure that cleanouts are installed flush with finished surfaces and, where required, grout or otherwise finish in a neat and workmanlike manner.

2.9 Exterior Cleanouts (ECO): Provide exterior cleanouts where indicated for all sanitary and storm lines leaving the building within 5'-0" of building perimeter. Permanently locate all exterior cleanouts with 12"x12"x12" solid finished concrete marker slightly above grade in grass areas or flush in concrete or pavement areas. Label "CO". Zurn Z-1400-HD cleanout with tractor cover for exterior locations. Provide concrete supporting pad crowned to shed water. Refer to drawings for pad size.

2.10 Cleanouts shall be as manufactured by Zurn, Josam, Wade, Ancon, Jay R. Smith, similar to the following:

- Zurn Z-1440 or Z-1445 cleanout tee at base of exposed stack and at change in direction of exposed lines.
- Zurn Z-1440 cleanout or Z-1445-1 cleanout tee where stacks are concealed in finished walls.
- Zurn ZN-1400-T cleanout with scoriated top in finished concrete and masonry tile floors.
- Zurn ZN-1400-Tx cleanout with square recessed top for VCT and linoleum finished floors.
- Zurn ZN-1400-Z cleanout with round recessed top for poured floors.
- Mueller D-731 or D-714, Nibco, Flage or equivalent for cleanouts in copper waste with cover plates and/or access panels listed for other cleanouts.
- Threaded hex head type cleanouts of same materials as pipe for piping 2" and smaller.
- Zurn cleanout with round top with adjustable retainer for carpet area. Install flush with carpet.

PART 3 – FLOOR DRAINS:

3.1 Floor Drains: Provide floor drains at locations indicated and/or as required by State Plumbing/Building Codes. Install in a neat and workmanlike manner. Install floor drains in strict accordance with manufacturer's recommendations and the State Plumbing and Building Codes. Coordinate locations with General Contractor to insure floor pitch to drain where required.

3.2 Insure by coordination with the General Contractor that spaces served with floor drains on all floors above the lowest level have a water seal extending at least three (3) inches from the floor. Also, for these locations, provide a 36"x36", four (4) pound sheet lead flashing sheet and clamping collar or a 30 mil chlorinated polyethylene shower pan liner. Lead pans shall be given a heavy coat of asphaltum on bottom and sides before installation and a heavy coat on any exposed surfaces. After installation, provide one ply of fifteen (15) pound roofing felt beneath each pan.

3.3 The floor drains shall be Zurn, Josam, Smith, Wade, Watts Drainage, Ancon, similar to the following:

- FD-1 - Zurn, ZN-415 floor drain with 6" dia. nickel bronze strainer, Type "B", dura-coated cast iron body with bottom 3" outlet. Provide with a trap primer conection or a Sure Seal Model SS3000 preassembled 3" Inline Floor Drain Trap Sealer. Commercial grade ABS plastic housing and neoprene rubber diaphragm with 1 soft rubber sealing gaskets. Floor rating ASSE – 1072 AF-GW.

- FD-2 - Zurn, ZN-511 floor drain with 9" dia. nickel bronze strainer, dura-coated cast iron deep sump with 4" bottom outlet, seepage pan and sediment bucket. Provide with a trap primer conection or a Sure Seal Model SS3000 preassembled 3” Inline Floor Drain Trap Sealer. Commercial grade ABS plastic housing and neoprene rubber diaphragm with 1 soft rubber sealing gaskets. Floor rating ASSE – 1072 AF-GW.

PART 4 – ROOF DRAINS:

4.1 Roof Drains: Provide roof drains at locations indicated within the Contract Documents. Install in a neat and workmanlike manner. Install roof drains in strict accordance with manufacturer's recommendations and the State Plumbing and Building Codes. Coordinate locations with General Contractor to insure pitch to drain.

4.2 Provide roof drains with accessories as required to match roof construction. Provide water tight seal at the connection of the body to the dome, to prevent roof water from entering into the body.

4.3 Adjust all water level regulators for overflow roof drains in the field.

4.4 Locate downspout nozzles in locations as directed by the Architect.

4.5 The roof drains shall be Zurn, Josam, Smith, Wade, Watts Drainage, Ancon, similar to the following:

- RD-1/OD1 - Zurn Z-164-SS 4” outlet roof drain, sump receiver, deck plate, cast iron dome strainer. Verify drain oulet & pipe size prior to ordering.
- OSD-1 – Zurn, ZARB-199-SS 4” outlet downspout nozzle. All rough bronze body, threaded inlet and decorative face of wall flange and outlet nozzle, with removable stainless steel screen. Verify drain outlet & pipe size prior to ordering.

PART 5 – FREEZEPROOF WALL HYDRANTS:

5.1 Freezeproof Wall Hydrants: Provide code approved wall hydrants at each location indicated in a neat and workmanlike manner. Affix tight to walls and insure that the feed piping is on the heated side of the building insulation blanket. Provide all water supply specialties indicated, specified and/or required for the complete installation. Install in accordance with the manufacturer's recommendations and the Building Code. Where required by the State Plumbing Code, install code approved vacuum breakers in each water supply specialty.

5.2 Wall hydrants shall be Zurn 1320 or equivalent, 3/4", with half-turn ceramic cartridge, encased, flush, non-freeze, anti-siphon, automatic draining wall hydrant with key lock and combination backflow preventer/vacuum breaker.

5.3 Mount all wall hydrants at least twenty (20) inches above finished exterior grade. Where this is not possible or practical, contact Engineer for direction.

5.4 Turn over for each hydrant, a key operator in an envelope labeled "Exterior Wall Hydrants" to Owner upon completion of the project. Where hydrants have lockable boxes, turn over a key operator for each in an envelope labeled "Exterior Wall Hydrant Locks” to Owner upon completion of project.

PART 6 – INTERIOR HOSE BIBBS AND DRAIN VALVES:

6.1 Hose Bibbs and Drain Valves: Provide code approved hose bibbs and drain valves at each location indicated in a neat and workmanlike manner. Affix hose bibs tight to walls. Provide all water supply specialties indicated, specified and/or required for the complete installation. Install in accordance with the manufacturer's recommendations and the Building Code. Where required

by the State Plumbing Code, install code approved vacuum breakers in each water supply specialty.

6.2 Toilet Room Hose Bibbs (HB):
Zurn Z1350-VB, Encased, Narrow Wall Hydrant, bronze body and bronze interior parts, key operated control valve and Vacuum Breaker.

6.3 Mechanical Room Hose Bibbs (HB-1): Provide code approved hose bibbs with vacuum breakers and male threaded spouts at each location indicated (mechanical rooms, etc.). The hose bibbs shall be Woodford Model 24 (or equal) with loose key handle polished chrome finish, brass construction. Hose bibbs shall be mounted at eighteen (18) inches above finished floor. Do not install hose bibbs in spaces which do not have floor drains. Do not install hose bibbs in ADA accessible toilet stalls.

6.4 Drain Valves: Install 3/4 inch bronze body drains, similar and equivalent to Nibco, No. 72 or 73, as indicated and at the following locations:

- At the low point and isolatable section of the plumbing system.
- At each low point and isolatable section of the hydronic system.
- At each isolatable pipe section.
- At each storage tank.
- At each heat pump.
- At each water-to-water unit.
- At each pump suction.
- Install a code approved vacuum breaker where installation on to domestic water system.

PART 7 – WATER HAMMER ARRESTORS (WHA):

7.1 Water Hammer Arrestors (WHA): Provide water hammer arrestors at each location indicated and/or as required to eliminate hydrostatic on the domestic water system. Install in an accessible location and in a neat and workmanlike manner. Provide all water supply specialties indicated, specified and/or required for the complete installation. Install in accordance with the manufacturer's recommendations and the Building Code. Where required by the State Plumbing Code, install code approved vacuum breakers in each water supply specialty.

7.2 Water hammer arrestors shall be Zurn, Z-1700, Shoktrol, Smith, Josam, Wade or equivalent. Water hammer arrestors shall be stainless steel, bellows type. Field fabricated capped cylinders shall not be acceptable. Provide insulating unions where arrestors are of dissimilar material from the piping served (unless piping is non-conducting, such as ABS or PVC).

7.3 Multiple Fixtures – Branch Line Less Than 20' Long: The preferred location for a Zurn Shoktrol is at the end of the branch line between the last two fixtures served when the branch lines do not exceed 20' in length, from the start of the horizontal branch line to the last fixture supply on this line.

7.4 Multiple Fixtures – Branch Line More Than 20' Long: On branch lines over 20' in length, use two Shoktrols whose capacities total the requirement of the branch. Locate one unit between the last and next to last fixture and the other unit approximately midway between the fixtures.

7.5 Provide at least one water hammer arrestor at all quick acting valve locations including:

- Clothes Washers – Type "A"
- Mop Basins, downstream of check valves – Type "A"
- Flush valve fixtures – Type "B", each toilet room with 1-3 flush valve fixtures shall have its own Type "B" water hammer arrestor.

7.6 Arrestor Schedule:

Mark	Zurn Model Z-1700	Fixture Units	P.D.I. Size
Type “A”	#100	1-11	A
Type “B”	#200	12-32	B
Type “C”	#300	33-60	C
Type “D”	#400	61-113	D

PART 8 - GENERAL SPECIALTIES:

8.1 Vacuum Breakers and Back Flow Preventers: Where required by the Building Code, whether indicated or not, provide approved vacuum breakers or backflow preventers at the following locations.

- Where domestic water system connects to hydronic system.
- At any threaded hose tap on the domestic water system.
- At all mop basins, provide check valves to the hot and cold water supply upstream of the faucet.

8.2 Roof Flashings: All plumbing vents or other plumbing passing thru the roof shall be flashed as approved by the State Plumbing and Building Codes and as recommended by the roofing manufacturer and/or Contractor.

END OF SECTION.

DIVISION 22 - PLUMBING

SECTION 220200 - PLUMBING FIXTURES, FITTINGS AND TRIM

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 The Contractor shall provide all fixtures complete with trim required and connect in a manner conforming to the State Plumbing Code.

1.3 The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of the rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

1.4 All fixtures and trim shall be new. All fixtures and trim shall be installed as recommended by the manufacturer. All fixtures shall be set level and true and shall be grouted into finished walls, floors, etc. in a neat and workmanlike manner with an approved waterproof non-yellowing grout for such service. All fixtures and trim hall be installed in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost. Pay particular attention to flush valves and bracket concealed portion to building structure during rough-in. Loose, shaky flush valves, lavatories, etc. shall not be acceptable.

1.5 Handicapped accessible fixtures shall be mounted as recommended by the Building Code and ADA. Special Note for Handicap Grab Rails: Coordinate top of shower valves, flush valves, flush tank, etc., with location of grab rails as shown on the architectural plans. The Contractor shall install all items to allow for installation, removal and service without removal of the grab bar.

1.6 Fixture seats shall be Church model 2155CTJ, elongated open front less cover w/ JUST-LIFT, STA-TITE check hinge and DuraGuard Antimicrobial Agent, or approved equal.

1.7 All exposed piping, stops, traps, tailpieces, etc. shall be code approved chrome plated brass unless otherwise indicated or specified. Where acid resistant piping is indicated on the drawing or the specifications, all piping and ancillary components from the sink/lavatory to dilution basin shall be acid resistant as specified and required by code.

1.8 Water supplies shall connect through walls with stops and chrome plated escutcheons with set screws. In general, furnish drinking fountains, wall-hung lavatories and hoseb bibbs with manual loose key stop valves. For all other fixtures, furnish with manual permanent-key stop valves (ie. sinks in casework, etc.). When in doubt, contact Engineer prior to installation.

1.9 Coordinate all stainless steel sinks with architectural casework shop drawings for appropriate fit. Do not order sinks until this has been coordinated. Change Orders will be immediately rejected for lack of coordination during construction.

1.10 Test for appropriate operation at least twice, ALL fixtures and trim including hands-free trim. Open all faucets and allow to run for fifteen (15) minutes, then remove all faucet aerators and thoroughly clean until smooth flow is obtained. Test by operation at least twice, adequate flow of water at flush valves including appropriate adjustment of hands-free devices, faucets including appropriate adjustment of hands-free devices, hose bibbs, fixture drains, shower heads, etc.

1.11 Remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from plumbing fixtures and thoroughly clean same.

1.12 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirement's manufacturers offering plumbing fixtures and trim which may be incorporated in the work include the following:

1.12.1 Plumbing Fixtures: American Standard, Sloan, Kohler, Zurn

1.12.2 Plumbing Trim: American Standard, Chicago Faucet, Kohler, Delta Commercial, T&S Brass, Moen Commercial, Speakman, Zurn Aqua-Spec

1.12.3 Flush Valves: Sloan, Zurn

1.12.4 Stainless Steel Sinks: Elkay, Just, Moen Commercial, Sterling

1.12.5 Service Sinks and Mop Basins: American Standard, Eljer, Fiat, Kohler, Mustee (Mop Basins), Acorn

1.12.6 Water Coolers: Elkay, Haws, Oasis, Halsey Taylor

1.12.7 Appliance Connection Boxes: Guy Gray, Oatley, Wolverine

1.12.8 Wash Fountains: Bradley, Acorn, Willoughby

1.12.9 Fixture Seats: Bemis, Church, Olsonite

1.12.10 Fixture Carriers: Josam, Kohler, Tyler Pipe, Zurn, Wade, Smith, Watts

PART 2 – PLUMBING FIXTURE SPECIFICATIONS:

P-1 Water Closet – Sensor Operated Flush Valve, Wall Mounted

Zurn model Z5615-BWL-AM vitreous china, elongated rim, siphon action water closet. Provide 1½" top spud, solid plastic elongated seat with open front, extended back, and check hinge. Provide with concealed carrier. Water closet flush valve shall be as follows:

- Hardwired automatic sensor operated flush valve shall be Zurn model ZEMS6000-IS-WS1 with P6000-HW6 power converter. 1.6 gpf.

P-1A Water Closet – ADA, Sensor Operated Flush Valve, Wall Mounted

Zurn model Z5615-BWL-AM vitreous china, elongated rim, siphon action water closet. Provide 1½" top spud, solid plastic elongated seat with open front, extended back, and check hinge. Provide with concealed carrier. Mount seat at 18" AFF. Install flush valve on "open" side of water closet. Water closet flush valve shall be as follows:

- Hardwired automatic sensor operated flush valve shall be Zurn model ZEMS6000-IS-WS1 with P6000-HW6 power converter. 1.6 gpf.

P-1B Water Closet – Flush Valve, Floor Mounted – Child Height

Zurn model Z5615-BWL-AM vitreous china, elongated rim, siphon action water closet. Provide 1½" top spud, solid plastic elongated seat with open front, extended back, and check hinge. Provide with concealed carrier. Mount seat at 18" AFF. Install flush valve on "open" side of water closet. Water closet flush valve shall be as follows:

- Manual flush valve shall be Zurn model Z6000-WS1. 1.6 gpf.

P-2 Lavatory – Standard, Backsplash, Self metering faucet, Wall Hung (student use)

Zurn model Z5344 vitreous china lavatory with backsplash, rectangular basin, splash lip, front overflow, and 4" center faucet holes. Provide with concealed arm support and wall carrier. Provide lavatory drain with integral perforated strainer, 3/8" angle rigid supplies with stops and P-trap. Lavatory trim shall be as follows:

- Self-metering faucet shall be Delta model 87T111 with polished chrome-plated cast brass body, single inlet, 3-3/4" centerline spout, and vandal resistant push-button handle. Furnish with vandal resistant 0.5 GPM aerator and 4" cover plate. Furnish and install Wilkins model ZW3870 tempering mixing valve.

P-2A Lavatory – ADA, Backsplash, Self metering faucet, Wall Hung (student use)

Zurn model Z5344, 20"x18" vitreous china lavatory with backsplash, rectangular basin, splash lip, front overflow, and 4" center faucet holes. Provide with concealed arm support and wall carrier. Provide lavatory drain with integral perforated strainer, 3/8" angle rigid supplies with stops and P-trap. Install insulation on the supply lines and P-trap similar to Brocar "Trap Wrap" vinyl plastic covering per ADA Standards. Mounting height to be per ADA. Lavatory trim shall be as follows:

- Self-metering faucet shall be Delta model 87T111 with polished chrome-plated cast brass body, single inlet, 3-3/4" centerline spout, and vandal resistant push-button handle. Furnish with vandal resistant 0.5 GPM aerator and 4" cover plate. Furnish and install Wilkins model ZW3870 tempering mixing valve.

P-2B Lavatory – ADA, Backsplash, Wall Hung (staff use)

Zurn model Z5344, 20"x18" vitreous china lavatory with backsplash, rectangular basin, splash lip, front overflow, and 4" center faucet holes. Provide with concealed arm support and wall carrier. Provide lavatory drain with integral perforated strainer, 3/8" angle rigid supplies with stops and P-trap. Install insulation on the supply lines and P-trap similar to Brocar "Trap Wrap" vinyl plastic covering per ADA Standards. Mounting height to be per ADA. Lavatory trim shall be as follows:

- Gooseneck faucet shall be T&S Brass model B-092 deck mounted faucet with 4" centers, brass construction, gooseneck spout, quarter turn ceramic cartridges, 4" wristblade handles and vandal resistant 1.5 GPM aerator.

P-2C Lavatory – ADA, Backsplash, Wall Hung

Zurn model Z5002.01Sundara Float Single Basin Hand Washing System, Solid Surface with backsplash, rectangular basin. Provide with concealed arm support and wall carrier. Provide lavatory drain with integral perforated strainer, 3/8" angle rigid supplies with stops and P-trap. Install insulation on the supply lines and P-trap similar to Brocar "Trap Wrap" vinyl plastic covering per ADA Standards. Mounting height to be per ADA. Lavatory trim shall be as follows:

- Hardwired sensor faucet shall be a Zurn model Z6950-XL-N deck mounted, faucet, field adjustable settings and 0.5 gpm vandal resistant aerator. Furnish and install Wilkins model ZW3870 tempering mixing valve.

P-3 URINAL - WALL-HUNG – STANDARD HEIGHT

Zurn model Z5755-U vitreous china, wall-hung, 1.0 GPF urinal with 3/4" top spud and concealed wall hanger brackets. Urinal flush valve shall be as follows:

- Hardwired automatic Sensor operated flush valve shall be Zurn model ZEMS6003-IS-WS1 with P6000-HW6 power converter.

P-3A URINAL – WALL-HUNG – ADA HEIGHT

Zurn model Z-5755-U vitreous china, wall-hung, 1.0 GPF urinal with 3/4” top spud and concealed wall hanger brackets. Mounting height shall be per ADA. Urinal flush valve shall be as follows:

- Hardwired automatic Sensor operated flush valve shall be Zurn model ZEMS6003-IS-WS1 with P6000-HW6 power converter.

P-4 Single Compartment Sink – 15”x17”, ADA

Elkay LRAD-151745, single compartment stainless steel sink, 15" x 17" O.D. x 4-1/2” deep, 18 gauge with 2-hole, 4" center faucet punching. Provide with grid strainer, 3/8" chrome supplies stops, tailpiece, P-trap, drain and escutcheons. Sink trim shall be as follows:

- Gooseneck faucet shall be T&S Brass model B-092 deck mounted faucet with 4” centers, brass construction, gooseneck spout, quarter turn ceramic cartridges, 4” wristblade handles and vandal resistant 1.5 GPM aerator.

P-4A Double Compartment Sink – 33”x22”

Elkay LRAD-332265, compartment stainless steel sink, 33" x 22" x 6.5”, each bowl, 18 gauge with 3-hole, 8" center faucet punching. Provide with grid strainer, chrome supply stops, tailpiece, 17 gauge P-trap, drain and escutcheons. Sink trim shall be as follows:

- Gooseneck faucet with wrist blade handles to be T&S Brass Faucet B-2866-134XPF15 concealed body faucet on 8" centers with swing gooseneck spout. Faucet to have cast bronze body with 4" forged brass wrist action handles, color coded indexes, quarter turn operating cartridges, polished chromium plated finish and 1.5 GPM vandal resistant aerator outlet.

P-4B Single Compartment Sink – 25”x17”, ADA

Elkay model DRKAD2220652LM, single compartment stainless steel sink, 22" x 20" O.D x 6.5” depth, 20 gauge with 3-hole, 4” center faucet punching. Punching shall be in a manner that 2 holes are punched at the center and front edge, a single punch shall be provided at opposite corner front edge for bubbler. Contractor shall provide shop drawings with punching information for review at time of submittal. U-Channel type mounting system shall be provided. Provide with grid strainer, 3/8" chrome supplies stops, tailpiece, P-trap, drain and escutcheons. Sink trim shall be as follows:

- Gooseneck faucet deck mounted single lever handle shall be Elkay model LK1000CR with polished chrome-plated cast brass faucet body on 4" centers with quarter turn ceramic disc cartridges and 5-3/8” swing gooseneck spout. Furnish with 1.5 GPM vandal-resistant aerator. Handle shall be located on the edge side on countertop.
- Bubbler deck mounted Elkay LKSS1141A stainless steel gooseneck glass filler. All components shall be lead free.

P-5 SHOWER, 36" X 60", HANDICAP – ENCLOSURE AND FITTING SET

Aqua Bath model C6436BF, ¾" acrylic and shall be molded from a single sheet so as to not have any joints or seams and shall meet ANSI Z124.2. The fixture shall also meet ADA and NAHB guidelines and other standards for accessibility. The enclosure shall have inside dimensions of 60"W x 36"D x 78"H and outside dimensions of 64"w x 37"D x 82-3/4" H. The unit shall be formed with a recessed trench system so as to direct water to the center drain. ADA states that threshold must be flush with the finished floor. The shower enclosure shall be installed in strict accordance with manufacturer's requirements. If shower is not installed securely, or if the shower has movement while standing on floor, the entire shower enclosure shall be removed and reinstalled properly at contractor's cost. Provide with the following accessories: grab bars and foldable seat, 1" stainless steel curtain rod, 10 oz. shower curtain with metal hooks, 2" cast brass drain with chrome strainer, recessed fluorescent light fixture.

Provide Symmons or equal pressure balancing mixing valve. Provide hand held shower head with arm and flange. Provide wall/hand shower with flexible metal hose, wall connection and flange 30" slide bar for hand shower mounting. Model to be Symmons S-96-300X-B30-L-V. All exposed parts, shall be chrome plated metal, which includes, but are not limited to the following: Hand held shower, flexible metal hose, shower head hook, wall mounted shower head hanger, escutcheons, and shower knob.

P-6 Mop Basin – 24"x24"

Fiat MSB-2424, 24" x 24" 10" high molded stone mop service basin in #231 white drift color and #874, 3" drain, Provide Chicago Faucet model 897-CP faucet, #832-AA hose and hose bracket, #889-CC mop hanger and #E-77-AA vinyl bumperguard. Provide with MSG stainless steel wall guards. Provide check valves on the hot and cold water supplies to the faucet.

P-7 Electric Water Cooler with Bottle Filling Station, Hi-Lo, ADA

Elkay Model LZSTL8WSLP filtered water cooler with bottle filling station. Bottle filling unit shall include an electronic sensor for no-touch activation with an automatic 30-second shut-off timer. Shall provide 1.1-1.5 gpm flow rate with laminar flow to minimize splashing. Shall include antimicrobial protected plastic components to prevent mold and mildew. Water cooler unit shall have push bar activation and water-efficient, vandal resistant bubbler. Shall include the filter, certified to NSF/ANSI 42 and 53 for lead reduction, with visual monitor to indicate when replacement is necessary. Bottle filling unit shall meet ADA guidelines for parallel approach. Cooler shall meet ADA guidelines for frontal or parallel approach. Unit shall be lead-free design which meets Safe Drinking Water Act and is certified to NSF/ANSI 61 and California AB1953. Unit shall be certified to UL 399 and CAN/CSA 22.2 No. 120. Provide each fixture with vandal-resistant bubbler, replacement filter 3-pack and receptacle adaptor plug.

P-8 Ice Maker Connection Box

IPS Corporation Water-Tite mini round ice maker outlet box with integral water hammer arrestor and preloaded nails. Connect cold water supply line to water supply at adjacent sink. Field paint exposed portions of box to match adjacent wall surfaces.

END OF SECTION.

DIVISION 22 - PLUMBING

SECTION 220300 - PLUMBING EQUIPMENT

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer's installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer's installation requirements whether specifically detailed or not within the Plans and Specifications.

1.3 The Contractor shall provide in complete working order the following plumbing equipment located as indicated and installed, connected and placed in operation in strict accordance with the manufacturer's recommendations. All equipment shall be factory painted and, where applicable, factory insulated and shall, where such standards exist, bear the label of the Underwriters Laboratory.

1.4 All equipment, material and labor warranties shall be furnished by the equipment supplier/vendor. All warranties begin on the date of Substantial Completion. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for special warranty requirements.

1.5 Review the Specification Section – REQUIRED SHOP DRAWINGS, ETC., and provide all documentations called for therein.

1.6 All plumbing equipment shall comply with the latest provisions of ASHRAE Standard 90.1 and all provisions of the International Energy Conservation Code.

1.7 Ensure that the equipment that is proposed to be furnish may be installed, connected, placed in operation and easily maintained at the location and in the space allocated for it.

1.8 Determine from the Bid Documents the date of completion of this project and ensure that equipment delivery schedules can be met so as to allow this completion date to be met.

1.9 Through coordination with other Contractors, Vendors and Suppliers associated with this Project, this Contractor shall ensure a complete, 100% functional, tested, inspected and approved systems. Claims for additional cost or change orders will immediately be rejected. Refer to Specification Section - ELECTRIC MOTORS, ETC. for additional requirements. All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

1.10 Review the Specification Section - CONTROLS to determine automatic controls requirements through the Building Automation System.

1.11 Review the Specification Section – TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS.

PART 2 – ELECTRIC WATER HEATERS:

2.1 ACCEPTABLE MANUFACTURERS: AO Smith, BOCK, State and Lochinvar.

2.2 Heater shall be rated as listed on the drawings and listed by Underwriters' Laboratories. Heater shall have 150 psi working pressure and be equipped with extruded high density anode rod. All internal surfaces of the heater exposed to water shall be glass lined with an alkaline borosilicate composition that has been fused to steel by firing at a temperature range of 1600 degree F. Electric heating elements shall be medium watt density with zinc plated copper sheath. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. The outer jacker shall be baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panels and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing.

2.3 Install water heaters on rubber/cork isolation pads.

2.4 EQUIPMENT START-UP: Prior to utilization of equipment, start-up service shall be performed by factory authorized representative. Utilize startup sheets provided by the manufacturer. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for additional requirements.

2.5 Provide four (4) hours of onsite training for this system. All training to occur after building completion. System shall function properly and O&M staff shall be able to operate the system prior to turnover.

END OF SECTION.

DIVISION 23 - HVAC

SECTION 230100 - PUMPS

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 Electric motors shall be furnished with the pumps and shall be of the size and type scheduled or otherwise specified. All motors shall be UL labeled and shall comply with applicable NEMA standard. Motors to be high efficiency type. Refer to Specification Section – ELECTRIC MOTORS, ETC.

1.3 Shop drawings shall be submitted as required and shall include complete pump specifications, installation and start-up instructions, current and accurate pump performance curves with the selection points clearly indicated, maintenance data and spare parts lists.

1.4 Pumps shall be factory tested, cleaned and painted prior to shipment. Size, type, capacity and electrical characteristics are listed in the pump schedule.

1.5 Insofar as possible, all pumps shall be by the same manufacturer.

PART 2 - CENTRIFUGAL INLINE PUMPS:

2.1 Pumps shall be in-line type, close-coupled, variable speed design, for installation in the horizontal position, and capable of being serviced without disturbing piping connections.

2.2 Pump casing shall be of Class 30 cast iron. The impeller shall be of cast bronze, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew.

2.3 The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A bronze shaft sleeve shall completely cover the wetted area under the seal.

2.4 Pumps shall be rated for minimum of 175 psi working pressure. The pump case shall have gauge tappings at the suction and discharge nozzles and will include vent and drain ports.

2.5 Motor shall meet NEMA specifications and shall be the size, voltage and enclosure called for on the plans. It shall have heavy-duty grease lubricated ball bearings, completely adequate for the maximum load which the pump is designed.

2.6 Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

2.7 Each pump Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable. Each motor shall have an Integrated Variable Frequency Drive. Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).

2.8 Pump shall have BACnet connections built into the VFD with the following analog inputs:

2.8.1 0-10V and 4-20mA, inputs built into the VFD for temperature control operation.

2.9 Pumps shall be manufactured by Bell & Gossett, Taco, Armstrong, Weinmann or approved equivalent.

PART 3 – END SUCTION BASE MOUNTED PUMPS:

3.1 End Suction Base Mounted Pumps shall be Series 1510 as manufactured by Bell & Gossett or equal by Taco, Armstrong, Patterson.

3.2 Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connection. Pump volute shall be Class 30 cast iron with integrally cast pedestal support feet. The impeller shall be cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew.

3.3 The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.

3.4 Baseplate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. A flexible type, center dropout design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupler shall be shielded by a coupler guard securely fastened to the base. Coupler shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical connections.

3.5 Provide all pumps with neoprene couplers. EPDM shall not be acceptable.

3.6 High efficiency motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by contractor after installation. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

3.7 Provide shaft guard with slotted window. Guard to be removable. Guard to meet ANSI B15.1, Section 8 and OSHA 1910.219 requirements.

3.8 Align pump and motor shafts and piping connections after setting them on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.

3.9 Comply with pump and coupling manufacturers' written instructions.

3.10 A qualified representative of the pump supplier shall perform the pump alignment prior to start-up of any base mounted separately coupled pump. Adjust alignment of pump and motor shafts for angular and parallel alignment by 1 of 2 methods specified in the H.I.'s Standards for Centrifugal, Rotary & Reciprocating Pumps, "Instructions for Installation, Operation and Maintenance."

3.11 After alignment is correct, tighten foundation bolts evenly but not too firmly. Fill base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

3.12 Alignment Tolerances: According to manufacturer's recommendations, but no more than ± .005” in the parallel and angular planes. Provide written report to Engineer and Owner from pump supplier indicating alignment procedure and readings from each pump installation

END OF SECTION

DIVISION 23 - HVAC

SECTION 230200 - HVAC EQUIPMENT

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

1.2 The Contractor shall provide in complete working order the following heating, ventilation and air conditioning equipment located as indicated and installed, connected and placed in operation in strict accordance with the manufacturer's recommendations. All equipment shall be factory painted and, where applicable, factory insulated and shall, where such standards exist, bear the label of the Underwriters Laboratory.

1.3 Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer's Checklists.

1.4 Factory startup is required for all HVAC equipment. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. Refer to Specification Section 15000.

1.5 All HVAC equipment shall comply with the latest provisions of ASHRAE Standard 90 and all provisions of the International Energy Conservation Code.

1.6 Note to Suppliers and Manufacturers Representative furnishing proposals for equipment for the project:

1.7 Review the Controls Section of these Specifications (if applicable) to determine controls to be furnished by the equipment manufacturer, if any.

1.7.1 All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

1.8 Review the section of these specifications entitle: REQUIRED SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS, TOOLS, ETC., and provide all documents called for therein.

1.9 Ensure that the equipment which you propose to furnish may be installed, connected, placed in operation and easily maintained at the location and in the space allocated for it.

1.10 Determine from the Bid Documents the date of completion of this project and insure that equipment delivery schedules can be met so as to allow this completion date to be met.

1.11 Electric motors shall be furnished with the equipment and shall be of the size and type scheduled or otherwise specified. All motors shall be UL labeled and shall comply with applicable NEMA standard. Motors shall be high efficiency type.

1.12 Review the Section on Motor Starters and Electrical Requirements for Mechanical Equipment.

1.13 Where manufacturer's temperature controls are specified, they shall be in full compliance with NFPA 90-A including automatic smoke shut down provisions.

1.14 For all belt driven equipment, provide final fan and motor sheaves as determined by the air balance contractor during project balancing phase. The mechanical contractor shall install any new sheaves and belts as required for balancing and smooth startup without any noticeable squealing.

PART 2 – INDOOR OUTSIDE AIR HANDLING UNITS:

2.1 GENERAL

2.2 Provide factory built and factory tested air handling units as indicated, as manufactured by Daikin, Trane or JCI of sizes and capacities as scheduled, and as specified herein. Unit layout shall be single path (single plenum), providing one path for outside air with all components arranged in series as specified. Factory fabricated air-handling units of sizes, capacities, and configurations as scheduled on drawings.

2.3 Provide factory built and factory tested air handling units of sizes, capacities and configurations as scheduled and as specified herein. Unit layout shall be dual path, providing one path for outside air with all components arranged in series as specified and providing one path for exhaust air with all components arranged in series as specified.

2.4 Provide factory installed external support kit on the base of the unit. Unit mounting devices not constructed of galvanized steel shall be chemically cleaned, coated with rust-inhibiting primer and finished with rust inhibiting enamel.

2.5 UNIT CASING

2.5.1 Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

2.5.2 Casing performance - Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft2 of casing surface area) = CL X P0.65.

2.5.3 Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

2.5.4 Under 55°F supply air temperature and design conditions on the exterior of the unit of 95°F dry bulb and 76°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.

2.5.5 Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).

2.5.6 Floor panels shall be double-wall construction and designed to support a 250-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span.

2.5.7 Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.

2.5.8 Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft2*°F/BTU.

2.5.9 Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.

2.5.10 Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.

2.5.11 Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

2.5.12 Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

2.6 ACCESS DOORS:

2.6.1 Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

2.6.2 All doors downstream of the cooling coil shall be provided with a thermal break construction of door panel and door frame.

2.6.3 Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

2.6.4 Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

2.6.5 Handle hardware shall be designed to prevent unintended closure.

2.6.6 Access doors shall be hinged and removable without the use of specialized tools to allow.

2.6.7 Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.

2.6.8 Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

2.6.9 All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.

2.6.10 Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

2.7 FAN SECTIONS:

2.7.1 Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.

2.7.2 Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.

2.7.3 All fans, including direct drive plenum fans, shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with 2 inch spring isolators. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

2.8 MOTORS AND DRIVES:

2.8.1 All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.

2.8.2 Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.

2.8.3 Fan Motors shall be heavy duty, open drip-proof operable. Motor efficiency shall meet or exceed NEMA Premium efficiencies.

2.8.4 Direct driven fans shall use 2-pole (3600 rpm), 4-pole (1800 rpm) or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.

2.8.5 Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

2.8.6 Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in startup and service personnel in maintenance a. Fan and motor sheave part number b. Fan and motor bushing part number c. Fan design RPM and motor HP.

2.8.7 Motors shall be 3 phase ODP with NEMA frame and 1.15 service factor. Motor base shall be adjustable. Motor brake horsepower shall not exceed scheduled values. Fan brake horsepower shall not exceed 85% of motor horsepower. All motors shall comply with EPACT efficiency requirements. Refer to Specification Section – 230513 – COMMON MOTOR ELECTRICAL REQUIREMENTS for more requirements. Fan sections controlled by variable frequency drives and shall be factory installed. Refer to Specification Section - CONTROLS for all VFD specification requirements.

2.9 COIL SECTIONS AND DRAIN PANS:

2.9.1 Provide double wall casing for coil sections. Inside surfaces exposed to the air stream shall be constructed of stainless steel. Design internal structure of coil section to allow for removal of coils. Provide suitable baffles to assure no air bypass around coils. Condensate drain pans and coil casing and all fasteners shall be constructed of stainless steel. Insulate coil section casings and drain pans as prior specified.

2.9.2 Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

2.9.3 Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

2.9.4 Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

2.9.5 Construct coil casings of stainless steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

2.9.6 All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

2.9.7 All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan.

2.9.8 The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. See section 2.07, paragraph F through H for specifications on intermediate drain pans between cooling coils.

2.9.9 The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

2.9.10 All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.

2.9.11 Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.

2.9.12 The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

2.9.13 Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

2.10 DAMPERS: Provide internally mounted ultra low leak outside air dampers. Dampers shall be double-skin airfoil design. Construct damper blades and damper frames of galvanized steel. Blades shall rotate on stainless steel sleeve bearings. Leakage rate shall not exceed 5 CFM/square foot at one inch water gauge and 9 CFM/square foot at 4 inches water gauge.

2.11 FACE AND BYPASS SECTION: Face and bypass section shall include hot/chilled water coil. A horizontal blank off wall shall be factory installed to bypass coil when damper is in the bypass position.

2.12 FILTERS: Filters shall be 2" thick, 35% efficient (min.) Merv 8, pleated and disposable. The filter pressure drop shall be 0.28" at 500 fpm face velocity. Each filter shall consist of a non-woven cotton and synthetic fabric media, media support grid and enclosing frame. The filter shall be listed by Underwriters' Laboratories as Class 2. Provide filter boxes with either hinged access doors at each end. Provide racks to receive filters in either flat or angle type pattern. Provide air filters to fit in filter box of the type scheduled on the drawings. Sizes and quantities shall be per the manufacturer's recommendations. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for Temporary Use of Equipment Requirements and filter quantities.

2.13 EQUIPMENT START-UP: Prior to utilization of equipment, start-up service shall be performed by factory authorized representative. Utilize startup sheets included in the Specification Section GENERAL PROVISIONS - MECHANICAL. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for additional requirements.

2.14 Provide eight (8) hours of onsite training for this system. All training to occur after building completion. System shall function properly and O&M staff shall be able to operate the system prior to turnover.

PART 3 - GEOTHERMAL HEAT PUMP UNITS:

3.1 Subject to compliance with requirements, provide water-source heat pumps by one of the following:

3.1.1 Acceptable Manufacturers: Water Furnace, Hydro-Temp or Trane or Florida Heat Pump.

3.2 The contractor shall furnish and install high efficiency, two stage water source heat pump unit(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled. Filtration is external to unit. Refer to filtration specifications, filter schedules and details.

3.3 A 100% complete mockup installation shall be required for a typical unit. This mockup shall be inspected/reviewed by the Engineer prior to installation of other units. Any mechanical closet dimension modifications or access requirements due to the manufacturer specifics shall be the

burden of the manufacturer and contractor. Coordinate access, maintenance, clearances and unit removal with equipment space as planned and provided.

3.4 Equipment shall be specifically designed for applications within conditioned interior areas. Capacities shall be rated in accordance with ARI for geothermal applications. Equipment shall be ETL or CSA approved. All equipment shall have decals and labels to aid in servicing and indicate caution areas.

3.5 Equipment shall be completely factory assembled and tested, piped, internally wired and fully charged with Refrigerant R-410A. Threaded female water inlet and outlet connections, threaded female condensate connection, duct collars and all safety controls shall be furnished and factory installed. Field installed DDC controller and controls shall be coordinated for BMS Interface and operation.

3.6 A terminal block with screw terminals shall be provided for control wiring. A condensate overflow device shall be factory installed to stop compressor operation if drain pan overflow is imminent. An energy management relay to allow unit control by an external source shall be factory installed.

3.7 Refer to Specification Section 200100 for special warranty requirements.

3.8 GENERAL UNIT DESCRIPTION:

3.8.1 Equipment shall be reverse cycle heating and cooling type and have an operating range between 25 and 120 degrees entering water temperature. The unit shall be factory assembled, piped, internally wired, fully charged with R-410A refrigerant and oil and test operated at the factory in both cooling and heating mode.

3.8.2 Products shall be designed, rated and certified in accordance with ETL, CETL and ISO-AHRI 13256-1. Units shall meet the efficiency standards of the ASHRAE 90.1 2010 Standard.

3.8.3 Unit(s) shall consist of heavy gauge, galvanized steel casing with compressor, water-to-refrigerant heat exchanger, air-to-refrigerant heat exchanger, thermal expansion valve, reversing valve, return-air filter, supply air fan motor and unit controls.

3.9 CABINET:

3.9.1 Provide unit factory assembled and pre-wired consisting of heavy gage galvanized steel cabinet with ½-inch thick cleanable foil faced glass fiber insulation on interior. The insulation shall be UL listed and meet NFPA-90A and UL 181 standard. Discharge duct collar and return air duct collar to accommodate flexible connections which allow unit removal.

3.9.2 Units shall be of vertical configuration with airflow arrangements as required for indicated installation (right return/top supply, right return/ back supply, left return/top supply or left return/back supply). Coordinate left/right connections as required for installation.

3.9.3 Access for inspection for inspection and cleaning of the unit drain pan, coils and fan section shall be provided. (Front access only).

3.10 REFRIGERATION SYSTEM:

3.10.1 Compressor: The unit shall include a compressor. External vibration isolation shall be provided by mounting devices located underneath the mounting base of the compressor. Thermal overload protection shall be provided.

3.10.2 Water-to-Refrigerant Heat Exchanger: The water-to-refrigerant heat exchanger shall be of a high quality co-axial coil for maximum heat transfer and insulated to prevent condensation at low temperatures. The copper coil shall be fluted to enhance heat transfer and minimize fouling and scaling. The coil shall have a working pressure of 600 psig on the refrigerant side and 400 psig on the water side.

3.10.3 Reversing Valve: The reversing valve shall be a pilot operating sliding piston type with replaceable encapsulated magnetic coil. This valve shall be energized in cooling.

3.10.4 Tubing: The refrigerant tubing shall be of 99% pure copper. This system shall be free from contaminants and conditions such as drilling fragments, dirt, and oil. All refrigerant and water lines shall be insulated with an elastomeric insulation that has a 3/8" thick wall wherever air is introduced to the assembly.

3.10.5 Refrigerant Metering: The equipment shall be provided with a thermal expansion valve (TXV). Capillary tubes may only be used if unit manufacturer provides water-regulating valve.

3.10.6 Schraeder Connections: The refrigerant access ports shall be factory supplied on the high and low pressure sides for easy refrigerant pressure or temperature testing.

3.10.7 Air-to-Refrigerant Coil: The air-to-refrigerant coil shall contain copper tubes mechanically expanded into evenly spaced aluminum fins. All coils are to be leak tested. The proof must be performed at 450 psi operating pressure and the leak test at 125 psi operating pressure with helium. In addition, the tubes are to be completely evacuated of air prior to shipment. The refrigerant coil distributor assembly shall be of orifice style with round copper distributor tubes. The tubes shall be sized consistently with the capacity of the coil. Suction headers shall be fabricated from rounded copper pipe.

3.11 ELECTRICAL: The factory tested and installed unit control box shall contain all necessary devices to allow heating and cooling operation of the equipment to occur from a building DDC control system utilizing thermostats and zone sensors. These devices shall be as follows:

3.11.1 24 VAC contactor for compressor control.

3.11.2 18 pole terminal strip located inside the control panel behind the service access panel. This terminal strip shall be used for low voltage (thermostat/zone sensor) connections.

3.11.3 An electrically operated safety lockout relay shall help prevent cycling of the compressor during adverse conditions of operation. This device shall be reset either at the remote thermostat/zone sensor, or by cycling power to the unit.

3.11.4 A high pressure switch shall help protect the compressor against operation at refrigerant system pressure in excess of 395 psig.

3.11.5 A low pressure switch shall help prevent compressor operation under low charge or catastrophic loss of charge situations.

3.12 SUPPLY AIR FAN AND MOTOR ASSEMBLY:

3.12.1 The fan shall be of forward-curved style wheel constructed of corrosion resistant galvanized material. The fan is placed in a draw-through configuration and shall be arranged for top or back supply air. This assembly shall attach the wheel and motor to the fan housing providing single side service access.

3.12.2 The fan motor is an ECM programmable type motor. The motor shall be pre-programmed at the factory for variable air flow. Minimum and maximum airflow settings shall be configurable.

3.12.3 The motor shall have permanently lubricated and sealed bearings and shall be protected by an internal thermal overload. Removal of the motor and fan wheel shall be made with the assistance of a factory provided orifice ring assembly. This assembly shall attach the wheel and motor to the fan housing providing single side (front) service access.

3.13 DRAIN PAN: The drain pan shall be constructed of stainless steel and insulated to prevent sweating. The bottom of the drain pan shall be sloped on two planes which pitches the condensate to the drain connection. When the unit is installed per the installation manual, the drain pan shall be designed to leave puddles no more than 2" in diameter, no more than 1/8" deep, for no longer than 3 minutes by temporarily plug the drain pan; fill the drain pan with 2" of water or the maximum allowed by the drain pan depth, whichever is smaller; and remove the temporary plug.

3.14 CONTROLS: Each WSHP shall be controlled by a field installed communicating microprocessor based controller with WSHP control logic.

3.15 UNIT CONTROLS – SAFETIES: A factory tested and installed control box shall contain all necessary devices to allow heating and cooling operation of the equipment to occur. These devices shall be as follows:

3.15.1 24 Vac, energy limiting class II transformer.

3.15.2 Blower motor controller shall be a 24 Vac relay.

3.15.3 Compressor controller shall be a 24 Vac contactor. All three-phase operated equipment shall have a contactor that interrupts all three-phases providing power to the compressor.

3.15.4 Anti-short cycling of the compressor during adverse conditions of operation. This device may be reset by either a remote thermostat or momentary interruption of power.

3.15.5 High pressure switch shall protect the compressor against operation at refrigerant system pressures in excess of 395 PSIG.

3.15.6 Low pressure switch shall prevent compressor operation underneath low charge or catastrophic loss of charge situations.

PART 4 – HEAT PUMP SYSTEM FILTRATION:

4.1 AIR FILTER SYSTEM: The Contractor shall completely assemble an Air Filter System for each unit and install ready to use. Heat pumps 5 tons and smaller require one 24" X 24" air filter system (one 24 X 24 filter). Heat pumps 6 tons through 10 tons require one 48" X 24" air filter system (two 24 X 24 filters). Heat pumps larger than 10 tons require one 48" x 48" air filter system (four 24 X 24 filters). See plans for sizes and quantities. Refer to Specification Section 230100 - COMMON WORK RESULTS FOR HVAC for Temporary Use of Equipment Requirements and filter quantities.

4.2 Side Access Filter Housing: Housings shall accommodate required quantity of 24" X 24" X 2" deep flat filters as noted above. Housings shall be factory assembled, have one hinged access door with quick access latches (operable without special tools), and be constructed on 18 gauge aluminized steel minimum.

4.3 Filters shall be 35% (min.) efficient Merv 8, pleated and disposable. Provide Flanders/FFI Pre Pleat 40, 24" x 24" x 2" thick or approved equal. The filter pressure drop shall be less than 0.25" at 400 fpm face velocity (mid-life). Each filter shall consist of a non-woven cotton and synthetic

fabric media, media support grid and enclosing frame. The filter shall be listed by Underwriters' Laboratories as Class 2.

PART 5 - GEOTHERMAL HEAT PUMP CHILLERS:

5.1 ACCEPTABLE MANUFACTURERS: ARCTI-CHILL, CLIMACOOL, AND MULTISTACK.

5.2 System Description: Heat Pump shall incorporate Scroll-type compressors and can consist of multiple modules. Each refrigerant circuit shall consist of an individual compressor, common dual circuited condenser, dual circuited evaporator, thermal expansion valves, reversing valve, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit heat pump must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits. Circuits shall not contain more than 12 lb. of R-410a refrigerant.

5.3 Equipment shall be specifically designed for applications within conditioned interior areas. Capacities shall be rated in accordance with ARI for geothermal applications. Equipment shall be ETL or CSA approved. All equipment shall have decals and labels to aid in servicing and indicate caution areas.

5.4 Equipment shall be completely factory assembled and tested, piped, internally wired and fully charged with Refrigerant R-410A. Threaded female water inlet and outlet connections, threaded female condensate connection and all safety controls shall be furnished and factory installed.

5.5 A terminal block with screw terminals shall be provided for control wiring. An energy management relay to allow unit control by an external source shall be factory installed.

5.6 Refer to Specification Section 200100 for warranty requirements.

5.7 OPERATING CONDITIONS:

5.7.1 Provide water-to-water heat pump with the capacity as scheduled on drawings at job site elevation operating with 45°F to 120°F geothermal water supply temperature.

5.7.2 Heat Pump shall be designed to operate using R-410a Refrigerant.

5.7.3 Heat Pump shall be designed for parallel evaporator water flow.

5.7.4 The liquid to be heated and cooled will be water containing corrosion inhibitors.

5.8 GENERAL:

5.8.1 Heat Pump Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236.

5.8.2 Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment on an AHRI certified or 3rd party verified test stand.

5.8.3 Compressors, heat exchangers, piping and controls shall be mounted on a heavy gauge, powder coated steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module.

5.9 Water Mains: Each module shall include supply and return mains for both load and source-sink water. Cut grooved end connections are provided for interconnection to six inch standard (6.625" outside diameter) piping with grooved type couplings. Rolled grooved shall be unacceptable.

Water Mains shall be installed such that they are beneath any power or control wiring so as to insure for safe operation in the event of condensation or minor piping leaks.

5.10 Heat Exchangers: Each load and source-sink heat exchanger shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig refrigerant side working pressure and 360 psig water side working pressure. Heat exchangers shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

5.11 Compressor: Each module shall contain two hermetic scroll compressors independently circuited and with internal spring isolation mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure manual reset safety cut-outs.

5.12 CENTRAL CONTROL SYSTEM.

5.12.1 Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.

5.12.2 The Master Controller shall monitor and report the following on each refrigeration system:

- Discharge Pressure Fault
- Suction Pressure Fault
- Compressor Winding Temperature
- Suction Temperature
- Load Leaving Water Temp.
- Source-Sink Leaving Water Temp.

5.12.3 The Master Controller shall be powered by the chillers single point power connection and shall monitor and report the following system parameters:

- Load Water Entering and Leaving Temperature
- Source-Sink Water Entering and Leaving Temperature
- Load Water and Source-Sink Water Flow

5.12.4 An out of tolerance indication from these controls or sensors shall cause a “fault” indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire heat pump will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller’s 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).

5.12.5 Individual monitoring of leaving water temperatures from each refrigeration system shall be programmed to protect against heat exchanger freeze-up.

5.12.6 The control system shall monitor entering and leaving water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to optimize the heat pump performance to different existing building loads.

5.12.7 The heat pump mode (heating or cooling) shall be selected by an external dry contact interlock to the Master Controller. If no interlock is present or in the event of a reversing valve solenoid failure, the system shall revert to heating mode.

5.12.8 Heat pump shall have a single point power connection and external inputs and outputs to be compatible with the building management system.

5.13 Each inlet water header shall incorporate a built in 30-mesh (maximum) in-line strainer system to prevent heat exchanger fouling and accommodate 100% flow filtration with a minimum surface area of 475 sq inches per module.

5.14 Single Point Power: Chiller shall be equipped with a pre-engineered genuine buss bar electrical system for single point power rated at a 5,000 amp SCCR. Where the equipment size exceeds the amp rating of the buss bar, multiple power connections may be applied. Pre-engineered system shall also incorporate individual module isolation circuit breakers for full redundancy and ability of a module to be taken off-line for repair while the rest of the modules continue to operate. Individual power feeds to each module shall be unacceptable.

5.15 SAFETIES, CONTROLS AND OPERATION:

5.15.1 Heat pump safety controls system shall be provided with the unit (minimum) as follows:

- Low refrigerant pressure
- Loss of flow through the source/sink heat exchanger
- Loss of flow through the load heat exchanger
- High refrigerant pressure
- High compressor motor temperature
- Low suction gas temperature
- Low leaving water temperature

5.16 Failure of heat pump to start or heat pump shutdown due to any of the above safety cutouts shall be annunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.

5.17 The heat pump shall be furnished with a Master Controller as an integral portion of the heat pump control circuitry to provide the following functions:

5.17.1 Provide automatic heat pump shutdown during periods when the load level decreases below the normal operating requirements of the heat pump. Upon an increase in load, the heat pump shall automatically restart.

5.17.2 Provisions for connection to automatically enable the heat pump from a remote energy management system.

5.17.3 The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.

5.18 NORMAL HEAT PUMP OPERATION:

5.18.1 When heat pump is enabled, the factory supplied Master Controller modulates the heat pump capacity from minimum to maximum as required by building load.

5.18.2 The heat pump control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

5.18.3 The operating mode (heating or cooling) shall be determined by a customer provided dry contact interlock.

5.19 POWER PHASE MONITOR:

5.19.1 Provide a Power Phase Monitor on the incoming power supply to the heat pump. This device shall prevent the heat pump from operating during periods when the incoming power is unsuitable for proper operation.

5.19.2 The Power Phase Monitor shall provide protection against the following conditions:

- Low Voltage (Brown-Out)
- Phase Rotation
- Loss of Phase
- Phase Imbalance

5.20 HOSE KIT & PIPING PACKAGE: Hose kits and piping package shall be as scheduled on the drawings. Two piece hose kits shall be provided for hose kits that are 2" and larger in size. Hose kits shall be the pipe runout size, not heat pump connection sizes. No exceptions! Hose kit and piping package configuration shall match the Geothermal Heat Pumps specifications. Refer to HOSE KIT Specification Section for additional requirements.

5.21 EQUIPMENT START-UP: Prior to utilization of equipment, start-up service shall be performed by factory authorized representative. Utilize startup sheets included in the Specification Section GENERAL PROVISIONS - MECHANICAL. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for additional requirements.

5.22 Provide eight (8) hours of onsite training for this system. All training to occur after building completion. System shall function properly and O&M staff shall be able to operate the system prior to turnover.

PART 6 - HEAT PUMP UNIT - HOSE KIT & PIPING PACKAGE:

6.1 Hose kits and piping package shall be as scheduled on the drawings. Single piece hose kits shall be provided for hose kits that are 1-1/2" or less in size. Two piece hose kits shall be provided for hose kits that are 2" and larger in size. Hose kits shall be the pipe runout size, not heat pump connection sizes. No exceptions!

6.2 Provide a factory-assembled hose kit/piping package for supply and return connections for each heat pump. Kits may be mounted in any direction and shall not require straight sections of pipe either upstream or downstream for proper operation. All hoses shall be equipped with end connections at terminal unit and shall be 24" long. All end connections shall be either permanently crimped swivel ends or butt welded to carbon steel end fittings to meet stated pressure ratings. Operational temperature shall be rated from fluid freezing to 200 degrees F. Minimum burst pressure shall be four times the working pressure. Furnish with field flushing connection fitting. Up to 1-1/4" shall be reinforced, fire retardant EPDM rubber, bonded to the inside wall of braiding. 1 ½" and larger shall be a corrugated type 321 stainless steel tube.

6.3 Each supply side (water inlet) hose kit/piping package shall include a single piece Y - valve body for sizes up to 1-1/2" and shall be constructed of hot forged brass with threaded inlets and outlets. 2" and larger sizes shall be two-piece and constructed of ductile iron with threaded inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure. Include single pressure/temperature test ports for verifying the pressure differential and system temperature. Include full flow design ball valve with blow out stems for shut off. Strainer shall be Y-type configuration furnished with hose connector blow down valve. Strainer screen shall be

stainless steel mesh and easily accessible for cleaning without disconnecting hoses. All valves shall be labeled with flow direction, manufacturer and model number, unit tagging.

6.4 Each return side (water outlet) hose kit/piping package shall include a single piece Y - valve body for sizes up to 1-1/2" and shall be constructed of hot forged brass with threaded inlets and outlets. 2" and larger sizes shall be two-piece and constructed of ductile iron with threaded inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure. Include single pressure/temperature test ports for verifying the pressure differential and system temperature. Include full flow design ball valve with blow out proof stems for shut off. All valves shall be labeled with flow direction, manufacturer and model number, unit tagging. Include automatic flow control valves which shall be factory set to rated flow and shall automatically control the flow to within 10% of the rated value subject to the operating parameters of 2-80 psid, fluid freezing to 225°F, 2-7 fps. Also provide a three-wire, two-way, two-position control valve with actuator. Actuator shall be field installed by the TCC.

PART 7 – HYDRONIC SPECIALTIES:

7.1 PRESSURIZED EXPANSION TANKS: Provide diaphragm compression tanks of size and number as indicated. Construct tank of welded steel, constructed, tested and stamped in accordance with section VII of the ASME Boiler and Pressure vessel code for a working pressure of 125 SI. Furnish National Board Form U-1 denoting compliance. Support vertical tanks with steel legs or base, support horizontal tanks with steel saddles. Provide specially compounded flexible diaphragm securely sealed into tank to permanently separate air change from system water to maintain design expansion capacity. Provide pressure gauge and air charging fitting.

END OF SECTION

DIVISION 23 - HVAC

SECTION 231100 - REGISTERS, GRILLES, DIFFUSERS & LOUVERS

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

PART 2 – REGISTERS, GRILLES AND DIFFUSERS:

2.1 Acceptable R, G & D manufacturers are Krueger, Anemostat, Titus and Tuttle & Bailey. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes for specified devices shall be selected by the Architect. Factory color samples shall be submitted with shop drawings. Devices shall be white unless noted otherwise. Aluminized steel devices are not acceptable. Steel devices are not acceptable unless specifically noted otherwise.

2.2 Include with the shop drawings a room-by-room schedule indicating devices installed. Also note ceiling types and installations.

2.3 Refer to drawings for schedule.

PART 3 – LOUVERS:

3.1 Acceptable louver manufacturers are Ruskin, United Enertech, Arrow. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect. Factory color samples shall be submitted with shop drawings.

3.2 Refer to drawings for schedule.

END OF SECTION.

DIVISION 23 - HVAC

SECTION 231200 - SHEET METAL

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's Duct Manual and Sheet Metal Construction for Low Velocity Ventilating and Air Conditioning Systems. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.

1.3 Ductwork shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4” above the floor and shall be completely covered in plastic. Installed ductwork shall be protected with plastic. Do not install the ductwork if the building is not “dried-in”. If this is required, the entire lengths of duct shall be covered in plastic to protect. The Owner/Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing a NADCA certified Contractor.

1.4 Prior to purchase and fabrication of ductwork (shop fabricated or manufactured), the Contractor shall coordinate installations with new and existing conditions. Notify the Engineer if there are any discrepancies for resolution.

PART 2 – LOW VELOCITY DUCTWORK:

2.1 Ductwork, plenums and other appurtenances shall be constructed of one of the following: Steel sheets, zinc coated, Federal Specification 00-S-775, Type I, Class E & ASTM A93-59T with G-90 zinc coating. Aluminum alloy sheets 3003, Federal Specification AA-A-359, Temper H-14.

2.2 Ductwork, plenums and other appurtenances shall be constructed of the materials of the minimum weights or gauges as required by the latest SMACNA 2” W.G. Standard or below table. When gauge thickness differs, the heavier gauge shall be selected. The below table shall serve as a minimum.

Round Diameter	Duct Gauge	Rectangular Width	Duct Gauge
3-12 Inches	26 Ga.	3-12 inches	26 Ga,
12-18 Inches	24 Ga.	13-30 inches	24 Ga.
19-28 Inches	22 Ga.	31-54 inches	22 Ga.
29-36 Inches	20 Ga.	55-84 inches	20 Ga.
37-52 Inches	18 Ga.	85 inches and up	18 Ga.

2.3 All ductwork connections, fittings, joints, etc., shall be sealed. Seal with high velocity, smooth-textured, water based duct sealant. Sealant shall be UL 181B-M listed, UL 723 classified, NFPA 90A & 90B compliant, permanently flexible, non-flammable, and rated to 15”wg. Apply per manufacturer's recommendations. Contractors shall insure no exposed sharp edges or burrs on ductwork.

2.4 Duct dimensions indicated are required inside clear dimensions. Plan duct layouts for adequate insulation and fitting clearance.

2.5 All angular turns shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct.

2.6 Cross-break all ducts where either cross sectional dimension is 18" or larger.

2.7 Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. There shall be no less than one set of hangers for each section of ductwork. Where ductwork contains filter sections, coils, fans or other equipment or items, such equipment or items shall be hung independently of ductwork with rods or angles. Do not suspend ducts from purlins or other weak structural members where no additional weight may be applied. If in doubt, consult the Structural Engineer.

2.8 Double turning vanes shall be installed in square turns and/or where indicated.

2.9 Provide a “high efficiency” type take-off with round damper (Flexmaster STOD-B03 or approved equal) for all round duct branches from a rectangular main to a GRD. Refer to the detail on the drawings for all installation requirements.

2.10 Air volume dampers shall be installed in each duct branch takeoffs and/or where indicated, whichever is more stringent. All such dampers shall be accessible without damage to finishes or insulation and shall be provided where required for proper system balance.

2.11 Unless otherwise dimensioned on the drawings, all diffusers, registers and grilles shall be located aesthetically and symmetrically with respect to lighting, ceiling patterns, doors, masonry bond, etc. Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.

2.12 The interior surface of the ductwork connecting to return/exhaust air grilles shall be painted flat black. The ductwork shall be painted a minimum of 24" starting from the grille.

2.13 Provide approved flexible connectors at inlet and outlet of each item of heating and cooling equipment whether indicated or not. Install so as to facilitate removal of equipment as well as for vibration and noise control.

2.14 All fans and other vibrating equipment shall be suspended by independent vibration isolators.

2.15 Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed at the inlet and discharge of all centrifugal fans, Fan sections of air handling units, at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

2.16 Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panel at each fire damper located and sized so as to allow hand reset of each fire dampers. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. All access doors shall be 16"x16" or as high as ductwork permits and 16" in length.

2.17 The Contractor who installs the sheet metal shall furnish to the Air Balancing Contractor, a qualified person to assist in testing and balancing the system.

2.18 Insulated Flexible Air Duct: Thermaflex G-KM or equal. Flexible air duct shall be one (1) inch thick fiberglass insulation with CPE liner permanently bonded to a coated spring steel wire helix supporting a fiberglass scrim and fiberglass insulating blanket. Flexible air duct shall be listed under UL Standard 181 as a Class I flexible air duct complying with NFPA 90A and 90B. Maximum flame spread = 25 and maximum smoke developed = 50. Minimum insulating value is R-6.0. Flexible duct shall be used only for GRD runouts and no section shall be more than five feet in length.

2.19 Flexible Connectors: Duro-Dyne, Ventfabrics, Inc., U.S. Rubber or equivalent; conforming to NFPA No. 90A; neoprene coated glass fabric; 20 oz. for low velocity ducts secured with snap lock.

2.20 Turning Vanes: Fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.

2.21 Access Doors in Ductwork: Flexmaster TBSM, Air Balance, Vent Products or equal. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length. Door shall be 2” thick double-wall insulated with continuous hinge and cam lock. Provide in ducts where indicated or where required for servicing equipment whether indicated or not. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position. Access doors shall also be provided on each side of duct coils.

2.22 Volume Dampers (Rectangular): Ruskin MD35 or Air Balance, Pottorff, rectangular volume dampers. Frames shall be 18 gauge galvanized steel. Blades shall be opposed blade 18 gauge galvanized steel with triple crimped blades on 6” centers. Linkage shall be concealed in jamb. Bearings shall be ½” nylon. Maximum single section size shall be 48" wide and 72" high. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

2.23 Volume Dampers (Round): Ruskin MDR525 or Air Balance, Pottorff round volume dampers. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 22 gauge steel and 5" long. Damper blades shall be 20 gauge crimped galvanized steel. Axle shall be 3/8"x5” square plated steel. Bearing shall be 3/8” nylon. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

2.24 Fire Dampers: Fire dampers shall be Ruskin 1BD2 1½ hour rating U-215B vertical 1½ hour rating or United Air Type U-255B for a 3 hour vertical rating. Other acceptable manufacturers are Air Balance or Pottorff. Fire dampers shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1½ or 3 hour fire protection rating as required by fire wall. Damper shall have a 165 degrees F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing minimum 20 gauge steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Blade and frame thickness shall be a minimum of 24 gauge. Installation shall be in accordance with the damper manufacturer's instructions. The blades shall be out of the air stream. Provide an access door for fire damper reset at all fire damper locations. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

2.25 Motor Driven Smoke Dampers – Air Foil Blade: Provide Ruskin SD60 smoke damper where required by the locations of smoke partitions or as shown on the plans, whichever is more stringent. Other acceptable manufacturers are Air Balance or Pottorff. All smoke dampers shall be three inches larger than HVAC duct in each direction. Frame shall be a minimum of 18 gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for

reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14 gauge equivalent thickness, on 6" maximum centers. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close under HVAC system operating conditions) with pressures of at least the maximum possible of the HVAC system in the closed position, and the system maximum duct air velocity in the open position. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Actuator to be mounted outside of air stream. The pressure drop shall not be greater than .16" wg @ 2500 FPM when tested by an independent laboratory. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

2.26 Motor Driven Fire/Smoke Dampers – Air Foil Blade: Fire damper shall be constructed and tested in accordance with UL Safety Standard 555. The damper shall be Ruskin FSD60. Other acceptable manufacturers are Air Balance or Pottorff. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14 gauge equivalent thickness, on 6" maximum centers. Frame is to be a minimum of 16 gauge galvanized steel, rollformed into a structural hat shape channel. Frame seals shall consist of flexible, compression type stainless steel. The damper and actuator electric shall be rated to an elevated temperature or 250 degrees F or 350 degrees F. In addition the damper must be factory supplied with actuator and sleeve to comply with the requirements of UL 555S. These dampers shall have been constructed and tested in compliance with U.L. Standard 555 and U.L. Standard 555S, current editions. The pressure drop shall not be greater than .25 in.wg. At 2500 fpm when tested by an independent laboratory. Each damper shall bear an approved U.L. label identifying its classification as a Dynamic Rated fire Damper (Static Rated dampers are not acceptable), and shall further be classified by U.L. as a Leakage Rated Damper for use in Smoke Control Systems. Each damper shall have a 1-1/2 hour fire protection rating, 212EF U.L. Listed fusible link and a leakage class I. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Provide factory supplied caulked sleeve, 20 gauge on dampers through 84” wide and 18 gauge above 84" wide. Actuator to be mounted outside of air stream. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

PART 3 – EXPOSED ROUND DUCTWORK IN OCCUPIED AREAS:

3.1 Prior to purchase/shipment of the ductwork, manufacturer shall provide as part of the submittal process scaled, field coordinated Autocad drawings of the complete system to be furnished. Drawings will indicate all system components including fittings, ductwork and manifolds. Drawings shall be available in an electronic format.

3.2 Furnish and install where indicated double wall duct. The double wall duct shall be Eastern Sheet Metal, United McGill, Semco or approved equivalent. The duct shall have an inner shell, a 1-inch layer of fiberglass insulation and an outer pressure shell.

3.3 Ductwork outer shell shall be spiral, lock-seam construction fabricated from galvanized steel meeting ASTM-527 standard. Any ductwork exposed to view shall be constructed of G90 galvanized steel, 20 gauge, and shall be supported as required with aircraft cables and self-tightening locks. Exposed metal shall be prepped and cleaned prior to painting. Coordinate with General Contractor. Ductwork shall be constructed as specified in LOW VELOCITY DUCTWORK.

3.4 Inner shell for spiral pipe shall be 26 gauge solid galvanized steel, as noted on drawings. Ductwork shall have 3 intermediate reinforcing ribs and be constructed of the minimum gauge specified.

3.5 Inner shell for fittings shall be galvanized steel. All fittings shall be manufactured by the same manufacturer as the spiral pipe. Fittings shall be constructed a minimum of 22 Ga.

3.6 The fiberglass liner shall have a maximum thermal conductivity (k) factor of 0.27 btu per hour per square foot per degree Fahrenheit per inch thickness at 75 degree F ambient temperature.

3.7 All double wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange which shall consist of a 1.5 outer flange and an inner secondary flange which shall keep the inner flange concentric and eliminate inner wall connections. Flanges requiring inner couplings will not be allowed, no insulation shall be exposed to the airstream at the connections.

3.8 All grille and register taps shall be factory manifolded. Field installed taps will not be allowed. Manifolded taps may be tack welded and caulked for appearance. Only taps for grilles and registers may be provided this way. All other fittings shall be full body welded.

PART 4 – DRYER VENT DUCTWORK

4.1 All dryer ducting shall be a minimum of 4" in diameter. Refer to the drawings for exact duct sizing.

4.2 Dryer vent ductwork shall be rigid metal 20-gauge aluminum duct. Duct joints shall be installed so that the male end of the duct points in the direction of the airflow. Joints shall be secured with metal tape (not duct tape). Do not use rivets or screws in the joints or anywhere else in the duct as these will incur lint collection.

4.3 Length of concealed rigid metal ducting shall not exceed the allowable length of 25 feet. Deduct 5 feet from the allowable length for every 90 degree elbow and 2.5 feet for every 45 degree fitting (reference codes 2009 IMC Section M1502.6, 2009 IMC Section 504.6.4 and 2009 IMC Section M1502.4). These lengths may vary per local codes and dryer manufacturer's recommendations. Provide a complete, working in-line booster fan system, including power, if the maximum allowable duct length is exceeded.

4.4 Flexible transition hose connection at the dryer shall be the aluminum flexible duct type. Do not use the plastic or vinyl.

4.5 Termination of dryer venting shall be to the exterior with a proper hood or roof jack equipped with a backdraft damper. Hood/jack shall be painted with suitable exterior grade paint and color per the Owner's direction. Small orifice metal screening shall not be part of the hood or roof jack as this will trap lint and block the opening. The hood opening shall point down and maintain a minimum of 12 inches of clearance between the bottom of the hood and the ground or other obstruction.

END OF SECTION.

DIVISION 25 – BUILDING AUTOMATION SYSTEM

SECTION 250100 - ELECTRIC MOTORS AND OTHER ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL PROVISIONS - MECHANICAL and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2 Through coordination with other Contractors, Vendors and Suppliers associated with this Project, this Contractor shall insure a complete, 100% functional, tested, inspected and approved systems. Claims for additional cost or change orders will immediately be rejected. Refer to Specification Section – HVAC EQUIPMENT for additional requirements. All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

1.3 Review the Specification Section - CONTROLS to determine controls, including variable frequency drives, to be furnished.

1.4 Prior to ordering any materials or rough-in of any kind, the Mechanical Contractor shall be responsible for final coordination of all electrical requirements (i.e. voltage, phase, circuit breaker, wire sizing, etc.) with the Electrical Contractor. There will be no change in the Contract Amount for any discrepancies. A final coordination meeting shall be held with the Architect, Owner, Engineer, General Contractor, Mechanical Contractor, Electrical Contractor and their sub-contractors.

PART 2 – MOTORS:

2.1 The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications and drawing schedules.

2.2 Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

2.3 Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

2.4 Motors shall be capable of frequency of starts as indicated by automatic control system and not less than five (5) evenly time spaced starts per hour for manually controlled motors.

2.5 Motors shall have a 1.15 service factor for poly-phase motors and 1.35 service factor for single phase motors.

2.6 Motors shall have a temperature rating for 40 deg C ambient environment with maximum 90 deg C temperature rise for continuous duty at full load with 1.15 service factor and Class B insulation.

2.7 Unless otherwise noted or required by application, motors shall confirm to NEMA Standard MG 1 (Table 12-10) for general purpose, continuous duty, horizontal, T-frame, single speed, design “A” or “B”. Utilize design "C" motors where required for high starting torque.

2.8 Motor frames shall be NEMA Standard No. 48 or 56. Use driven equipment (fans, pumps, etc.) manufacturer's standards to suit specific application.

2.9 Provide inverter rated motors where variable frequency drives are utilized. Motor shall be premium efficiency type with Class F insulation and shall conform to NEMA MG 1 parts 30 and 31. Inverter duty rated motors shall have a temperature rating for 40 deg C ambient environment with maximum of 105 deg C temperature rise.

2.10 Motor bearings shall be ball or roller bearings with inner and outer shaft seals. Bearings shall be re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance. Bearings shall be designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.

2.11 Motor enclosure type shall be open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation. Enclosures shall be guarded drip-proof type motors where exposed to contact by employees or building occupants. Enclosure shall be weather protected Type I for outdoor use or Type II where not housed.

2.12 Provide built-in thermal overload protection and, where required, internal sensing device suitable for signaling and stopping motor at starter.

2.13 Provide energy efficient motors with a minimum EPACT efficiency in accordance with NEMA MG 1, Table 12-10 for 1800 rpm, enclosed motors. If efficiency not specified, motors shall have a minimum efficiency as listed below:

1 hp - 82.5%	7.5 hp – 89.5%	30 hp – 92.4%
1.5 hp – 84.0%	10 hp – 89.5%	40 hp – 93%
2 hp – 84%	15 hp – 91%	50 hp – 93%
3 hp – 87.5%	20 hp – 91%	60 hp – 93.6%
5 hp – 87.5%	25 hp – 92.4%	75 hp – 94.1%

2.14 On the motor nameplate, indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

PART 3 – MOTOR STARTERS:

3.1 Provide motor starters where indicated on the mechanical equipment schedules or elsewhere in the Contract Documents.

3.2 Motor starters shall be NEMA style. Their sizing and installation shall be coordinated with the equipment manufacturer's requirements and in accordance with the National Electrical Code.

3.3 All starters shall be size 0 minimum. They shall be constructed and tested in accord with latest edition of NEMA standards. All starters shall be across-the-line magnetic type, unless indicated otherwise. On motors of 20 H.P. or greater rating, the supplier shall provide starters capable of limiting inrush currents. These shall be the reduced voltage open-transition type. Do not utilize closed transition starters unless specifically indicated.

3.4 Magnetic starters shall be furnished with the following characteristics and accessories as a minimum. See remaining paragraphs of the Part and mechanical schedules for further requirements.

3.5 Contacts shall be silver-alloy, double-break type except NEMA size 8 and 9 shall be single-break type. Contacts shall be replaceable without removal of wiring or removal of starter from enclosure. Number of contacts shall be as required for service indicated. Contacts shall be gravity dropout type, positive operation.

3.6 Coil voltage shall be 120 volts, A.C., 60 HZ or less, as required to suit control systems available voltages. Coils shall be of molded construction, except for size 8 and 9 which shall be hand wound. Provide coil clearing contact as required.

3.7 Provide control transformer of adequate K.V.A. as required on all starters with line-to-line voltages higher than 120 volts A.C. Provide fuse block and slow-blow fuse to protect control transformer per NEMA, N.E.C. and U.L.

3.8 Provide hand-off-auto selector switch in face of starter, wired into hand and off switch positions. Auto position (if needed) to be field wired as indicated for automatic control.

3.9 Provide NEMA Class 20 resetable overload relays, accurately sized to the motor nameplate rating of the motor served and the temperature differential between motor and controller. Overloads shall be easily replaceable, and resetable without opening enclosure, via a push button or similar means. Class 10 or Class 30 overloads may be used depending on type of motor duty encountered.

3.10 Provide at least one N.O. auxiliary contact (field-convertible to N.C. operation) with each starter. All starters shall have space for two additional single-pole contacts.

3.11 All starters shall be thru-wiring type.

3.12 Provide phase failure sensing relay to open starter coil circuit (on loss of one or more phases) on all three-phase starters controlling motors of 7½ H.P. or larger.

PART 4 – ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT:

4.1 All mechanical equipment shall be provided for single point electrical connection unless noted otherwise.

4.2 The equipment manufacturer shall provide internally mounted fuses with the equipment, as required, to comply with the U.L. listing on the equipment name plate. (i.e., hermetically sealed compressors or equipment with name plate data that recommends or requires fuse protection.) See also, National Electrical Code, Article 440, Part C, and other applicable sections of the N.E.C.

4.3 It shall be the Contractor's responsibility to assure that all mechanical equipment requiring electrical connections be provided with all required proper wiring, electrical protective devices, disconnecting means and electro-mechanical starting units to properly match the mechanical equipment requirement.

4.4 Each separate contractor engaged for the project shall coordinate with all other trades to ensure all necessary equipment and labor is included for fully functioning mechanical systems, installed per Code and Project requirements.

4.5 Refrigeration condensing units with internal compressors shall be furnished with integral starter.

4.6 All interlock or other control wiring, unless specifically noted otherwise, is the responsibility of this Contractor.

4.7 All equipment shall be suitably enclosed. All enclosures for equipment shall be rated and approved for the environment in which it operates. (i.e., NEMA 1, NEMA 3R, NEMA 7, NEMA 12, etc.) Verify the requirement with the installation condition if not indicated on the plans.

4.8 Observe the following standards for manufacture of equipment and in selection of components: (1) Starters, control devices and assemblies - NEMA (I.E.C. style not acceptable), (2) Enclosures for electrical equipment – NEMA, (3) Enclosed switches – NEMA, (4) All electrical work, generally NFPA 70, (5) All electrical work in industrial occupancies - J.I.C. standards, (6) All electrical components and materials - U.L. listing required.

4.9 Where scheduled on the drawings, provide disconnect switches and contactors. Disconnect switches shall be fusible type or circuit breaker type.

PART 5 – REQUIREMENTS FOR MECHANICAL EQUIPMENT 3/4 H.P. OR LESS:

5.1 This section describes requirements for small mechanical equipment such as (but not limited to) package terminal heating/cooling units, VAV boxes, unit heaters, unit ventilators, exhaust fans, fans, fan coil units, cabinet heaters, DDC temperature control panels, etc.

5.2 Small equipment with motor(s) of 3/4 H.P., single phase or less are generally not required to be furnished with starter(s), unless otherwise noted. For such equipment, provide integral contactor or horsepower-rated relay where controlled by thermostat or other type of switch. Contactors or relays shall be as recommended by the manufacturer of the equipment.

5.3 Provide transformer within unit as required to provide low voltage A.C. for thermostat control.

5.4 Provide internal fusing for unit motor and other loads in fuse block or in-line fuseholder.

5.5 Where externally-mounted disconnecting means is required and would be impractical, unsightly or inappropriate in the judgment of the Engineer, disconnects shall be located within the unit. These disconnects may be fusible H.P.-rated snap switches or manual starters with overload elements, as required. Locate this and other electrical equipment within enclosure where easily accessible behind access panel or door on unit, and as acceptable to the electrical inspector or local authority having jurisdiction.

END OF SECTION.

DIVISION 25 – BUILDING AUTOMATION

SECTION 250400 - CONTROL - DIRECT DIGITAL

PART 1 – GENERAL:

1.1 The controls system for this project shall be a web-based digital controls system. All controllers, control interface hardware, services, installation, warranty, training, etc., shall be included as hereinafter specified. The system shall utilize a network controller and unitary" type controllers. Including such minor details not specifically mentioned or shown, as may be necessary for the complete operation of the system.

1.2 The Temperature Control Contractor (TCC) shall furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation System (BAS), utilizing Web Based Direct Digital Controls. All labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned shall be included for the complete, fully functional and commissioned temperature controls system.

1.3 The TCC shall provide all items, articles, materials, devices, operations or methods listed, mentioned or scheduled on the drawings including all labor, materials, equipment and incidentals necessary and required for their completion to provide a complete and operating temperature control system. This will include connecting to any mechanical equipment furnished with a control interface device and contacting the equipment suppliers and/or manufacturers for information for the proper interface to the equipment being furnished.

1.4 These apparatus' shall consist of, but not limited to, all necessary thermostats, sensing devices, valves, automatic dampers, damper motors, actuators, (except automatic dampers, valves, and damper motors furnished with HVAC equipment), and with the necessary accessories for the complete control of all equipment hereinafter specified.

1.5 Control sequences are specified at the end of this section. Provide all control equipment required to perform sequences described. Coordinate all dampers with the sheet metal contractor and equipment provider. It is the responsibility of the control contractor to ensure all required dampers in the sequence of operations are provided.

1.6 Include all power wiring and cabling for the operation of the controls system. Refer to Electrical Division Specifications for additional requirements.

1.7 **APPROVED MANUFACTURER'S: Trane, JCI and Siemens**. These TCCs/manufacturers have prior approval with the Owner and Engineer and are the only allowed suppliers and/or installing TCCs.

1.8 The TCC shall have an established working relationship with the control manufacturer of not less than five years and shall have prior approval from the Owner and Engineer and are the only allowed suppliers and/or installing contractors. The TCC shall have a local office within 100 miles of the project site and provide service and/or replacement parts within a 24 hour notification of a control failure.

1.9 A mandatory pre-installation meeting shall occur prior to the TCC beginning any work on site. This meeting shall be attended minimally the prime contractor, mechanical contractor superintendent, TCC superintendent, Engineer, Owner and Architect. The purpose of the meeting is to have the controls installer communicate their understanding of the system design

and how the system is intended operate to the Engineer and get the Engineer's input and agreement. The agreement between the TCC and the mechanical engineer is to be thoroughly documented by the TCC for later reference.

1.10 The installation shall comply with the Local Authorities and State Fire Marshal code requirements, including normal operating and smoke mode functions (where applicable). The installation shall comply with the requirements of the NEC, NFPA, UL and the Building Codes, including referenced mechanical, electrical, energy codes, etc.

1.11 ABBREVIATIONS:

- TCC – Temperature Control Contractor

1.12 The TCC shall list the following cost breakdowns, material and labor, on the official project schedule of values:

- Controls shop drawings
- Controls graphics
- Controls materials and labor
- Controls startup, commissioning, testing, documentation (2.5% of controls contract value)
- Controls training and Owner acceptance (2.5% of controls contract value)

PART 2 – GENERAL SYSTEM REQUIREMENTS:

2.1 All labeling for this system shall utilize actual final room names and numbers. The room names and numbers on the Contract Documents may not be the Owner's exact requirements. Coordinate with the Owner to insure compliance.

2.2 Include in the bid for the Controls Contractor to perform additional 40 on-site hours of on-site programming, adjustments, modifications, etc. as requested by the Engineer during the warranty period after the date of substantial completion for the project.

2.3 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the control's manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

2.4 The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system integrated utilizing ANSI/ASHRAE Standard 135-2001 BACNet, LONWorks technology, OBIX TCP/IP, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system

2.5 The TCC shall connect to any mechanical and electrical (power monitoring) equipment furnished with a control interface device. The TCC shall contact the equipment suppliers and/or manufacturers for information for the proper interface to the equipment being furnished. All points not provided with the equipment control interface are the responsibility of the TCC.

2.6 The operating system shall be based on a distributed control system in accordance with specifications. All building controllers, application controllers and all input/output devices shall communicate via BACnet MS/TP or LonMark/LonTalk communication protocol. Network controller shall communicate via BACnet over Ethernet (IP).

2.7 The TCC contractor shall provide access to the system from a location determined by the Owner and from the Consulting Engineer's office (CMTA, Inc.). This shall include remote access requirements, set-up, passwords and any software necessary to access the BAS system.

2.8 The TCC shall all have access to various types of WEB browsers (i.e. Netscape, IE, etc.), which shall be included for access to the Direct Digital Control (DDC) system via the Owner's Wide Area Network (WAN) and/or Local Area Network (LAN).

2.9 The TCC shall be responsible for coordination with the Owner's IT staff to ensure that their system will perform in the Owner's environment without disruption to any of the other activities taking place on that WAN/LAN.

PART 3 – SPECIAL PROJECT REQUIREMENTS

3.1 Put any special requirements in this section such as allowances, existing conditions modifications, etc.

3.2 Owner's existing Facility Management Control System consists of a Trane Tracer ES BAS. The new BAS shall interface with the existing facilities Tracer ES Framework. A new server is to be provided as part of this contract. It is the responsibility of the contractor to install and update the server with the existing buildings.

3.3 All network controllers, unitary controllers and wireless device temperature, humidity and CO2 sensors shall utilize an Air-FI Wireless Communication Interface (WCI) throughout all project components.

3.4 It will be the responsibility of the TCC to implement this project onto the Master WEB Supervisor at the maintenance services office with no damage to the existing projects. Any computer connected to the WAN, utilizing a web browser and having the proper password shall be able to communicate with the Owner's DDC system.

3.5 If TCC needs to update or revise any of the existing software, to allow their software to operate seamlessly with the owners existing server, it will be completed by the TCC as a part of this contract.

3.6 If the existing building head end software needs to be updated or revised to communicate with TCC's software it is to be completed by the TCC as a part of the bid.

3.7 All new software, graphics, terminology, operation, trending, scheduling etc. is match any existing systems and any changes needed to accomplish this will be the responsibility of the TCC.

PART 4 – SUBMITTALS:

4.1 The TCC shall not start the project installation until the shop drawing submittals have been reviewed by the Engineer.

4.2 Submittals shall include hardware, end devices, ancillary control components, a written operating sequence, unitary control wiring, building floor plans showing communication cabling and labels as well as logic flow diagrams. All submittals shall be provided on paper and electronically in PDF format.

4.3 Submittals shall contain one control drawing per specified system and equipment. Drawing shall include point descriptors (DI, DO, AI, AO), addressing, and point names. Each point names shall be unique (within a system and between systems). For example, the point named for the mixed air temperature for AHU #1, AHU #2, and AHU #3 shall not be MAT but should be named AHU#1MAT, AHU#2MAT, and AHU#3MAT. The point names should be logical and consistent between systems and AHU's. The abbreviation or short hand notation (e.g., MAT) shall be clearly defined in writing by the TCC.

4.4 Control diagrams shall identify: System being controlled (attach abbreviated control logic text, all digital points, analog points, virtual points, all functions (logic, math, and control) within control loop, legend for graphical icons or symbols, definition of variables or point names and detailed electric connections to all control devices and sensors.

4.5 Points list shall include all physical input/output. Points list shall be provided in both hard copy and in electronic format and shall include: Name, address, engineering units, high and low alarm values and alarm differentials for return to normal condition, default value to be used when the normal controlling value is not reporting, message and alarm reporting as specified, identification of all adjustable points and description of all points.

4.6 Submittals shall contain floor plans depicting DDC control devices (control units, network devices, LAN interface devices, and power transformers as well as static pressure sensor in duct and temperature sensors in rooms) in relation to mechanical rooms, HVAC equipment, and building footprint.

4.7 Submittals shall contain DDC system architecture diagram indicating schematic location of all control units, workstations, LAN Interface devices, gateways, etc. Indicate address and type for each control unit, Indicate protocol, baud rate, and type of LAN per control unit.

4.8 Electrical wiring diagrams shall include motor start, control, and safety circuits and detailed digital interface panel control point termination diagrams with all wire numbers and terminal block numbers identified. Indicate all required electrical wiring. Provide panel termination drawings on separate drawings. Clearly differentiate between portions of wiring that are existing, factory-installed and portions to be field-installed.

4.9 Show all electric connections of the controls system to equipment furnished by others complete to terminal points identified with manufacturer's terminal recommendations.

4.10 TCC shall provide one complete drawing that shows the control-wiring interface with equipment provided by others.

4.11 Submittals shall include project specific graphic screens for each system including a picture of the screen with a list of the variables to be placed on the screen.

4.12 Submittals shall include TCC's hardware checkout sheets and test reports.

4.13 Submittals shall include the agenda for approval by the engineer and owner of the specified training periods. See training section for requirements.

4.14 Provide complete panel drawings that are:

- Clearly labeled and schematic or drawn to scale.
- Show the internal and external component arrangement so that the operators can identify the components by their position if the labels come off.
- Wiring access routes shall also be identified so that Class 1 wiring is separated from Class 2 and 3 and so high voltage wiring is segregated from low voltage wiring.
- Complete identification of all control devices (manufacturer's type, number, and function).
- Provide details for labeling all wiring, control devices, and controllers.
- Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications shall be provided.

4.15 Include room schedule including a separate line for each terminal unit, heat pump, etc. indicating location and address.

4.16 Include control valve schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: code number, configuration, fail position, pipe size, valve size, body configuration, close-off pressure, capacity, valve Cv, design pressure, and actuator type.

4.17 Include control damper schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: code number, fail position, damper type, damper operator, duct size, damper size, mounting, and actuator type.

PART 5 – O&M MANUALS AND CLOSEOUT DOCUMENTS:

5.1 Refer to Mechanical Specification Section – REQUIRED SHOP DRAWINGS, ETC. for additional requirements.

5.2 Operating instructions, maintenance procedures, parts and repair manuals shall be supplied. Repair manuals shall include detailed instructions in the setup, calibration, repair and maintenance of all equipment furnished. Also supplied with these manuals will be a complete parts listing of all devices supplied which is to include part numbers and model numbers of all parts and component parts along with exploded views of devices.

5.3 All as built drawings (wiring diagrams, flowcharts, floor plans, etc.) shall also be supplied to the owner electronically in PDF format.

5.4 System specific wiring, control diagrams, sequence of operation and points lists shall be as installed in each control panel. This means as-built drawings, not design (submittal) drawings.

5.5 Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and down-loading the entire unitary data base or any part of the automated system for backup or archiving.

5.6 Supply one copy of the software programming manual (hard copy and PDF format). The manual shall describe all furnished software. The manual shall be oriented to programmers and shall describe calling requirements, data exchange requirements, data file requirements, and other information necessary to enable proper integration, loading, testing, and program execution.

5.7 Provide a Bill of Materials with each schematic drawing. List all devices/equipment and match to schematic and actual field labeling. Provide quantity, manufacturer, actual product ordering number, description, size, accuracy, operating ranges (voltage, temperature, pressure, etc.), input/output parameters, etc.

5.8 Maintenance manual shall include copies of signed-off acceptance test forms, commissioning reports, start-up reports, etc.

5.9 The TCC shall turn over to owner two (2) sets of computerized back-ups of the complete temperature control system.

PART 6 – WARRANTY & SOFTWARE LICENSES:

6.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after substantial completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.

6.2 The TCC shall respond to the Owner's request for warranty service within 24 hours during normal business hours. The TCC shall respond to the Owner's request for Emergency service (defined as life-threatening or creating the potential to cause property damage) during the warranty period within 4 hours.

6.3 The TCC shall provide technical phone support to the owner during the warranty period for warranty related issues and for two years after the warranty period. If the technical support location of the TCC is outside of the toll free calling area for the customer, the TCC shall have a

toll free number or accept collect calls for the purpose of providing technical support.

6.4 During the warranty period, standard parts for the DDC system shall arrive at the facility within 48 hours of placing an order. Non-standard parts (requiring re-manufacturing or ordering from another supplier) shall be shipped within 96 hours.

6.5 Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the TCC shall be provided and correctly installed at no charge during the warranty period.

6.6 Provide licensed electronic copies of all software for each workstation, laptop, server. This includes, but is not limited to: project graphic images (editing/modifying/creating), project database, trouble-shooting and debugging programs, project-specific programming code and all other software required to operate and modify the programming code (including software at system level, primary control units, secondary control units, and all communication software). Any hardware devices (cables, protection devices) required to operate the software/hardware shall also be provided.

6.7 All additional licensing needed for this project shall be supplied by TCC. Software license shall not expire or utilize any sort of protection hardware device for its use. In any case owner shall be free to direct the modification of any software license, regardless of supplier to allow open access to all controllers. Owner shall hold the software and firmware licensing. Software license shall not expire or utilize any sort of protection hardware device for its use.

6.8 System software shall be the latest version available with upgrades provided at the end of the warranty period, and shall be fully licensed to the Owner for the entire system. Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and down-loading the entire unitary data base or any part of the automated system for backup or archiving. Software shall be "IBM compatible".

PART 7 – TRAINING:

7.1 A formal on-site "Hands On" training session shall be conducted for the owner's maintenance personnel. This session shall be a minimum of one (1) eight (8) hour days to train the staff on setup, operation, and maintenance of all system(s) and/or devices. This will be at a time and location selected by the owner. One (1) additional eight (8) hour session shall be provided as “opposite season” training – generally 6 months into the warranty period. One (1) additional eight (8) hour session shall be provided at a later date. (This may be requested any time during the warranty period.) All training materials and books shall be provided. Both sessions shall be given by the manufacturers "factory" technical representative. (This is defined as someone other than the installing contractor’s representative.) All expenses are to be provided by the TCC. All training sessions shall be scheduled at owner’s request.

7.2 Training shall be a mix of, test exercises, and actual keyboard entry and screen viewing at the operator’s terminal. A curriculum shall be discussed and implemented based on the level of expertise of the employees. Hands-on experience and problem solving shall be emphasized.

7.3 If during any training session, the trainer/owner finds more than three (3) items that need repair, the training session will be immediately terminated. The session will be rescheduled for another date. The re-scheduled training session will be carried out at no additional cost to the Owner.

7.4 The training shall be oriented to making the owner self sufficient in the day-to-day use and operation of the DDC system.

7.5 Additionally, the training shall include:

- System start-up, shutdowns, power outage and restart routines, alarms, security levels, changing setpoints, changing schedules and other parameters, overrides, freeze protection, manual operation, return to automatic operation, and resetting equipment.
- All screens shall be discussed, allowing time for questions.
- Information specifically focused on showing the owner methods of troubleshooting the mechanical systems using the DDC.
- Use of laptop and hand-held operator interface device, if applicable.
- Creating, modifying, viewing, downloading, and reloading, trend logs.
- Remote access to the system.
- The other training sessions shall be oriented toward answering specific questions from Owner's staff.
- The trainer must be well grounded in both DDC system operation and in mechanical systems service and shall be the programmer.

7.6 This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals.

PART 8 – COMMISSIONING & VERIFICATION, FUNCTIONAL PERFORMANCE TESTING & CHECKLISTS:

8.1 100% compliance with the requirements of this section is a condition of the Owner's acceptance and start of the warranty period.

8.2 The TCC shall be responsible for completion of (1) their hardware checkout sheets and test reports, (2) Point-by-point confirmations of ALL points – this includes visual inspection of installed components, and (3) sequence of operation confirmation.

8.3 This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals.

8.4 Air and water balancing shall be completed (and discrepancies resolved) before the TCC's final system check and before the acceptance test to be conducted in the presence of the Engineer.

8.5 Refer to Mechanical Specification Section – GENERAL PROVISIONS for additional information and requirements.

PART 9 – WIRE MANAGEMENT, ELECTRICAL POWER, ETC:

9.1 Refer to CABLING section of this specification for additional requirements.

9.2 Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.

9.3 All wiring and cabling in mechanical and electrical rooms shall be in conduit. No wiring or conduit can be exposed to view in any other area. Conceal all wiring and cabling in conduit in wall from thermostats or other controls devices to above ceiling. Install conduit in wall from wall thermostats to above ceiling for cabling. Route wiring directly to cable tray from control points above the ceiling. Rough-in for control devices shall be in compliance with the requirements of the ELECTRICAL SPECIFICATIONS.

9.4 Any power for controls shall be fed from dedicated circuits in emergency electrical panels, when provided for a project, and shall not be obtained from receptacles, lighting, or equipment circuits.

Unitary control power may be obtained from the equipment served. If power is obtained from the equipment served, the power may not be interrupted to the electronics if the equipment is off for any reason.

9.5 The TCC shall be responsible for the power source to any control panels, unitary controllers, etc. on any controlled equipment and all other control power requirements. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.

9.6 Prior to installation, insure through coordination with all trades, that appropriate clearances (36" minimum) as required by the N.E.C. are maintained at all control panels, including unitary controllers for heat pumps, etc.

9.7 The TCC shall provide all CAT5 or CAT6 cabling network cabling for a complete system. This shall include cabling to the Owner's data drop. The main system data drop will be provided by others.

9.8 All control circuits within the electrical panels shall be marked to indicate equipment served.

9.9 The TCC shall perform all temperature control interlock wiring. This shall include control valves, dampers, thermostats, indoor/outdoor HVAC systems, etc. Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.

9.10 The TCC shall be responsible for any power required for the unitary controls or control panels. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.

9.11 Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic control components. This receptacle may be served from the control panel 120 VAC power source.

9.12 All wiring shall be continuous runs. Any junctions must be made in metal enclosure.

9.13 Grounding terminals shall be color coded green and yellow and shall be compatible with the other specialty terminals specified above and shall mount on the same DIN rail system. Units shall be arranged so that the wiring connected to them is grounded to the enclosure via the mounting rail. These terminals shall be provided for grounding cable shields at the points where the cables enter a control panel and terminate on the control panel terminal strip. Terminals shall be Entrelec M 4/5.3A.PI or equivalent by Weidmuller, Phoenix, or Allen Bradley.

9.14 The Department of Housing, Building and Construction's Electrical Division requires that all new lighting control panels, new Building Automation Systems control panels, and new conventional HVAC control panels be certified as being constructed and wired in accordance with NFPA 70 110.3 (a) (1) and article 409.

9.15 Contractor shall insure control panels have an identification label stating the "Certification Agency" such as UL, CSA, CE, etc. or a label of certification for each control panel by a Professional Engineer (P.E.) registered in the State of Kentucky, stating that the design of the control panel was under their direct supervisory control. Include with shop drawings.

9.16 The Electrical Advisory Council for the State of Kentucky requires that only an electrical contractor licensed by the State of Kentucky with a licensed Master Electrician and a licensed on-site electrician can install the electrical wiring for lighting controls systems or Building Automation Systems (BAS).

PART 10 – CABLING:

10.1 Refer to WIRE MANAGEMENT section of this specification for additional requirements.

10.2 ALL CONTROL WIRING SHALL BE INSTALLED IN A WIRE MANAGEMENT SYSTEM TO INCLUDE CABLE TRAYS, BRIDLE RINGS, & CONDUITS. NO EXCEPTIONS! COORDINATE WITH ELECTRICAL CONTRACTOR TO INSURE A COMPLETE WIRE MANGEMENT SYSTEM.

10.3 Acceptable cable manufacturers are Belden, West Penn or Alpha.

10.4 A complete cabling system shall be furnished and installed, which shall adhere to the highest workmanlike standard of quality and appearance. Cabling shall be installed square with building lines and contained within a wire management system.

10.5 All sizing of cabling shall be according to manufacturer's recommendations, but shall be a minimum of 18 AWG.

10.6 Furnish a floor plan of the building indicating communication cable labeling and routing as well as addresses and branch wiring from the unitary devices. All cabling shall be labeled on both ends. The type, size and label of all cabling shall be indicated on submittal floor plan drawings.

10.7 Wall space temperature sensor cabling (from the sensor to the unitary controller) shall have a minimum of four (4) conductors.

10.8 All cabling shall be stranded. "NO" solid conductors will be accepted. All cabling shall be 100% shielded with appropriate drain wire and insulation.

10.9 All cable connections shall be continuous run (including shield). Any junctions must be made in a metal enclosure, connections must be soldered, taped and the metal enclosure must be mechanically attached to the nearest ground. No wire nuts or crimped connections will be accepted. Note location of junction boxes on the as built floor plans. All cabling networking unitary controllers, and other networked equipment, shall be in soldered.

10.10 All shields must be terminated as per manufacturer's recommendation. Shield termination requirements by the manufacturer must be provided with submittals.

PART 11 – SYSTEM SOFTWARE:

11.1 System software will be the latest version available with upgrades provided for full warranty period, and shall be fully licensed to the owner for all network controllers and servers. Refer to WARRANTY section of this specification for additional requirements.

11.2 The BAS shall include trend logging screens accessible from tabs on the home page for building utilities usage.

11.3 System software shall, at a minimum, provide:

- Monitor and supervise all control points.
- Add new points and edit system database.
- Change control setpoints, timing parameters and loop tuning of PID coefficients in all control loops in all control units.
- Enter programmed start/stop schedules.
- View alarm and messages.
- Modify existing control logic (or sequence of operation) in all control units.
- Upload/Download programs, databases, control parameters, etc.

- Modify graphic screens.

11.4 Sequence of operation programming methodology - The application software shall be user programmable. Application programming shall be (1) Line type programming that uses text programming in a language similar to BASIC or FORTRAN, or (2) graphical block programming - The method of programming shall be by manipulation of graphic icon "blocks." Each block represents a subroutine containing the programming necessary to execute the function of the device that the block represents.

11.5 Unitary Control Unit Database Archiving - The host software shall provide capability to upload sequence of operation, database, and other control parameters from each controller. Uploaded programs shall be retained on hard disk for system backup. Programs may be modified using Editor functions, and downloaded to individual controllers as desired. Downloading of databases shall not interrupt other multi-tasked functions that are ongoing.

11.6 THIRD PARTY SOFTWARE PACKAGES: The host software shall provide the capacity to run third party software packages for word processing, spreadsheets, or database management programs. Use of third party software shall not suspend operation of background tasks of multi-tasking operating system, such as alarm logging, and report generation.

PART 12 – NETWORK CONTROLLER

12.1 Install the Network Controller in a surface mounted panel, NEMA type 1 enclosures, with a removable hinged door. Provide a flush mounted key lock. All control panels must be painted the same color and identified. The boxes are to be made from 16 gauge material. Panels should not be provided with knockouts.

12.2 Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet arc flash requirements.

12.3 The Network Controller shall be web-based and communicate BACnet IP. It shall issue all time schedules, summer/winter commands, customized trending, holiday scheduling, alarm handling, clock or other shared commands to all unitary controllers within the building network. If for any reason communications between the unitary(s) and the Network Controller is lost, the unitary(s) shall operate in a stand-alone manner (in day operation) until communications is restored. It shall also operate in the “summer” or “winter” mode as last commanded.

12.4 The Network Controller shall be integrated and interoperable with the facility infrastructure and include user access to all system data locally over the Local Area Network (LAN) / Wide Area Network (WAN) within the building and remotely by a standard Web Browser over the Internet. Any computer connected to the network, utilizing a web browser and having the proper password.

12.5 The Network Controller shall be a fully user-programmable, supervisory controller. It shall monitor the network of distributed unitary controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers.

12.6 The Network Controller shall have battery back-up to allow a minimum of seven days of operation. The Network Controller shall be composed of one or more independent, stand-alone, microprocessor to manage the network strategies described in Application software section. The network controller shall have ample memory to support its operating system, database and programming requirements. The operating system of the Network Controller shall manage the input and output communications signals to allow distributed unitary controllers to share real and virtual point information and allow central monitoring and alarms. The database and custom programming routines of the Network Controller shall be editable from a single operator station.

12.7 The Network Controller shall be remotely monitored via the internet. Additionally, it shall include automatic emailing and texting out alarms, gathering alarms, reports and logs, programming and downloading database.

12.8 The Network Controller shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:

- Assume a predetermined failure mode.
- Emit an alarm.
- Display card failure identification.

12.9 Under no circumstance shall more than 75% of the total number of sensor and control points be connected through a single Network Controller. Each DDC system component shall provide for the future addition of at least 20% of each type of the number of sensor and control points connected to that component including a minimum of one universal input and one universal output.

PART 13 – UNITARY CONTROLLER

13.1 Unless otherwise specified, each piece of equipment shall have its own Unitary Controller (i.e., heat pump, AHU, terminal unit, etc.). The Unitary Controller for each piece of equipment shall be mounted on the side of the unit. The Unitary Controller for all other equipment shall be mounted in a panel and properly labeled.

13.2 Each Central Station Air Handler and/or Outside Air Unit shall have its own Unitary Controller mounted where shown on the drawings. If an installation location is not clear, the Contractor shall notify the Engineer for clarification prior to installation.

13.3 Unitary Controllers used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F. All Unitary Controllers shall have an RJ-11 or similar type connection for monitoring or programming access by room or local equipment level with access to any unitary within the network without modification.

13.4 Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet arc flash requirements.

13.5 Unitary Controllers utilized in the network shall have full stand alone capability including time of day and holiday scheduling as well as all energy management functions such as optimal start/stop, duty cycling, etc. The terminal unit Unitary Controllers may be pre-programmed with the project specific sequence of operation as specified for the application. Any re-programming of the electronics shall be performed on location using a portable personal computer with appropriate software or through the Network Controller. The entire unitary data base shall have the capability of being backed up and or downloaded locally.

13.6 All points to have a unique digital input to the BAS system. The use of digital point count expanders is not an acceptable replacement to digital inputs to the unitary controller. The conversion of a single universal input channel to accept up to multiple voltage free contacts such as relay contacts, auxiliary starter contacts, differential pressure switches, etc. IS NOT ACCEPTABLE.

13.7 Unitary Controllers shall communicate via BACnet MSTP or LonMark/LonTalk communication protocol. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each Unitary Contoller that will communicate on the BACnet MS/TP Bus.

13.8 All Unitary Controllers shall be fully application programmable. All control sequences within or programmed into the unitary controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery shall be retained.

13.9 Unitary Controllers shall have a 10% spare point capacity to be provided for all applications.

13.10 The Unitary Controller for each piece of equipment shall be mounted on the side of the unit. The unitary controller for all other equipment shall be mounted in a panel and properly labeled. Prior to installation, insure through coordination with all trades, that appropriate clearances (36" minimum) as required by the N.E.C. are maintained at all control panels, including unitary controllers for heat pumps, etc.

13.11 After a power failure, the Unitary Controller shall operate the control application using the current setpoints and configuration. Reverting to default or factory setpoints are not acceptable.

PART 14 – SENSORS AND MISCELLANEOUS DEVICES:

14.1 WEATHER STATION HOUSING: Provide Kele Model A21 Outdoor Aspirated Humidity/Temperature housing. NEMA 3R enclosure is painted white to reduce the effect of radiation, and the enclosure has a lockable latch for security. The outdoor air sensor will be installed on the north wall in the shade as not to be effected by sunlight, building ventilation or weather. This location shall be indicated on the control drawings. Installation in outside air ductwork or louvers is not acceptable. If not installed to provide "accurate" temperature readings, it shall be relocated (at the TCC's expense) until a suitable location is found.

14.2 SENSOR RESOLUTION: All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period. Space sensors shall be tested and accurate to within 0.75 degrees F. Outside air, water and duct sensors shall be tested and accurate to within 2.0 degrees F.

14.3 SPACE SENSORS AND THERMOSTATS:

- Refer to the drawings for proper type and location.
- All thermostat and sensors shall be provided with temperature indication, unless otherwise noted.
- Programmed set-point shall be locally adjustable limited to 2 degrees above set-point and 2 degrees below set-point for supervised areas.
- Unsupervised areas shall have non-adjustable set-point.
- Generally, thermostats/sensors shall be installed 5'-0" above the finished floor.
- Where thermostats/sensors are to be mounted next to a light switch, install at the same height as the light switch.
- Sensors in hallways, vestibules, stairways, restrooms and locker rooms shall utilize a stainless steel surface mount temperature sensor installed on an interior wall or partition (2"x4" blank plate). Care must be taken in the installation of these sensors to ensure proper insulation from the wall temperatures in order to properly sense space temperature.
- If there is a question consult engineer prior to rough-in.

14.4 WATER SENSORS: Temperature sensors for water lines are to be the well type. Wells are to be threaded brass (same manufacturer as the temperature sensor) with the sensor coated with a heat transfer compound. Strap on sensors will not be acceptable.

14.5 MIXED AIR SENSORS: These sensors shall be bendable averaging, type made of copper or aluminum elements. In unit ventilators, these sensors shall be at least five (5) feet in length and installed in the discharge air of the unit. For Air Handling Units, Outside Air Units, etc. the sensors shall be at least 20 feet in length.

14.6 DISCHARGE AIR AND DUCT ROOM RETURN AIR SENSORS: Shall be rigid insertion type. In all applications, care shall be taken to insure that the sensors are securely mounted as not to allow any vibration and installed in such a manner as to indicate the truest possible temperature.

14.7 FREEZE/LOW-LIMIT THERMOSTAT: Provide a freeze/low-limit thermostat in each Air Handling Unit, Outside Air Unit, etc with a water coil for freeze protection. These devices shall be the manual reset type. This device shall be wired by using a normally closed contact in series with the motor starting circuit and a normally open set of contacts as an input to the unitary controller. The element shall be constructed of copper and be at least 20 feet in length. It shall be installed serpentined across the air entering the coil. In some cases it may require being installed after the coil. Each application should be closely evaluated before installation. The device shall sense the lowest temperature by any one foot section of its element.

14.8 HUMIDITY SENSORS: These devices shall be 100% solid state, linear and temperature compensated with scaling 0-100% RH range with LED or LCD Display. Accuracy at 25°C from 10-80% RH* ±2%, operating Humidity Range 0 to 100% RH (non-condensing), Stability ±1% @ 20°C (68°F) annually, for two years, Hysteresis 1.5% typical, Temperature Effect ±0.1% RH/°C above or below 25°C (typical), 1% accuracy between 0% - 90% RH, Operating Temperature Range -40° to 50°C (-40° to 122°F) +/- 1%.-Do not submit products that do not meet this range. The output of the device shall utilize an analog output 4-20 mA, 2-wire, polarity insensitive, (clipped and capped), The device shall use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.

14.9 COMBINATION TEMPERATURE/HUMIDITY SENSORS: All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period. Space sensors shall be tested and accurate to within 0.75 degrees F. The humidity sensing device shall be 100% solid state, linear and temperature compensated with a 0-100% RH range. The response time shall be a minimum of 30 seconds for a 60% change. They shall have a minimum of 2% accuracy minimum accuracy of +/-2% RH minimum rangeability 5 to95% RH non-condensing and maximum hysteresis +/_1.5% RH.– Do not submit products that do not meet this range. The output of the device must utilize a 0-10 VDC or 4-20mA signal as required. The device must use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.

14.10 LOW PRESSURE TRANSDUCERS: These devises shall be 100% solid state, linear and temperature compensated. Accuracy shall be no less than plus or minus 1% of its full range. Linearity, repeatability and hysteresis shall be no less that plus or minus 0.1%. All pressure sensors shall utilize output averaging/output clipping to adjust and stabilize any fluctuations in the output. The output of the device shall utilize a 0 - 10 VDC signal. The device shall use a power supply of 24 VAC or VDC. The enclosure 16 gauge steel. For sensing internal static pressure of air handling ducts utilize sensors with a rage of 0 to 5 inches water column. For sensing building static pressures (building compared to atmospheric) utilize a sensor with a range of -0.25 to +0.25 inches water column.

14.11 RELAYS: Relays for starting and stopping fractional horsepower motors shall be rated as follows:

- 1/4 horsepower motors or less use 15 ampere rated relays,
- 1/3 horsepower motors use 20 ampere rated relays,
- 1/2 horsepower motors use 30 ampere rated relays,
- Relays used for pilot duty service shall be rated at a minimum of 10 amperes.
- Provide auxiliary pilot duty relays on motor starters as required for control function.

- Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.

14.12 CENTRAL STATION AIR HANDLERS: All Central Station Outside Air and Rooftop Air Handling Units, etc shall be provided with a D.A.P. (differential air pressure) switch across each the supply fan to provide fan status for each air handler.

14.13 SMOKE SHUTDOWN: All AHUs, OA units, Heat Pump Units, etc with fans of greater than 2,000 CFM are required to have smoke shutdown safeties as required by the Building Code. These smoke detectors shall have a set of auxiliary contracts wired to a dedicated input of the Unitary to provide status of the smoke detector. All units must be provided with a current sensor to provide fan status for each air handler. For projects with Outside Air (OA) units, any system fire alarm activation shall shutdown all OA units. Coordinate with the Fire Alarm Contractor to insure a complete, code compliant installation.

14.14 CURRENT SENSING DEVICES: Veris Industries model Hx08 Series and H701 or equal. All current sensors shall be capable of alarming to the BAS for belt losses, pump coupling shear or other mechanical failure on loads.

14.15 SINGLE DIRECTION WATER FLOW METER: Onicon Model F-1200 series dual turbine insertion flow meter. 50:1 turn down with 2% accuracy with 0.4 to 20 fps range. Install flow meter with sufficient pipe diameters as recommended by manufacturer. Provide factory authorized start-up verification of operation and calibration. Provide with remote display where indicated.

14.16 BTU METER: Provide and install ONICON System -10 MTU Meter system, including F-1200 dual turbine insertion flow meter, supply and return temperature sensors and wells and control panel. The entire system shall be factory calibrated and programmed for particular system where installed (heat pump system and 2-pipe system) and shall be re-programmable at the control panel keypad. Furnish a certificate of calibration for each BTU meter. Interface the control panel into the DDC controls system to obtain energy totals, flow rates, temperatures (supply and return) for trending. Install flow meter with sufficient pipe diameters as recommended by manufacturer. Provide factory authorized start-up verification of operation and calibration. Provide with remote display where indicated.

14.17 DIFFERENTIAL PRESSURE TRANSMITTERS: Provide Rosemount (ITT Bell & Gossett ST-102R) or Johnson Controls Setra DPT 2302-050-V field mounted differential pressure sensor transmitters as indicated on the plans. Range shall be 0-25 psig. Accuracy shall be .025% full span.

14.18 CARBON DIOXIDE SENSORS: This sensor shall have a range of 0-2000 ppm +/-5% and +/- 50 ppm. Analog output of 0-10 or 2-10 VDC. Power shall be 24VAC. Calibration interval rated for 5 years. Sensor shall not be provided with a digital display. Honeywell Model C7232 or equal. A replacement CO2 sensor shall be installed annually for 5 years after substantial completion by the controls contractor. Provide with LED display.

PART 15 - VALVES, DAMPERS AND ACTUATORS:

15.1 Unless otherwise specified, valves shall be furnished and sized by the TCC. The valves are to provide the required capacity and the close off rating shall be in excess of the system pressures encountered (minimum 40 psi differential). Proportioning-type valve bodies shall be packed type with throttling type inner valve (quick close plug shall not be acceptable). Proportional type valves to be rated at 125 psi static pressure. Modulating control valves shall be selected within a 3-5 psig pressure drop range. Two position control valves (open/close) shall be line size.

15.2 Dampers for various units requiring field mounting shall be tight closing, "ultra low leakage", opposed blade with side and edge seals. They shall be sized and furnished under this section.

Installation of dampers shall be by the sheet metal contractor, coordinated by the TCC. Frames shall be no less than 16 gauge galvanized steel and furnished with mounting holes for duct mounting. Damper blades shall be no less than 14 gauge galvanized steel with maximum blade width of 8 inches. Blades shall be secured to 1/2 inch zinc plated axles and hardware with nylon bearings. Provide thrust bearings at the end of each blade. **All dampers shall have end switches to positively prove damper position. No Exceptions!**

15.3 All damper and valve actuators shall be fail safe spring return type with sufficient force to operate the dampers or valves under all normal operating conditions. They shall return to the normally open position upon a loss of power. Exceptions to the spring return applications are (1) face and bypass actuators, (2) boiler 3-way loop mixing valves, (2) boiler room seasonal changeover valves. Actuators for fan coil units, terminal units, etc. shall fail in the last position.

15.4 "ALL" Actuators shall be of the same manufacturer and have internal feedback circuitry to provide a positive action to insure proper positioning of the damper or valve through the entire sequence. Actuators shall have an adjustable starting point to accurately set the range of travel to the output of the controller. All actuators shall also utilize the same input signal (6-9 VDC, 0-010V, 2-10 VDC, 4-20 MA) in order to maintain some consistency in the control application. Analog actuation is 6-9 VDC, 0-010V, 2-10 VDC or 4-20 MA, floating point control with 2 digital outputs is NOT approved as analog actuation.

15.5 Actuators may be factory installed. If not factory installed they shall be installed as per instructions by the terminal equipment manufacturer.

15.6 Locations mounted above ceiling shall be marked on ceiling grid.

15.7 Install damper motors on the outside of the duct in warm areas where possible, not in air stream or locations exposed to outdoor conditions.

PART 16 – OPERATOR INTERFACE AND SERVER:

16.1 Include TWO laptop operator interface in the bid as follows:

- Processor: 2.7 GHz or higher.
- Operating System: Microsoft latest operating system
- Memory: 6GB
- Hard Drive: 500 GB minimum
- Monitor: 16" HD LED widescreen, VGA/DVI
- Video Card: HD Graphics VGA, HDMI
- Optical Drive: 16X DVD+/-RW with double-layer DVD+/-R write
- Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector)
- Wireless Network Support: wireless 802.11b and 802.11g protocols must be supported

16.2 Provide uninterruptible power supply (UPS) for all major components. This includes all front ends, routers, servers and control workstations on site.

PART 17 – REFRIGERANT MONITORING SYSTEM:

17.1 Not required.

PART 18 – ISOLATION ROOM CONTROL SYSTEM:

18.1 Not required.

PART 19 - VARIABLE FREQUENCY DRIVES (VFDs):

19.1 The work includes all labor, materials, and related items to completely furnish and install, start up and test, and place into service the Variable Frequency Drives (VFDs) indicated and scheduled on the Drawings and described in the Specifications.

19.2 VFDs shall be as manufactured by ABB, Graham/Danfoss, or Square D. These are the only acceptable manufacturers. All VFDs for the project shall be by the same manufacturer (no exceptions).

19.3 VFDs shall be consist of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

19.4 The VFD shall be capable of operation form AC voltage in two rages 208–240 VAC ± 10%, or 380–480 VAC ± 10%. 50/60 HZ operation, ± 2 hertz.

19.5 The VFD enclosure shall be rated UL type 1 and shall be UL listed as a plenum rated, suitable operating conditions: 0 – 40^0 C continuous. Drives that have thermal cut out circuits, or that cannot operate continuously at 40^0 C shall not be acceptable. Altitude 0 to 3300 feet above sea level, up to 95% humidity, non-condensing.

19.6 The VFD shall produce an adjustable AC voltage/frequency output for step less motor speed control utilizing sine wave coded Pulse Width Modulation (PWM) The Drive shall provide automatic power factor correction and a .98 displacement power factor by incorporating a full wave diode bridge rectifier. The VFD shall have an overload rating of 110% of nominal rated current for 1 minute out of every 10 minutes of operation, which is an acceptable overload for centrifugal loads.

19.7 The VFD shall include a built-in first environment RFI/EMI filter and be CE and UL labeled. It shall also meet the CE requirement of EN61800-3 which provides an actual test procedure that shows that the VFD is immune from RFI/EMI interference and at the same time does not emit RFI/EMI noise that would interfere with other sensitive equipment near the VFD.

19.8 The VFD shall include as a minimum a 5% dual DC link or AC line reactor for a clean harmonic signature, which aides in complying with IEEE-519-1992 recommended levels. The VFD manufacturer and representative shall assist in ensuring that the VFD's applied meet IEEE-519-1992 by completing a computer aided Harmonic Analysis of the complete system.

19.9 The VFD shall include as a standard a built in digital keypad/display panel. This panel shall provide "Hand" off "Auto" selection, and a manual speed adjustment via up and down arrows. All faults and warnings shall be provided in "Plain English" for operation without a manual. The drive shall have a complete manual stored in memory that can be accessed with a single keystroke. This display shall be password protected and allow all setup parameters to be adjusted only by authorized personnel.

19.10 The VFD shall include built in Startup, Diagnostic, and Maintenance assistants, which allow for step-by-step startup procedures, troubleshooting, and the ability to indicate when the VFD and the system it is applied to needs preventive maintenance performed.

19.11 The VFD shall include a real time clock with a day/date stamp for troubleshooting purposes. In addition with the use of this clock the drive shall be capable of stand-alone operation and act as a unitary controller.

19.12 The VFD shall include (2) Analog inputs either 4–20 madc or 0-10 vdc, (6) programmable Digital Inputs, (2) Programmable analog Outputs, (3) Form C Relay output rated 2 amps continuous minimum, and (2) PID Process controllers.

19.13 The VFD keypad shall include a backlit LCD display. The display shall be in complete English

words for programming and fault diagnostics (LED and alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words.

19.14 BYPASS: As scheduled on the drawings, the drive shall be provided with an integral Bypass circuit which includes a pair of 115V electrically interlocked contactors for drive and bypass operation. The drive shall include a main input circuit breaker, drive input service/isolation switch, and motor overload protection adjustable for either Class 10, 20 or 30 operation. The bypass shall include a built in status display which shows via colored LED's the system operational status including safeties and run permissives for ease of operation. The Bypass shall have its own interactive, programmable keypad. The Bypass shall provide single-phase protection for the motor while operating in bypass. Bypass that does not protect the motor from single-phase operation shall not be acceptable.

19.15 The drive and bypass system shall have embedded serial communication capabilities that allow direct connection to Modbus, Johnson Controls, Siemens and BACnet automation systems as part of the drives software suite without the need for extra hardware cards or gateways. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). In addition, the drive shall be capable of interfacing with Lonworks with the addition of a communication module.

19.16 All VFDs shall be provided and installed in strict accordance with the manufacturer's recommendations.

19.17 Factory-authorized startup for each drive is mandatory. Provide a written record of the startup of each unit. Start up and programming by a factory-authorized technician. At startup, lockout any speed with the VFD that does not meet the vibration allowanced of the equipment manufacturers.

19.18 A parts and labor warranty of **3 years from startup and 2 years from the date of substantial completion** shall be included. Warranty shall include travel time and expenses.

PART 20 – GRAPHICS SCREENS AND TRENDS:

20.1 All graphics screens shall be submitted for review by Engineer. Provide the following animated, color graphics screens minimally:

20.2 Entire floor plan home screen with OAT, Time and Date displays.
- Floor plan showing major zones,
- Click major zone displays enlarged floor plan of the zone showing individual heat pump zones & numbers. Include link to respective mechanical room.
- Click individual zone shows heat pump graphic. Display all data points from points list, occ/unocc schedule and setpoints, cfm and setpoint, OAT, Time and Date.

20.3 Color Graphic Screens shall be designed for all mechanical systems and shall include the following:
- A graphic shall be the starting page with the building graphically indicated. Break up the floor plan into zones to match Contract Documents. The building shall be the point of reference to enter into the respective building control system.
- All heat pump units including pumps, filters, humidifiers, etc.
- All OA units.
- Domestic hot water heaters and pumps.
- The summation of all supply OA for each unit shall be displayed on the AHU graphic pages.
- All floor plans indicating all actual room numbers, thermostats and mechanical equipment. Operator shall be capable of clicking on any equipment and pull up the respective graphic screen.

20.4 Graphics to include floor plans with room numbers (as-built room numbers) and thermostat locations, links to flow diagrams for heat pumps, zone dampers, hydronic loop systems, outside air systems, domestic hot water and lighting controls.

20.5 All new graphics shall match the existing system graphics, unless noted otherwise.

20.6 The graphical programming software shall allow for interactive mouse-driven placement of block icons on the graphic screen and connection of block inputs to block outputs by means of drawing lines to form a graphic logic diagram. The user shall not have to manually input text to assign block input/output interconnections. Blocks shall allow entry of adjustable settings and parameters via pop-up windows.

20.7 The clarity of sequence shall be such that the user has the ability to verify that the system programming meets the specs without having to learn or interpret a manufacturer's unique programming language. Provide a means for testing and/or debugging the control programs off-line (not communicating with control units) using operator entered values for physical inputs and time. Provide a means for testing and/or debugging the control programs on-line (communicating with control units), showing actual physical inputs land all block outputs in real time.

20.8 Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time output values.

20.9 All graphic software shall be in the html web browser format and support multiple simultaneous screens to be opened and resizable in a "Windows" type environment. All functions, except text entry, shall be executable with a mouse. Graphic software shall provide for multitasking such that third party programs can be used while the Operator Workstation Software is on-line. Provide the ability to alarm graphically even when operator is in another software package. The software shall allow for Owner to create user defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics.

20.10 The contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, coils, filters, dampers, etc.), mechanical system components (e.g., pumps, heat pumps, etc.), complete mechanical systems and electrical symbols.

20.11 The graphic development package shall use a mouse or similar pointing device to allow the user to perform the following:

- Define symbols
- Position items on graphic screens
- Attach physical or virtual points to a graphic
- Define background screens
- Define connecting lines and curves
- Locate, orient and size descriptive text
- Define and display colors for all elements
- Establish correlation between symbols or text and associated system points or other displays.
- Create hot spots or link triggers to other graphic displays or other functions in the software

20.12 The TCC shall including programming of 25 point trends as directed by the Engineer. These can be requested at any time during the project including the warranty period. Trend "change of state" for digital inputs. Trend analog points in 30 minute increments. Maintain trend history for 30 days. Include the following:

- Outside air temperature
- OA unit leaving air temperatures for each unit

- VFD speeds (OA & EA)
- Heat pump main supply and return temperatures
- Heat pump main flow rate
- Water to water unit main supply and return temperatures (load side)
- Critical room space temperatures
- Domestic hot water supply temperatures
- Freezer/Cooler temperatures
- Makeup water flow rate
- Electrical power kW and kWh
- Others as directed in the field

PART 21 - TIME SCHEDULES (ALL TIMES SHALL BE USER ADJUSTABLE):

21.1 During construction, the time schedule (for all equipment except OA unit) will be Occupied at 5:00 AM, Unoccupied at 10:30 PM. seven (7) days a week.

21.2 When the system is fully tested and operational and after the Owner's staff have been fully instructed as to the operation of the system the schedule shall be as follows unless otherwise instructed:

21.3 CLASSROOM AREAS: Monday through Friday Occupied mode at 7:15 AM, Unoccupied mode at 3:30 PM. Unoccupied for Saturday and Sunday. Stage Classrooms in Area B on first, Area C on 15 minutes later and all other spaces 15 minutes after Area C.

21.4 MEDIA CENTER: Monday through Friday Occupied mode at 7:15 AM, Unoccupied mode at 3:30 PM. Unoccupied for Saturday and Sunday.

21.5 KITCHEN AREA: Monday through Friday Occupied mode at 6:00 AM, Unoccupied mode at 2:00 PM. Unoccupied for Saturday and Sunday.

21.6 GYMNASIUM: Monday through Friday Occupied mode at 7:15 AM, Unoccupied mode at 3:30 PM. Unoccupied for Saturday and Sunday.

21.7 Administration areas: Monday through Friday Occupied mode at 7:00 AM, Unoccupied mode at 4:00 PM. Unoccupied for Saturday and Sunday.

21.8 Cafeteria: Monday through Friday: Occupied mode at 7:15 AM, Unoccupied at 12:30 PM. Unoccupied for Saturday and Sunday.

21.9 Building outside air handling unit shall operate Monday thru Friday, 7:50 AM to 2:40 PM.

21.10 Each piece of equipment shall have its own adjustable time schedule.

21.11 All schedules shall be coordinated and confirmed with the Owner prior to final implementation.

SEQUENCES OF OPERATION

PART 22 - HEAT PUMP WATER LOOP CONTROL:

22.1 The Heat Pump Water Loop System consists of the following major equipment:
- P-1A, P-1B, P-2 (Variable Flow)

22.2 The Heat Pump Water Loop System shall operate under the control of a local, stand-alone, microprocessor based DDC controller. The Heat Pump Water Loop System shall

be placed into the occupied/unoccupied mode based upon the user adjustable schedule at the Network Controller. In the unoccupied mode, the pumps shall be off. If communication is lost between the Network Controller and the Heat Pump Water Loop Controller, then the Heat Pump Water Loop Controller shall be placed into the occupied mode until communication is restored.

22.3 Pump P-1A and P-1B are selected for 100% of the fully connected On-Peak geothermal water flow rate. Pump P-2 is selected for Off-Peak geothermal water flow rates (12-100 gpm). All pumps are variable flow with integral or wall mounted variable speed drives. The BAS contractor shall provide controllers and interface with pump VFD's to control the speed and quantity of the pumps required to meet building load.

22.4 Two differential pressure sensors are located on the drawings to control the pump speed. This contractor shall provide all control wiring necessary for proper system operation. This includes wiring to the following, provided as components to the system:

22.4.1 Pump VFD controller for enable/disable control on each pump.
22.4.2 Two differential pressure sensors. (See drawings)
22.4.3 Temperature sensors
22.4.4 Flow meter
22.4.5 No flow alarms
22.4.6 Other sensors specified as part of the variable speed pumping system.

22.5 The pumping system shall be OFF when all heat pumps in the system are disabled. The pumping system controller shall continuously survey all heat pumps, once any heat pump is enabled, the pumping system shall be enabled. If the BMS senses that one of the two differential pressure sensors are below the pressure setpoint, the speed of the controlled pump(s) shall increase. If the pump controller senses that all differential pressure sensors are above the pressure setpoint, the speed of the controlled pump(s) shall decreases. If additional pumps are required to maintain the system pressures, the controller will activate and deactivate pumps as required to maintain Off-Peak and On-Peak flow rates as follows:

22.5.1 Off-Peak Flow: Pump P-2 shall be enabled on total heat pump loop flow meter reading from 0-100 gpm. VHP-24 (Zone 4) and Existing VHP-Kitchen (Room 125) two-way control valve shall be <u>open</u> for P-2 operation.

22.5.2 On-Peak Flow: Pump P-1X shall be enabled when the total heat pump loop flow meter reading is greater than 100 gpm, and disable when loop flow is less than 80 gpm. VHP-24 (Zone 4) and Existing VHP-Kitchen (Room 125) two-way control valve shall be <u>closed</u> for P-1X operation. Rotate Lead/Lag/standby pump P-1X operation.

22.5.3 Transition from Off-Peak to On Peak Flow: When total loop flow rises above 80 gpm, pump P-1X shall be enabled and pumps P-2 shall linearly decrease VFD and pump speed until P-2 is disabled. System differential pressure shall be maintained during pumping system change-over.

22.5.4 Transition from On-Peak to Off-Peak Flow: Pumps P-2 shall start and linearly increase VFD and pump speed as P-1X is disable. System differential pressure shall be maintained during pumping system change-over.

22.6 For all pumps, if no water flow is sensed by a differential water pressure sensor at the pumps, then an alarm signal shall be generated and the lag pump shall be engaged. A thirty-second-time delay relay shall be provided for the pumps to prevent false alarms. After the cause of the alarm has been eliminated, the system shall be capable of resetting and re-establishing the lead pump. If no waterflow is sensed after thirty-second time-delay then the respective systems shall be shut down and an additional lag pump alarm shall be sent to the designated Maintenance Staff.

22.7 The differential pressure shall initially be set low at 7 psi (adj.). The BAS shall optimize the required setpoint to obtain the design waterflow with all heat pumps and in conjunction with the TAB Contractor and the Mechanical Engineer. Note the final setpoint in the BAS record documents.

22.8 The heat pump loop water flow rate shall be determined from an Onicon F-3200 series in-line electromagnetic flow meter located in the Mechanical Room 172 with 0.2% accuracy from 10-700 gpm. This meter shall also be used in conjunction with the well field supply and return temperature sensors to provide system BTU Calculation.

PART 23 – OUTSIDE AIR SYSTEM (OA-1):

23.1 The system shall operate under the control of a local, stand-alone, microprocessor based DDC controller. The system shall be placed into the occupied/unoccupied mode based upon the user adjustable schedule at the Network Controller. The system shall be in the occupied mode during regular school hours only. If communication is lost between the Network Controller and the Outside Air System Controller, then the Outside Air System shall be placed into the unoccupied mode until communication is restored.

23.2 The system will be placed into a Mode of Operation based upon the following adjustable temperature schedule:

Outside Air Temperature	Mode of Operation
72 deg F or greater (adj.)	Cooling Mode
Between 55 deg F and 72 deg F (adj.)	Economizer Mode
55 deg F or less (adj.)	Heating Mode

23.3 In the unoccupied mode:
- The supply fan and exhaust shall be off,
- The energy recovery wheel shall be off and modulating wheel bypass dampers closed,
- The outside air damper and exhaust air damper shall be fully closed,
- The face damper shall be full coil face.

23.4 When placed into the occupied mode, the following shall occur in sequential order after operation of the Water-to-Water Heat Pump System (HPC-1 & P-3) has reached temperature setpoint.
- The energy recovery wheel bypass dampers shall be confirmed closed via end switch,
- The energy recovery wheel shall start and operation shall be proved via current switch,
- The outside air damper and exhaust air damper shall fully open and be proved via end switch,

- The supply fan and exhaust fan shall start and operation shall be proved via current switches.
- The system shall not start if any one component does not prove operation, including the Geothermal Water-to-Water Heat Exchanger System.

23.5 In the occupied mode, the face and bypass dampers shall modulate to maintain discharge air temperature (adj.) based upon the following schedule:

Discharge Air Temperature	Mode of Operation
68 deg F (adj.)	Cooling Mode
Varies	Economizer Mode
65 deg F (adj.)	Heating Mode

23.6 If the outside air temperature is between 60 deg F (adj.) and 65 deg F (adj.), then the energy recovery wheel shall be off and the wheel bypass dampers shall be open. The water-to-water heat pump system shall remain off.

23.7 If the OA system is in the Cooling Mode, the water-to-water heat pump system shall provide chilled water to the unit as specified. If the OA system is in the Heating Mode, the water-to-water heat pump system shall provide hot water to the unit as specified. Pump P-3 shall modulate as required to maintain the coil leaving air temperature specified. Cooling Mode - 54 deg F (adj.). Heating Mode - 95 deg F (adj.). If the pumps are operating at their minimum speed the coil leaving air temperature setpoints shall be overridden.

23.8 If the outside air temperature is below 60 deg F (adj.), then the energy recovery wheel shall be on and the wheel exhaust bypass dampers shall modulate to maintain the Discharge Air Temperature. The outside air bypass dampers shall remain closed.

23.9 When the outside air temperature is below 35 deg F (adj.), the exhaust bypass damper shall close for 5 minutes (adj.) every hour to prevent the wheel from freezing.

23.10 The supply and exhaust air fans shall be enabled/disabled based on building occupancy schedule. A current sensor shall prove each fans status.

23.11 A manual reset low limit installed downstream of the chilled/hot water coil shall stop the operation of the system if the discharge temperature falls below 35 deg F.

23.12 A smoke detector shall be located in each air stream. If smoke is detected, then the system shall shutoff and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. Coordinate with Fire Alarm System. Any activation of the building's fire alarm system shall shutdown the OAU unit completely.

PART 24 – GEOTHERMAL WATER TO WATER HEAT PUMP CHILLER SYSTEM:

24.1 The system shall operate under the control of a local, stand-alone, microprocessor based BAS controller field installed adjacent to units. If communication is lost between the BAS and the Controller, then the Controller shall be placed into the occupied mode until communication is restored.

24.2 In the unoccupied mode or economizer mode:
- HPC-1 two-way control valve (source side) shall be closed,
- HPC-1 shall be off,
- Chilled/Hot Water Pumps P-3 shall be off.

24.3 When placed into the occupied mode, the following shall occur in sequential order prior to starting air handling system:
- HPC-1 two-way control valve (source side) shall open 100% as needed and prove open via field installed flow switch.
- Chilled/Hot Water Pump P-3 shall start and operation shall be proven via field installed flow switch.
- HPC-1 shall start as required and operation shall be proved via leaving water temperature.
- The system shall not start if any one component does not prove operation.

24.4 If any one component of the lead system does not prove operation, then the lag systems shall activate according to the same sequence and an alarm shall be generated. There shall be a 5-minute adjustable time delay before an additional compressor can be staged on or off. Additionally, the water-to-water unit compressors shall have the ability to sequence the start order.

24.5 The pumps are to be constant flow. If the OA unit is in the Cooling Mode, the geothermal water-to-water heat pump system shall provide chilled water to the unit as specified. If the OA unit is in the Heating Mode, the water-to-water heat pump system shall provide hot water to the unit as specified. Pumps P-3 shall be enabled with associated HPC-1.

24.6 In the Cooling Mode, HPC-1 shall operate to maintain 49 deg F (adj) +/- 1 deg F (adj.) supply water temperature. In the Heating Mode, HPC-1 shall operate to maintain 110 deg F (adj) +/- 1 deg F (adj.) supply water temperature. The compressors shall cycle on/off as required. The source-side control valve shall open and prove flow prior to operating the unit via field installed flow switch.

24.7 For all pumps, if no water flow is sensed by a differential water pressure sensor at the pumps, then an alarm signal shall be generated and the lag pump shall be engaged. A thirty-second-time delay relay shall be provided for the pumps to prevent false alarms. After the cause of the alarm has been eliminated, the system shall be capable of resetting and re-establishing the lead pump. If no waterflow is sensed after thirty-second time delay then the respective systems shall be shut down and an additional lag pump alarm shall be sent to the designated Maintenance Staff.

PART 25 - DOMESTIC WATER HEATING SYSTEM

25.1 BAS shall monitor status of the domestic water heater, associated recirculating pump and supply water temperature.

PART 26 - GEOTHERMAL HEAT PUMP UNITS

26.1 Each unit shall operate under the control of a local, stand-alone, microprocessor based DDC controller field installed adjacent to unit. The TCC shall install and hard-wire an

L.E.D. pilot light on the control panel for each heat pump compressor. When compressor is operating, its individual pilot light shall be on.

26.2 Each unit shall be placed into the occupied/unoccupied mode based upon the building's Global Time Schedule.

26.3 If communication is lost between the Global Time Schedule and the Heat Pump Controller, then the Heat Pump Controller shall be placed into the occupied mode until communication is restored.

26.4 A smoke detector shall be located in the return air stream of units greater than 2,000 cfm (larger than 5 tons). If smoke is detected, then the system shall shutoff and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. Coordinate with Fire Alarm System.

26.5 During the occupied mode, the heat pump and associated circulating pump shall cycle as required to satisfy space thermostat/sensor setpoint. The unit shall automatically changeover from heating to cooling. The pump shall start and prove flow via a current sensor prior to compressor/fan operation. When space temperature is satisfied the fan, compressor and pump shall be off.

26.6 During the occupied mode, if the occupancy sensor detects no occupancy, the unit shall operate in a temporary setback mode. The heat pump shall not operate in this condition unless the space temperature falls below 65 deg F (adj.) or rises above 78 deg F (adj.). If any occupancy sensor in the heat pump zone detects occupancy, the unit shall operate in the occupied mode.

26.7 During the unoccupied mode, the heat pump shall not operate unless the space temperature falls below 60 deg F (adj.) or rises above 85 deg F (adj.).

26.8 The majority of heat pumps operate with averaging sensors, the space temperature setpoint shall be adjustable only thru the EAS. The average space temperature of the sensors will determine the space temperature used to determine operation of the unit.

26.9 Provide a pushbutton override on all sensors located in the Administration Suite. If the Global Time Schedule is in the unoccupied when a pushbutton override is activated, then the heat pumps within the Administration Suite shall be placed into operation for 2 hours (adj.).

26.10 All other sensors shall also be provided with push button override sensors. These units shall be programmed with the override "locked out". The owner shall have the ability to activate these sensors at a future time without adding wires or making software changes.

26.11 The following additional requirements also apply to heat pump units serving the gym and media center. These units shall be equipped with airside economizer capabilities.

26.11.1 Provide full size modulating damper in the return air ductwork and outside air ductwork to intake hood.

26.11.2 BMS shall monitor OA enthalpy and room enthalpy and provide a 0-10 VDC

differential enthalpy signal to the heat pump controller. A signal of 0.0 VDC shall indicate that the OA enthalpy is less than or equal to the room air enthalpy; any positive signal shall indicate that the room enthalpy is less than the OA enthalpy.

26.11.3 When OA enthalpy is greater than the room enthalpy, the heat pump controller will command the OA damper to lock out economizer control on the heat pump. The OA damper shall modulate as required to maintain minimum room CO2 levels. The heat pump controller system shall receive indoor and outdoor CO2 levels from the FMS system. The OA damper shall modulate as required to maintain a differential of 600 ppm (adj.). An override shall be provided that will limit the OA dampers position to a maximum of 20% open (adj.).

26.11.4 When the OA enthalpy is less than the room enthalpy, the heat pump controller/BAS will command the units economizer to operate and the OA damper shall be allowed to modulate to 100%.

26.11.5 The heat pump controller/BAS will modulate the OA damper and RA damper to mix OA and RA to maintain a minimum mixed air temperature set point of 55 deg F.

26.11.6 Should air conditioning be required and the outside air enthalpy is less than the indoor enthalpy, then the airside economizer cycle shall be enabled. Mixed air temperature shall not fall below 55°F.

PART 27 – KITCHEN REFRIGERATOR AND FREEZER

27.1 Provide a wall-mounted temperature sensor in the walk-in refrigerator and freezer units to monitor temperature.

27.2 If the temperatures exceed a pre-designated setpoint (adj.), an alarm shall be generated.

PART 28 – FLOW METER ALARM AND EMERGENCY SHUTDOWN FOR MAKE-UP WATER:

28.1 On the make-up water line, a two-way, two-position, normally open valve shall close if (after a time delay of 2 minutes) the make-up water continues flowing at a rate of 3 gallon per minute while the system switch is in the normal operating position. An alarm shall be sent to the school board security operations via interface to the building security system. An audible alarm mounted on the control panel (mounted very near the make-up network) shall sound and an indicator light will provide visual indication of a problem. A momentary push button on the panel shall be used to silence/acknowledge the alarm and reset system for normal operation after any necessary repairs are made. A switch mounted on the panel shall be used to shut down the alarm while normal system fill operations are performed. This switch and all panel mounted devices are to be appropriately labeled. Provide and coordinate installation by mechanical contractor the valve and ONICON Model F-1310 Inline Turbine Flow meter. Flow meter to be ¾ inch union body, scaled 0-10 GPM range is 0-10 volt output.

PART 29 – CHEMICAL TREATMENT:

29.1 Provide all required wiring, conduit, etc., for a complete and operating system.

PART 30 – FIRE PUMP HOUSE:

30.1 Enable/Disable exhaust fan and open and close intake and exhaust motorized dampers to maintain space temperature of 85 deg-F.

PART 31 – ENERGY RECOVERY UNIT (ERV-X):

31.1 During occupied hours ERV-X supply and exhaust fan shall run continuously and motorized OA/EA dampers shall be fully open. During unoccupied hours the fan shall be off and motorized OA/EA dampers shall be fully closed.

PART 32 – HVAC POINTS LIST:

PUMP LOOP POINT LIST							
	BINARY			ANALOG			POINT DETAILS
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	
Pump P-1A/B – 2	X	X					On/Off
Pump VFD's				X			Hz
System GPM (in loop main)				X			GPM
Supply Temp.				X	X - 100		Degrees
Return Temp.				X		X - 35	Degrees
Geo Loop				X			Total GPM
Geo Loop Field GS/GR				X			Degrees
Differential Pressure Sensor (2 sensors)				X			PSI
Heat Pump Loop Make-up Water Flow Meter	X	X		X			GPM
Heat Pump Loop Make-up water Control Valve	X	X		X			Open/Closed
END OF PUMP LOOP POINT LIST							

ERV-X POINT LIST							
	BINARY			ANALOG			POINT DETAILS
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	
Supply Air Fan	X	X					On/Off
Exhaust Air Fan	X	X					On/Off
ERV Entering EA Temp				X			Degrees
ERV Discharge EA Temp				X			Degrees
ERV Entering OA Temp				X			Degrees
ERV Discharge OA Temp				X		X	Degrees
OA Motorized Damper				X			Open/Closed
EA Motorized Damper				X			Open/Closed
EA Filter Diff, Pressure		X		X			Delta P
OA Filter Diff, Pressure		X		X			Delta P
END OF ERV-X POINT LIST							

HEAT PUMP POINT LIST							
	BINARY			ANALOG			POINT DETAILS
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	
Compressor (s)	X		X				On/Off
Supply Fan	X		X				On/Off
Reversing Valve				X			Htg/Clg
Zone Temperature Setpoint				X			Degrees
Zone Temperature				X	X	X	Degrees
Discharge Air Temperature				X			Degrees
Control Valve				X			Open / Closed
Smoke Detectors (where required)		X					
Min OA Damper (Gym and Media Ctr)				X			% Open
Economizer OA Damper (Gym and Media Ctr)				X			% Open
Return Damper (Gym and Media Ctr)				X			% Open
Relief Damper (Gym and Media Ctr)				X			% Open
Mixed Air Temperature (Gym and Media Ctr)				X	X	X	Degrees
Room CO2 (where indicated)				X			CO2
END OF HEAT PUMP POINT LIST							

HEAT PUMP CHILLER							
	BINARY			ANALOG			POINT DETAILS
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	
HPC-1	X	X					Enable/ Disable
Mode of Operation	X						Heating / Cooling
Process EWT/LWT				X	X	X	Degrees
Geo EWT/LWT				X	X	X	Degrees
Compressor	X	X					Stages
Process Delta P.				X	X		PSI
Geo Delta P.				X	X		PSI
Pump P-3	X	X					On/Off
END OF HEAT PUMP CHILLER POINT LIST							

OAU: OUTSIDE AIR/EXHAUST AIR SYSTEMS POINT LIST							
	BINARY			ANALOG			POINT DETAILS
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	
Supply Fan	X						On/Off
Exhaust Fan	X						On/Off
Energy Recovery Wheel (E.R.W.)	X						On/Off
Outside Air Damper				X	X		% Open
Exhaust Air Damper				X	X		% Open
F&B Damper				X			% Open
Outside Air Temp. Upstream of E.R.W.				X			Degrees
Outside Air Temp. Downstream of E.R.W.				X	X	X	Degrees
Exhaust Air Temp. Upstream of E.R.W.				X			Degrees
Exhaust Air Temp. Downstream of E.R.W.				X		X	Degrees
Coil Leaving Air Temp.				X			Degrees
Unit Discharge Air Temp.				X			Degrees
Coil EWT / LWT				X	X	X	Degrees
Filter Diff, Pressure				X	X		Delta P
Duct Smoke Detector		X					
END OF OUTSIDE AIR/EXHAUST AIR SYSTEMS POINT LIST							

MISC SYSTEM POINT LIST							
	BINARY			ANALOG			POINT DETAILS
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	
Exhaust Fans	X	X					On/Off
Intake and exhaust Louver/Hood Dampers	X	X					Open / Closed
Loop Filter LF-1				X	X		PSI
Domestic WH	X						Degrees
Domestic WH Pump	X						On/Off
Freezer				X	X		Degrees
Cooler				X	X		Degrees
Fire Pump House Space Temperature				X		X	Degrees
Fire Pump House Temp Setpoint				X			Degrees
END OF MISC SYSTEM POINT LIST							

END OF SECTION

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SECTION 260501 - GENERAL PROVISIONS - ELECTRICAL

PART 1 - GENERAL

1.1 The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

1.2 Each Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect his part of the work.

1.3 The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating Electrical Systems indicated on the drawings and/or specified herein.

1.4 Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.5 It is not the intent of this Section of the Specifications to make any Contractor, other than the Construction Manager responsible to the Owner. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Construction Manager to the Architect, then to the Engineer. Also, this Section of the Specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

1.6 This section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the Prime Contract.

1.7 It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.

1.8 In general, and to the extent possible, all work shall be accomplished without interruption of the existing facilities' operations. Each Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will occur. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed. Contractor will not be entitled to additional compensation due to work stoppage mandated by unscheduled interruption.

1.9 Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work. The Contractor shall abide by the requirements of the Special Conditions.

1.10 Definitions and Abbreviations

A. Prime Contractor - The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.

B. Contractor - Any Contractor whether bidding, proposing or working independently or under the supervision of a Prime Contractor, Construction Manager and who installs any type of Electrical Work as specified in the Contract Documents.

C. Electrical Contractor - Any Contractor whether bidding or working independently or under the supervision of a Construction Manager, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

D. Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.

E. Engineer - The Consulting Mechanical-Electrical Engineer either consulting to the Owner, Architect, or Other, etc. In this case: CMTA, Inc., Consulting Engineers.

F. Architect - The Architect of Record for the project.

G. Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Manager's Assignments, Architect's Supplemental Instructions, Construction Contract with Owner, etc.

H. Bidder/Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

I. The Project - All of the work required under this Contract.

J. Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

K. Provide - Furnish and install complete, tested and ready for operation.

L. Install - Install equipment furnished by others in complete working order.

M. Indicated - Listed in the Specifications, shown on the Plans or Addenda thereto.

N. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.

O. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.

P. Start-up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to functional testing.

Q. Vendor: Supplier of equipment.

R. Typical or Typ- Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

S. ADA - Americans with Disabilities Act.

T. ANSI - American National Standards Institute.

U. ASA – American Standards Association.

V. ASTM – American Society for Testing Materials.

W. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.

X. BAS – Building Automation System.

Y. BICSI – Building Industry Consulting Services International

Z. CM – Construction Manager

AA. EE – Electrical Contractor

BB. FCC – United States Federal Communications Commission

CC. IECC – International Energy Conservation Code

DD. IEEE – Institute of Electrical and Electronics Engineers.

EE. ISO – International Standards Organization.

FF. NEC – National Electrical Code (NFPA 70).

GG. NECA – Standards for Installation.

HH. NEMA - National Electrical Manufacturers Association.

II. NESC – National Electrical Safety Code.

JJ. NFPA - National Fire Protection Association.

KK. OSHA - Office of Safety and Health Administration.

LL. TIA – Telecommunications Industry Association

MM. RFI – Request for Information

NN. RIO – Rough-in Only

OO. UL - Underwriters Laboratories, Inc.

PP. UON – Unless otherwise noted.

1.11 Note: Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

1.12 Required Notices: Ten days prior to the submission of a proposal, each proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system.

1.13 In each of the specifications and drawings referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.14 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

PART 2 - INTENT AND INTERPRETATION

2.1 It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete, tested and ready for operation."

2.2 Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

2.3 It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.

2.4 All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer’s installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer’s installation requirements whether specifically detailed or not within the Plans and Specifications.

2.5 Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

2.6 The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer / Architect. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.

2.7 The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten (10) days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory

PART 3 - ELECTRICAL DRAWINGS AND SPECIFICATIONS

3.1 The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.

3.2 The drawings and specifications are intended to supplement each other. No Contractor, bidder, proposer or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

3.3 The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

3.4 This Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

3.5 The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.

3.6 Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation.

Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

3.7 Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

3.8 The Electrical drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

3.9 The Electrical Contractor and his Sub-Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten (10) days prior to bids, for issuance of clarification by written addendum.

3.10 Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

3.11 Special Note: Always check ceiling heights indicated on Drawings and Schedules and insure that these heights may be maintained after all mechanical and electrical equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions.

PART 4 - EXAMINATION OF SITE AND CONDITIONS

4.1 Each Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.

4.2 Each Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten (10) days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

4.3 The Electrical Contractor is required to provide coordination drawings, data and collaboration for all aspects of his work in accordance with the general and special

conditions – Divisions 20, 21, 22, 23, 25, 26, 27 and 28 and the Construction Manager's procedures.

PART 5 - EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

5.1 When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility.

5.2 References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of Paragraph 5.1 immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten (10) days prior to bid date for approval to bid in written form through addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

5.3 Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the engineers.

5.4 Each Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

PART 6 - SINGLE SOURCE RESPONSIBILITY AND OBSOLETE EQUIPMENT

6.1 Except where specifically noted otherwise, all equipment supplied by the Contractor shall be the standard products of a single manufacturer of known reputation and experience in the industry. Only equipment, components and accessories in current production for at least five (5) years beyond the completion date of this system shall be used and installed. Any equipment found to be obsolete or not in future production will be removed and replaced at Contractor's expense. This includes all equipment, materials and labor.

PART 7 - CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

7.1 The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans,

utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

7.2 Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

7.3 The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.

7.4 All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.

7.5 All material and equipment for the electrical systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.

7.6 All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.

7.7 The Contractor shall insure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.

7.8 Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

PART 8 - COST SUPERVISION OF WORK

8.1 Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act for him in matters related to the project.

PART 9 - BREAKDOWNS

9.1 Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns

are submitted. Refer to Division 0 and 1 specification sections for additional requirements.

9.2 In addition to cost breakdowns by specification section, the following shall also be provided: Material and labor shall be listed separately. These items are in addition to items listed in front-end specifications. Pay special attention to required withholding percentages for startup, testing, documentation, acceptance, owner training, etc. The breakdown shall be minimally as follows:

1. Permitting
2. Mobilization
3. Electrical Shop Drawings/Submittals
4. Electrical Coordination Drawings
5. Temporary Power
6. Interior Lighting Materials & Labor
7. Exterior Lighting Materials & Labor
8. Lighting Controls Materials & Labor
9. Electrical Distribution (Switchgear) Materials & Labor
10. Feeders Materials & Labor
11. Branch Circuiting Materials & Labor
12. Service Grounding Materials & Labor
13. Surge Suppression Materials & Labor
14. Electrical Devices Materials & Labor
15. Ladder/Cable Trays Materials & Labor
16. Fiber/Communication Duct Banks Materials & Labor
17. Fire Alarm Materials & Labor
18. Low-Voltage Data/Voice Cabling Materials & Labor
19. Low-voltage Data/Voice Equipment Materials & Labor
20. CATV Equipment and Cabling Materials & Labor
21. Security Equipment and Cabling Materials & Labor
22. Spare lamps and ballasts
23. Fire Alarm System Startup, Testing, & Verification (shall equal 5% of Equipment Value)
24. Electrical Distribution Equipment Startup, Testing, & Verification (shall equal 2.5% of Equipment Value)
25. Lighting and Lighting Controls Startup, Testing, & Verification (shall equal 2.5% of Equipment Value)
26. Low Voltage Systems Startup, Testing, & Verification (shall equal 5% of Equipment Value)
27. Owner Training & Acceptance
28. Punchlist
29. As-Built/Record Drawings & Acceptance
30. O&M Manuals & Acceptance
31. Warranty
32. Demobilization

PART 10 - GUARANTEES AND WARRANTIES

10.1 Each Contractor shall unconditionally guarantee all equipment, apparatus, materials, and workmanship entering into this Contract to be the best of its respective kind and shall replace all parts at his own expense, which fail or are deemed defective within

one year from final acceptance of the work by the Engineer. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Engineer and Owner's Statement of Substantial Completion.

10.2 Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

10.3 The Warranties specified in this and other Articles shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

10.4 All light fixtures shall have a five (5) year unconditional warranty. (Parts, Labor and Travel).

10.5 Provide all warranty certificates to Owner. All warranties begin starting at the substantial completion date, submit warranty certificates accordingly.

PART 11 - INSPECTION, APPROVALS AND TESTS

11.1 Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.

11.2 Owner's and Engineer's inspections: Two (2) inspections will be held to generate and then review punchlist items. All site visits thereafter shall be billed to the Contractor at the Engineer's standard hourly rates.

11.3 The Contractor shall provide as a part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.

11.4 The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

11.5 Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

11.6 Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

11.7 Before final acceptance, the Contractor shall furnish three (3) copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one (1) copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

11.8 The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

PART 12 - CHANGES IN ELECTRICAL WORK

12.1 REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 13 - CLAIMS FOR EXTRA COST

13.1 REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 14 - SURVEYS, MEASUREMENTS AND GRADES

14.1 The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

14.2 The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

14.3 Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

PART 15 - UTILITY COMPANY REQUIREMENTS

15.1 The Contractor shall provide the local utility company with a drawing produced by a licensed Land Surveyor (or a licensed Engineer) in the State of Kentucky and acceptable to the utility that locates the centerline of the primary duct. Coordinate further requirements with utility company.

15.2 Contact the utility company for specifics on construction of pads, conduit, etc., prior to bidding the work and determine all their requirements. All work shall be in accordance with their standards.

15.3 The electrical contractor is responsible for all fees, permit costs, etc., from the electrical utility, data, telephone and cable TV companies. This includes any cost associated with the electrical service extension.

15.4 Each contractor, prior to bidding the work, is to contact the utility companies (electric, data, telephone and cable TV) and determine the exact points of extension of all underground services in the field with a representative of each utility company. Also, obtain construction details on manholes, transformer pads, pedestal stub-ups, etc., from each utility company as applicable. Extension points indicated on the plans are approximate, and are given for the bidder's information only.

PART 16 - TEMPORARY SERVICES

16.1 The Contractor shall arrange for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

16.2 All temporary services shall be removed by Contractor prior to acceptance of work.

PART 17 - TEMPORARY USE OF EQUIPMENT

17.1 The permanent electrical equipment, (except lighting),when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.

17.2 Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

PART 18 - MATERIALS AND WORKMANSHIP

18.1 All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

18.2 All conduit and/or conductors shall be concealed in or below walls, below floors or above ceilings, unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein. Raceways shall not be placed within foundation walls and footings.

18.3 All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer approved testing agency, where such a standard has been established.

18.4 Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the makers mark or name.

18.5 All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

18.6 All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

18.7 Comply with National Electrical Contractors Association (NECA) performance standards that are published as National Electrical Installation Standards (NEIS).

18.8 All applicable equipment and devices provided shall meet all FCC requirements and restrictions.

PART 19 - QUALIFICATIONS OF WORKMEN

19.1 All electrical contractors bidding this project must have been a licensed company for a minimum of three (3) years to qualify to bid this project. Individual employee experience does not supercede this requirement.

19.2 All subcontractors bidding the electrical work must have completed one project of 70% this subcontract cost size and two projects of 50% this subcontract cost size.

19.3 All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

19.4 All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

19.5 Special electrical systems, such as Fire Detection and Alarm Systems, Telecommunications or Data Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer, within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

PART 20 - CONDUCT OF WORKMEN

20.1 The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

PART 21 - COOPERATION AND COORDINATION BETWEEN TRADES

21.1 The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be effected.

21.2 Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements. The Contractor is responsible for the correct location of all rough-in and connections at every piece of equipment. Work not correctly located shall be relocated at the Contractor's expense.

21.3 Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than ¼" = 1'-0", clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. He shall make the necessary changes in his work to correct the condition without extra charge.

21.4 The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

PART 22 - PROTECTION OF EQUIPMENT

22.1 The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor. Electrical equipment exposed to the weather shall be replaced by the Contractor at his expense.

PART 23 - SCAFFOLDING, RIGGING AND HOISTING

23.1 The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

PART 24 - CONCRETE WORK

24.1 The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.

24.2 All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than l8" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish.

24.3 Special Note: All pads and concrete lighting standard bases shall be crowned slightly so as to avoid water ponding beneath equipment.

24.4 In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads l8" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.

24.5 Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, trowelled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

PART 25 - SMOKE AND FIRE PROOFING

25.1 The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction. Refer to architectural plans and specifications for further requirements.

25.2 Contractor to provide heat detectors in the area of construction with complete fire detection until fire alarm system is operational and construction is complete.

25.3 Firestopping materials and installation shall be by a single source through-out the project, by all trades.

25.4 All fire-stopping assemblies must be UL listed. Provide shop drawings indicating penetration detail for each type of wall and floor construction. Shop drawings must be specific for each individual type (i.e., one hour fire rated gypsum wall board with insulated metal pipe penetration.) and must indicate a UL listing for the complete fire-stopping assembly.

25.5 3M fire protection products are listed below. Equivalent products may be submitted if they are UL listed.

25.6 All fire-stopping shall be applied by a Contractor who is certified by the manufacturer of the fire-stopping product for installation of the product.

25.7 Fire-stopping materials to include but not limited to the following:

A. 3M fire barrier FS-195 wrap/strip.

B. 3M fire barrier CP 25 caulk.

C. 3M fire barrier MP moldable putty.

D. 3M fire barrier RC-1 restricting collar with steel hose clamp.

E. 3M fire barrier damming materials.

F. 3M fire barrier CS-195 composite sheet.

G. 3M fire barrier fire dam 150 caulk.

H. Steel sleeves.

I. Hilti Speed Sleeves.

PART 26 - QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

26.1 All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.

26.2 All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

26.3 The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

PART 27 - WELDING

27.1 The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained.

PART 28 - ACCESSIBILITY

28.1 The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the Construction Manager and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

28.2 The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

28.3 Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work. In the absence of such specifications, at a minimum such work shall comply with the specifications below. All locations for access panels which are not specifically indicated on the drawings shall be submitted to and approved by the architect prior to ordering.

28.4 Access Doors; in Ceilings or Walls:

A. In mechanical, electrical, or service spaces: 14 gauge aluminum brushed satin finish, 1" border.

B. In finished areas: 14 gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.

C. In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

PART 29 - RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

29.1 The Contractor shall replace to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations.

Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable. Patchwork on new construction will not be accepted.

PART 30 - MAINTENANCE OF EXISTING UTILITIES AND LINES

30.1 The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that come within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utilities grants permission to interrupt same temporarily, if need be. Provide one week's written notice to Engineer, Architect and Owner prior to interrupting any utility service or line. Also see Part 1 - GENERAL, of this specification.

30.2 Known utilities and lines as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain and mark all utilities or lines that would be endangered by the excavation. Contractor shall bear costs of repairing damaged utilities.

30.3 If the above mentioned utilities or lines occur in the earth within the construction site, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area.

30.4 Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.

30.5 The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

30.6 Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.

30.7 Protect all new or existing lines from damage by traffic, etc. during construction.

30.8 Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

PART 31 - MANUFACTURER'S NAMEPLATE

31.1 Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

PART 32 - ELECTRICAL CONNECTIONS

32.1 The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. The

Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also, refer to Division 20, 22, 23, 25, 27, and 28 of Specifications, shop drawings and equipment schedules for additional information and requirements.

32.2 All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.

32.3 Each Contractor or Sub-Contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

PART 33 - FINAL CONNECTIONS TO EQUIPMENT

33.1 The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturer's representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

PART 34 - ENERGIZED EQUIPMENT

34.1 At no time shall the contractor work on energized electrical equipment. Contractor shall comply with NFPA 70E requirements at all times throughout construction.

PART 35 - MOTORS

35.1 Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box and NEC required disconnecting means as indicated or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.

35.2 The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. Refer to Division 20, 22, 23, 24 and 25 of the Specifications for further requirements and scheduled sizes.

35.3 All three-phase motors shall be tested for proper rotation. Correct wiring if needed and retest. Document testing and corrective action in operations and maintenance manual.

PART 36 - CUTTING AND PATCHING

36.1 Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

36.2 No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

36.3 When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

PART 37 - SLEEVES AND PLATES

37.1 Each Contractor shall provide and locate all sleeves and inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

37.2 Sleeves shall be provided for all electrical conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction. Sleeves shall not be provided for piping running embedded in concrete or insulating concrete slabs on grade, unless otherwise noted.

37.3 Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be packed with oakum and lead, mechanical waterstop or other approved material and made completely water tight by a method approved by the Engineer and/or Architect.

37.4 Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

A. Terminate sleeves flush with walls, partitions and ceiling.

B. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.

C. In all areas where pipes are exposed, extend sleeves 1/2 inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

37.5 Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

37.6 Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

PART 38 - ANCHORS

38.1 Each Contractor shall provide and locate all inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

PART 39 - CONDUIT MOUNTING HEIGHTS

39.1 All exposed or concealed conduit, raceways, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed conduit shall, insofar as possible, run perpendicular or parallel to the building structure.

PART 40 - PAINTING

40.1 Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

PART 41 - WEATHERPROOFING

41.1 Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

41.2 Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

PART 42 - EQUIPMENT/CONTROLS STARTUP & VERIFICATION

42.1 A pre-start-up conference shall be held with the Engineer, Owner, Construction Manager, Mechanical Contractor, Electrical Contractor, Controls Contractor, Test and Balance Contractor, and any manufacturer's providing startup services. The purpose of this meeting will be to discuss the goals, procedures, etc. for start-up

42.2 Equipment and controls startup and verification shall be required for this project. A specific line-item shall be included on the schedule of values by each Trade for "equipment and controls startup". This line-item value shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspectors shall closely monitor progress and quality of the equipment and controls startup and may withhold pay requests as deemed appropriate.

42.3 The Contractor shall include in the bid to provide equipment and controls startup and verification for ALL Electrical systems specified for this project. Specific startup/verification specifications are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (not third party contractors) and shall complete and submit start-up reports/checklists. Submit factory start-up reports to the Engineer. The contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner.

42.4 Many pieces of equipment and systems are specified with "manufacturer" startup. In general, the manufacturer's recommended startup procedures and checklists will be acceptable for use in the project. Where "manufacturer" startup is not specified, then this Contractor shall perform startup services in strict accordance with manufacturer's instructions. All startup/verification process shall be thoroughly documented by the Contractor and shall include the time and date when performed.

42.5 The Contractor shall be responsible for completion of their own System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

PART 43 - OPERATING INSTRUCTIONS

43.1 Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

43.2 Unless specified otherwise in Division 1, each Contractor shall furnish three (3) complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue.

Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.

43.3 Unless specified otherwise in Division 1, each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

PART 44 - CLEANING

44.1 The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible or all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

44.2 After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

PART 45 - INDEMNIFICATION

45.1 The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

PART 46 - HAZARDOUS MATERIALS

46.1 The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

46.2 Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work,

insure that their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

46.3 CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

46.4 If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

46.5 The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

PART 47 - ABOVE-CEILING AND FINAL PUNCH LISTS

47.1 The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project.

A. For review of in-wall work that will be concealed by drywall or other materials well before substantial completion.

B. For review of the above-ceiling work that will be concealed by tile or other materials well before substantial completion.

C. For review of all other work as the project nears substantial completion.

47.2 When all work form the Contractor’s punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing two weeks prior to the proposed date. After all corrections have been made from the Engineer’s punch list, the Contractor shall review and initial off on each item. This signed-off punch list and all work prior to the ceilings being installed and at the final punch list review.

47.3 After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.

47.4 At the engineer’s option, the contractor shall supply digital photographs via email or file-share of any installed work.

47.5 If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money

order (due net 10 days from date of each additional visit) at a rate of $150.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.

47.6 All panelboard fronts shall be omitted until final punch list inspection is made. Directories for each panelboard shall be completed and available for review by the Engineer at that time.

PART 48 - POSTED OPERATING INSTRUCTIONS

48.1 Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

A. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

B. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

C. Safety precautions.

D. The procedure in the event of equipment failure.

E. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

48.2 Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

PART 49 - TRAINING AND RELATED SUBMITTALS

49.1 Upon completion of all work and all tests, Contractor shall provide classroom and in the field training for each type and/or model of equipment installed. Training shall be led by qualified factory certified technician. Contractor shall submit a request to schedule training sessions a minimum of two weeks in advance. Submission shall include qualifications of instructor as well as a syllabus that the Owner will add/deduct to as they see fit. Each individual listed as an “Attendee” on the roster submitted by the Owner shall receive a copy of the maintenance manual to review during training. All training sessions shall be recorded and a DVD with proper labels identifying the date, equipment, and project shall be delivered prior to Completion of the project. If the audio from the recording is unclear, narration shall be added. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

49.2 The training phase shall be accompanied by complete as-built documentation and the technical systems operation manual.

49.3 These training sessions shall be videotaped by the Installer and copies provided to the Owner within one (1) week of training

49.4 Brochures: Furnish Owner a complete set of operating instructions and diagrams.

49.5 Systems/Components which require owner training. The training shall be accomplished by a factory trained representative. Include (8) hours minimum for each system

described here-in. Each equipment representative shall be represented wherever their equipment is used. All training shall be videotaped by the Installer. The following systems shall include owner training at a minimum:

A. Lighting control system

B. Electrical Distribution (Switchgear)

C. Service Grounding

D. Electrical Devices

E. Fire Alarm Materials & Labor

F. Access Controls

G. Each Low Voltage System (See System Responsibilities Matrix and SCOPE OF THE ELECTRICAL WORK)

49.6 Instruction Program: Submit outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

49.7 At completion of training, submit two complete training manual(s) for Owner's use.

49.8 Qualification Data: For facilitator, instructor and photographer.

49.9 Attendance Record: For each training module, submit list of participants and length of instruction time.

49.10 Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

49.11 Demonstration and Training DVDs: Submit two copies within seven days of end of each training module.

49.12 Identification: On each copy, provide an applied label with the following information:

A. Name of Project.

B. Name and address of photographer.

C. Name of Architect and Construction Manager.

D. Name of Contractor.

E. Date video was recorded.

F. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

49.13 Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video. Include name of Project and date of video on each page.

PART 50 - EQUIPMENT/SYSTEMS TESTING, VERIFICATION, & START-UP

50.1 The Contractor (and Sub-Contractors) shall be responsible for commissioning, starting-up, testing, checking, examining, inspecting, etc. their own systems.

50.2 The Electrical Contractor shall designate an individual under his employment to lead the startup , testing and verification process. This person should not be the project manager or job site superintendent, but a person dedicated to making this critical task successful and completed in a timely manner.

50.3 This individual shall also be responsible for the following items:

A. All identification and labeling requirements per plans and specifications.

B. Submission of switchgear coordination study, fault current study, and arc flash hazard analysis.

50.4 A pre-start-up conference shall be held with the Architect, Owner, Construction Manager, Electrical Contractor, and the Manufacturers providing startup services. The purpose of this meeting will be discuss the goals, procedures, etc. for start-up.

50.5 A specific line-item shall be included on the schedule of values for testing and verification of all systems indicated in this section. This line-item value shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspector(s) shall closely monitor progress and quality of the testing, verification, and startup and may withhold pay requests as deemed appropriate.

50.6 The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

50.7 Systems Requiring Testing & Verification:

A. Fire Alarm System

B. Electrical Distribution Equipment

C. Lighting and Lighting Controls

D. Emergency Standby Systems

E. All Low Voltage Systems

F. Grounding Systems

G. Wiring and Terminations

50.8 The Contractor shall include in the bid to provide systems startup and verification for ALL electrical systems specified for this project. Specific startup, testing, and verification specifications are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (not third party Contractors) and shall complete and submit start-up reports/checklists. Submit start-up reports to the Engineer. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner. Where factory start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up.

50.9 The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

50.10 The completed reports shall be organized and bound together in a tabbed binder and submitted for review and approval.

PART 51 - SPECIAL WRENCHES, TOOLS AND KEYS

51.1 Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, alarm pull boxes and panels, etc. At least two (2) of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

PART 52 - CLOSEOUT DOCUMENTS

52.1 All items listed in this section shall be provided to the engineer upon substantial completion. Provide three bound copies with complete index and tabs to locate each item.

52.2 As-Built Record Drawings:

A. The Contractor shall insure that any deviations from the design are being recorded daily, as necessary, on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Deliver these record drawings to the Engineer as a system is completed, within ten days of the mark-up and/or while the accuracy of the mark-ups can be verified visually. Monthly payment may be withheld if the requirement is not complied with.

B. All underground utilities/piping installed as part of this project shall be surveyed by a land surveyor licensed in Kentucky. This shall include underground electrical primary, communications, vaults. The survey shall include actual duct bank depths to top of conduit every 100 feet in length. The survey shall also include benchmarks dimensions relative to above grade, fixed structures. The survey shall be furnished on a compact disc in AutoCad ".dwg" format and ".pdf" format. Provide a GPS coordinate of each geothermal well and indicate on the as-built drawing. The survey information shall be included in the closeout documentation.

C. Refer to additional record drawing requirements within the general conditions and other sections of these specifications.

52.3 Start-up and System Testing Certifications and Reports:

A. Provide reports from all required testing to indicate procedures followed and complete results of all tests. Provide reports on manufacturer's standard forms for all equipment

and system tests. Testing shall be per applicable NEC, NFPA, UL, NETA, and/or ANSI standards.

52.4 Operation and Maintenance Manuals

A. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three (3) complete bound hard copies and a digital copy of operation and maintenance instructions and parts lists for all equipment provided in this contract. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:

B. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.

C. Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

D. The operation and maintenance document directory should provide easy access and be well organized and clearly identified.

E. The operation and maintenance manuals shall contain the following information:

1. Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
2. Provide contacts (company name, address, phone number, email) where parts may be purchased for all equipment.
3. Provide detailed maintenance instructions, including recommended preventative maintenance schedules for all equipment requiring maintenance. For lighting and lighting controls, provide recommended relamping program, provide a schedule for inspecting and recalibrating lighting controls, and provide a recommended settings list for all components with adjustable settings.
4. General Information. Provide the following:

    a. Building function
    b. Building description
    c. Operating standards and logs

5. Technical Information. Provide the following:

    a. System description
    b. Operating routines and procedures
    c. Seasonal start-up and shutdown
    d. Special procedures
    e. Basic troubleshooting

6. The maintenance manual should contain the following information:

    a. Equipment data sheets. Provide the following:

        1) Operating and nameplate data
        2) Warranty
        3) Detailed operating instructions.

b. Maintenance program information. Provide the following:

1) Manufacturer's installation, operation, and maintenance instructions
2) Spare parts information
3) Preventive maintenance actions
4) Schedule of actions
5) Action description
6) History

7. Test reports document observed performance during start-up and commissioning.
8. Reference Division 1 specifications for additional requirements.

52.5 Shop drawings will not be accepted as satisfying the requirement for Operation and Maintenance Manuals.

52.6 Shop Drawings: Provide complete copies of all approved shop drawings. Where shop drawings were returned "Furnish as Corrected", the contractor shall make the corrections noted by the engineer and submit final corrected shop drawings with close-out documentation.

52.7 Parts Lists: Provide an inventory of all spare parts, special tools, attic stock, etc. that have been provided to the owner.

52.8 Warranties: Contractor's one year warranty and all other specific warranties indicated in the construction documents.

52.9 Training Verification: Provide certification that all specified training has been completed. List training session dates, times, and types.

52.10 Inspection Certificates: Provide certificates of inspection from electrical inspector, fire marshal, and any other required special inspections.

52.11 Panel Schedules: Provide hard copies and digital copies of Excel files for all panel-board schedules.

52.12 Final Power System Study Reports.

52.13 Fire Alarm System Certification.

52.14 Power Riser Diagram: Provide a framed full-size copy of the overall power riser diagram (under glass) to the Owner. Also, provide three vinyl-coated copies of same. Where an existing power riser diagram is present, the Contractor shall obtain the document from the Owner, and update in digital format with the scope of this project. Edits shall be in digital format and this work shall be closely coordinated with the Owner.

52.15 Fire Alarm Riser Diagram: Provide vinyl coated fire alarm system diagrams including floor plans and device addresses at fire alarm equipment. Provide a full system diagram at the main fire alarm control panel and provide the respective level's system diagram at the NAC panels located on other levels of the structure. Where an existing power riser diagram is present, the Contractor shall obtain the document from the Owner, and update in digital format with the scope of this project. Edits shall be in digital format and this work shall be closely coordinated with the Owner.

END OF SECTION 260501

DIVISION 26 - ELECTRICAL

SECTION 260502 - SCOPE OF THE ELECTRICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SCOPE OF THE ELECTRICAL WORK

A. The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, verify place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

1. All raceways, conduits, cable management systems, cable trays, J-hooks, conductors, outlet boxes, fittings, pull boxes, manholes, etc.
2. All low-voltage distribution equipment, switchboards, panelboards, disconnect switches, fuses, transformers, contactors, starters, etc.
3. Electrical Studies including Fault Current, Arc Flash, and Coordination Studies. All studies to be performed by manufacturer of electrical distribution equipment.
4. All wiring devices and device plates.
5. Cable splicing, terminations, supports, etc.
6. All light fixtures, drivers, ballasts and lamps.
7. All branch circuits and feeders.
8. Electrical connection to all electrically operated equipment furnished and/or installed by others, including powered casework, athletic equipment, mechanical equipment, kitchen equipment, etc.
9. Electrical Contractor shall install, mount and wire VFD’s which shall be furnished by the Mechanical Contractor, unless otherwise noted.
10. Lightning protection system.
11. Grounding, per NEC and specified requirements.
12. Identification of electrical systems and equipment labeling.
13. All low-voltage systems as listed in System Responsibilities Matrix on Electrical Legend.

14. Pathways and raceways for all low-voltage systems shall be in accordance with Division 26 and 27 Specifications and provided by the Division 26 Contractor. All other Division 27 infrastructure shall be provided by the Division 27 contractor.
15. Fire alarm system in accordance with Division 28 Specifications.
16. Video system, including antennas, cabling, electronics, terminal plates, service conductors, etc.
17. Security system, complete with equipment, detectors, wiring, etc.
18. Cabling, testing and devices for data/voice network.
19. All necessary coordination with the Owner, electric utility company, telephone company, cable television company, etc. to ensure that work, connections, etc., that they are to provide is accomplished and that service to this facility is delivered complete prior to occupancy.
20. Paying all necessary fees and cost for inspection of Division 26, 27 and 28 electrical systems by a Licensed Electrical Inspector.
21. Paying all necessary fees and cost for permits.
22. Prior to submitting a bid, the Contractor shall contact all serving utility companies and municipal services to determine exactly what each utility company will provide and exactly what is required of the Contractor and the Contractor shall include all such requirements in his base bid. This shall include relocation fees and construction cost recovery due to Power Utility Company and Cable Company or their successors.
23. All general and special conditions required to accomplish the work.
24. Prior to commencing any work, contractor shall provide this Engineer and the Owner with a pre-certification of the entire fire alarm, security, video surveillance, AI-phone, video, sound, and intercom systems. This test shall be in writing and shall be performed immediately after receipt of notice to proceed. No work is to commence until owner is in possession of certification. The Owner will then instruct on how to proceed with connections of any found problems. Failure of the contractor to perform this work in a timely fashion will not result in a change or time extension to the project. The data/voice system will be assumed without problems and the contractor shall be responsible for any problems found during or after construction.
25. Power and pathways for Security Systems, including Door Access and Video Surveillance, shall be in accordance with Divisions 26 and 28 Specifications and shall be provide by Division 26 Contractor. All other Division 28 infrastructure and equipment shall be provided by the Division 28 Contractor.
26. Special Note: A specialty sub-contractor (Electronic Systems Contractor) shall be utilized for all video, paging-intercom system, data/voice network, fire alarm work, sound systems and for the security system installation. The sub-contractor shall be especially skilled in such work and shall be able to demonstrate that their regular business involves such installations. The specialty sub-contractor(s) shall be acceptable to and approved by the Owner. The names of each such sub-contractor shall be listed on the form of proposal at the time of opening bids. Provisions for branch circuits, pulling of cabling, and installation of raceways for specialty systems may be regular sub-contractor if approved by specialty contractor. All terminations, connections, check-out and testing shall be by specialty contractor.
27. Special Note: A specialty sub-contractor (Lightning Protection System Contractor) shall be utilized for the lightning protection system installation. The sub-contractor shall be especially skilled in such work and shall be able to

demonstrate that their regular business involves such installations. The specialty sub-contractor(s) shall be acceptable to and approved by the Owner. The names of each such sub-contractor shall be listed on the form of proposal at the time of opening bids.

1.3 SPECIAL REQUIREMENTS

A. Remove all obsolete security and video surveillance devices and wiring whether shown on drawings or not and turn over devices to Owner.

B. All existing Low-Voltage cables that are not replaced under the scope of this project shall be supported on J-hooks every 4'.

1.4 SYSTEM COMMISSIONING

A. Section 019113 requires the engagement of a Commissioning Authority to document the completion of the Mechanical, Fire Protection, Plumbing, Electrical, Electronic Safety and Security, and associated Control Systems for the project. Section 019113 defines the roles and responsibilities of each member of the commissioning team.

B. Comply with the requirements of Section 019113 for the commissioning of the various building systems.

END OF SECTION 260502

DIVISION 26 - ELECTRICAL

SECTION 260503 - SHOP DRAWINGS, SUBMITTALS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, eight (8) sets of shop drawings and/or manufacturer's descriptive literature on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. Shop Drawings: Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

G. Product Data: Submittal shall include performance and characteristic curves.

1.3 SUBMITTALS AND SHOP DRAWING

A. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

1. Power Equipment

    a. Fault Current, Arc Flash and Coordination studies (submit along with switchgear & panelboards).
    b. Switchboards, distribution panelboards and panelboards.
    c. Circuit breakers or fusible switches, per each type.
    d. Dry-type transformers.
    e. Power and lighting contactors.
    f. Disconnect switches.
    g. Fuses, per each type required.
    h. Magnetic starters, if not submitted with unit equipment by supplier.
    i. Control components (relays, timers, selector switches, pilots, etc.)
    j. Motor starters, if not submitted with unit equipment by supplier.
    k. Building service grounding electrode components.
    l. Metering devices.
    m. Transient voltage surge suppression devices (SPD).

2. Raceways

    a. Conduits and each type of conduit fittings.
    b. Cable/ladder tray and each type of cable tray fitting.
    c. Surface-mounted metal or plastic raceways, with each type of fitting.
    d. Wireways and each type of wireway fitting.

e. J-hook assembly.
f. Composite pullboxes.

3. Conductors

a. Conductors, splicing devices, and connectors, each by type.
b. Splice or tap blocks.

4. Devices

a. Each type of wiring device and their coverplates.
b. Floor boxes and poke-thrus, each by type, with required accessories.
c. Any special items not listed above.

5. Lighting

a. Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Architect and/or Engineer to indicate color selection.
b. Lamps, each by type.
c. Ballast and drivers, each by type.
d. Lighting standards or poles.
e. Photocells, time clocks or other lighting accessories.
f. Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

6. Fire alarm system.

a. Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Include system specific wiring schematics showing each device and its specific interconnect/wiring requirements. For rack mounted equipment, provide a scalable elevation drawing with proposed component locations & specific interconnect wiring requirements for each component/panel. Also, provide scale building specific layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification 283100 for additional submittal requirements where required.

7. Complete Grounding System

a. Electrodes, bonding devices, terminals, etc.
b. Building service grounding electrode components.

8. Lightning Protection System

9. Dimensioned electrical room plans/equipment layouts

10. Miscellaneous

a. Control panel assemblies.
b. Non-standard junction/pullboxes.
c. Manholes, hand holes, and all outdoor electrical equipment and fittings.
d. Floor plan and riser drawings that show the location of all fire alarm devices.

e. Floor plan and riser drawings that show the location of all low-voltage systems. Fire-stopping
f. Seismic Restraints

11. Systems

a. Note: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Also provide scale building layout drawings that indicate device placement, wiring, etc. Drawings shall be in digital format and shall include complete (not typical) riser diagrams of all systems. Refer to specific system's specification for additional submittal requirements where required.
b. Fire alarm system
c. Building paging/intercom audio system
d. Telephone system
e. Television/video system
f. Data network
g. Wireless intercom system
h. Security systems(s)
i. Sound reinforcement system(s)
j. Video surveillance system
k. All other systems as listed on Systems Responsibility Matrix - See Electrical Legend.

12. Special wrenches, tools and keys

1.4 FIRE ALARM SHOP DRAWINGS

A. The Contractor and equipment supplier shall submit to the Architect and/or Engineer, fire alarm system shop drawings complete with catalog cuts, descriptive literature and complete system wiring diagrams for their review prior to the Contractor's submittal to the Department of Housing, Buildings and Construction or other governing authority for their review. No work shall be done until drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

B. Fire alarm drawings shall be created in digital format (CAD or equivalent). Drawings shall include all power supply, battery, and circuit load and voltage drop calculations as required by NFPA. Complete wiring diagrams and proposed device addresses shall be provided.

C. Shop drawings shall indicate all devices as required to satisfy all local and state mandates, whether indicated on construction drawings or not. Include all components as required for a complete and operational system.

D. Provide battery back-up calculations indicating batteries have capacity to provide emergency power to the system in compliance with NFPA.

E. Provide name, location and UL number of UL listed Central Station Monitoring System.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION 260503

DIVISION 26 - ELECTRICAL

SECTION 260504 - SLEEVING, CUTTING, PATCHING AND REPAIRING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 SUMMARY

A. The Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the Construction Manager, General Contractor and all other trades. He shall determine and coordinate any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Architect. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

C. The Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

D. The Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

E. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

F. Where any cutting, coring, etc. of reinforced concrete is required, such structures shall be x-rayed to avoid damaging existing reinforcing steel.

G. Cast iron sleeves shall be installed through all walls where conduits enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering conduit to permit thorough caulking with lead and oakum between conduit and sleeve for waterproofing.

H. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

I. All roof penetrations shall be made inside mechanical equipment curbs, UON.

J. Sleeves passing through roof or exterior wall or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed.

K. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

L. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Architect and Structural Engineer.

M. The Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Architect.

N. All work improperly done or not done at all as required by the Electrical trades in this section will be performed by the Contractor at the direction of the trade whose work is affected. The cost of this work shall be paid for by the Contractor who is in non-compliance with the Contract.

O. All penetrations shall be patched with materials matching that which has been disturbed.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, hot-dipped galvanized, plain ends.

B. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness: 0.138 inch (10 gauge)

2.2 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for conduits where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the conduit and the sleeves shall be made completely and permanently water tight.

D. Conduits that penetrate fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

E. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

F. Sleeves in floors shall extend 3" above finished floor level.

G. Escutcheon plates shall be provided for all conduits passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the conduit. Where plates are provided for conduits passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the conduit sleeves.

H. In all areas where busducts are exposed and pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.

I. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.2 CUTTING

A. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

B. Conduit openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

C. X-ray concrete slabs and walls prior to core drilling. Do not core drill through rebar, steel or reinforcing material without written permission from the Structural Engineer and Architect.

D. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

3.3 PATCHING AND REPAIRING

A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.

B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.

C. Where the installation of conduit, raceways, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, raceways, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

D. Conduits passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the conduit around which it is installed.

E. Stainless steel collars shall be provided around all conduits, raceways, etc., at all wall penetrations; both sides where exposed.

F. Where conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to insure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

END OF SECTION 260504

DIVISION 26 – ELECTRICAL

SECTION 260506 – DEMOLITION, RESTORATION AND SALVAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This section includes electrical demolition, patching, disposal and salvaging requirements.

B. This Section includes all labor, material, equipment and services necessary and incidental to complete all the demolition and removal of electrical work as shown on the Drawings or as required.

C. The demolition drawings do not necessarily indicate all the conditions, details, or work required. The Contractor shall examine the building to determine the actual conditions and extent of the work. Any details not clear to this Contractor shall be referred to the Architect/Engineer for clarification prior to bidding.

D. The Contractor shall be responsible for demolition and removal of all existing electrical systems where shown for demolition. No portion of electrical systems shown for demolition may be abandoned in place.

1.3 DESCRIPTION OF WORK

A. This section covers all demolition, restoration and salvage required to perform the electrical work indicted on the drawings, specified and/or as required to complete the project. It is the intent of this section of work to remove all existing electrical equipment, materials, etc. which are not required for the completed building and to restore any and all finished surfaces to their original type and conditions. To accomplish these requirements, the Contractor(s) shall, at his own expense, engage the services of others already performing finish work on this project. All work shall be completed to the satisfaction of the Architect/Engineers whose decisions shall be final. This requirement shall apply to all restoration work whether indicated or specified.

B. Electrical Contractor shall re-pull new wire/cable to all devices and equipment that have been cut-off from a panelboard or electronics due to demolition work. Contractor shall check/test all devices and verify they are functional.

C. All adjacent areas need to remain in operation and services to other areas need to be maintained during demolition.

D. Schedule all demolition and any outages affecting other areas with owner.

E. Provide and maintain temporary partitions and/or dust barrier per Owner’s dust control plan.

1.4 SCHEDULING

A. Schedule work to coincide with new construction.

B. Cease operations immediately when structure appears to be in danger and notify Architect. Do not resume operations until directed.

1.5 QUALITY ASSURANCE

A. Comply with NFPA, NEC and OSHA requirements.

B. Contractor shall verify the extent of the demolition work. Any questions as to which systems are to be removed versus which systems are to remain shall be referred to the Architect/Engineer for clarification prior to commencing demolition work.

C. The demolition work shall be a phased operation and shall comply with the construction sequence schedule. The Contractor shall submit a schedule of demolition work 14 days prior to the start of work. The Contractor shall not proceed with the work until receiving written approval.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate electrical system demolition with other systems being demolished.

1.7 SITE SURVEY

A. Before submitting bid, bidder shall carefully examine existing field conditions, including the main power and power distribution system. Claims for extra labor, equipment and materials required due to existing conditions, which could have been foreseen, will not be recognized.

1.8 ELECTRICAL

A. Where electrical fixtures, equipment or other materials are removed and/or relocated, all abandoned conduit and conductors shall be removed in exposed areas. In concealed areas, materials shall be abandoned in place or removed as indicated and patch all openings. Contractor shall remove all conduit, wire, connections, etc. for electrical items being demolished. Contractor shall maintain continuity of existing circuits where removed items do not represent the complete circuit and devices. Field verify exact requirements.

B. The Contractor shall be responsible for the removal and/or relocation of any electrical equipment, fixtures, devices, appurtenances, etc. which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Mechanical, Electrical, Structural or Fire Protection Systems whether indicated or not.

C. Relocate junction boxes and provide low-voltage raceways and supports for existing cabling in areas above new inaccessible ceilings.

D. Where components of any system in this Contractor’s scope of work are to be reused, the contractor shall test those components prior to removal and record the state of functionality and condition of the components as tested. These records shall be provided to the owner or engineer upon request. In the absence of these records, all components removed shall be assumed functional at the time of removal. Any device subsequently found to be non-functioning or in unsuitable condition for reuse shall be replaced at the expense of the contractor.

1.9 REPAIR

A. Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where electrical equipment is removed. Patching shall be accomplished with similar materials to the existing ceilings, walls and floors and shall match adjacent surfaces.

1.10 COORDINATION

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Coordinating and sequence demolition so as not to cause shutdown of operation of surrounding areas.

C. Coordinate demolition of all affected electrical systems to prevent disruption to the Owner and minimize downtime.

D. Coordinate demolition by other Divisions of the Specifications to prevent disruption to the Owner and minimize the downtime.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.

B. Verify termination points for demolished services.

C. Verify field measurements and circuiting arrangements are as shown on Drawings.

D. Verify that abandoned wiring and equipment serve only abandoned facilities.

E. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.

F. Beginning of demolition means installer accepts existing conditions.

3.2 DOCUMENTATION

A. Contractor is responsible for submitting photos and documenting existing conditions to Owner prior to commencing demolition. Systems and equipment found to be defective after demolition has commenced shall be repaired or replaced by Contractor at no additional cost to Owner.

3.3 PREPARATION

A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.

B. All existing computer equipment racks and open or closed raceways must be covered before start of Work.

C. Use temporary egress signage and emergency lighting as needed.

D. Thoroughly examine, review and document all existing infrastructure conditions to determine use. Submit plan to Owner detailing all planned modifications to existing conditions and new work. Owner shall provide written approval to Contractor before proceeding with work.

E. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

F. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.4 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Remove demolished material from Project site, except as indicated on drawings.

C. Remove all existing concrete pads supporting electrical equipment complete. Existing concrete pads shall not be re-used.

D. Remove abandoned wiring to source of supply.

E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

G. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

H. Remove abandoned conduit, wire, boxes, and fastening devices including abandoned conduit, wire, boxes, and fastening devices above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

I. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.

J. Reconnect equipment being disturbed by renovation work and required for continued Service.

K. Disconnect or shut-off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring that are not part of final project.

L. Install temporary wiring and connections to maintain existing systems in service during construction.

M. Perform work on energized equipment or circuits with experienced and trained personnel.

N. Remove, relocate, and extend existing installations to accommodate new construction.

O. Repair adjacent construction and finishes damaged during demolition and extension work.

P. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finishes and below raised floor areas. Cut embedded support elements flush with walls and floors.

Q. Clean and repair existing equipment to remain or to be reinstalled.

R. Protect and retain power to existing active equipment remaining.

S. Cap abandoned empty conduit at both ends.

T. Repair adjacent construction and finishes damaged during demolition and extension work. T-bar ceiling tiles damaged under normal construction conditions or having voids where junction boxes were removed shall be replaced by the Contractor.

U. Maintain access to existing electrical installations which remain active.

V. Where materials or equipment are to be turned over to Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain condition of materials and equipment equal to the existing condition of the equipment before the work began. Repair or replace damaged materials or equipment at no additional cost to the Owner.

3.5 EXISTING PANELBOARDS

A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.

B. Disconnect and tag unused circuits as spare.

C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.

D. Remove existing wire no longer in use from panel to equipment.

E. Provide new updated directories where circuits have been modified or rewired.

3.6 LAMP DISPOSAL

A. Contractor shall be responsible for the careful removal of all lamps and fluorescent tubes without breakage from existing lighting fixtures.

B. Lamps removed from fluorescent, metal halide, mercury vapor, and sodium fixtures shall be placed by the Contractor in cardboard boxes. The Contractor shall label each box with type and quantity of lamps in each box and seal the box. Boxes shall be properly disposed of by the Contractor.

C. Broken, fluorescent, metal halide, mercury vapor, and sodium lamps without green end caps shall be immediately and carefully cleaned up by the Contractor and placed in a 55 gallon steel drum. 55 gallon steel drums shall properly dispose of by the Contractor.

D. All incandescent lamps shall be disposed of by the Contractor in his dumpster.

3.7 MASONRY UNIT REMOVAL AND REPLACEMENT

A. Carefully demolish or remove entire concrete masonry unit (CMU) block face from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with new full-size CMU block face.

B. Support and protect remaining masonry that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.

C. Clean CMU surrounding removal areas by removing mortar, duct, and loose particles in preparation for replacement.

D. Install replacement CMU into bonding and coursing pattern of existing units. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.

E. Lay replacement units with completely filed bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding masonry that has ASTM C67 initial rates of absorption of more that 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid. Maintain joint width for replacement units to match existing joints.

F. Tool exposed mortar joints in repaired areas to match joints of surrounding existing masonry.

G. Rake out mortar used for laying masonry before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and at the same time as repointing of surrounding area.

H. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or fiber brushes, and clean water, spray applied at low pressure. Do not use metal scrapers or brushes. Do not use acidic or alkaline cleaners.

I. Wash adjacent non-masonry surfaces. Use detergent and soft brushes or cloths suitable for surface material being cleaned.

J. Sweep and rake adjacent pavement, concrete and ground to remove masonry debris. Where necessary, pressure wash surfaces to remove mortar, dust, dirt and stains.

3.8 SALVAGE

A. It is the intent of this section to deliver to the Owner all components of any electrical system (including fire alarm systems) which they may want to salvage. The Contractor shall make every effort to remove reusable components without damage. Coordinate removal with the owner and deliver to maintenance all items the owner requests from demolition. These items typically include switchgear, fire alarm system, public address system, etc.

B. All salvaged equipment shall be delivered to Owner’s storage facility.

3.9 CLEANING AND REPAIR

A. Remove demolished materials as work progresses. Legally recycle or dispose.

B. Keep workplace neat on a daily basis.

C. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION 260506

DIVISION 26 - ELECTRICAL

SECTION 260508 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 COORDINATION

A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

C. The Contractor shall be responsible for coordination with all trades to ensure that they have made provision for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc. that are required for equipment operation shall be provided as a part of this contract.

D. Review and coordinate connections to electrically operated equipment furnished by other trades with project contract documents, shop drawings, submittals, and installation instructions. Notify architect in writing of discrepancies prior to proceeding with work. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

E. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

F. In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s), the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Architect and Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Architect or Engineer where in doubt about the potential acceptability of an installation.

G. Refer to equipment schedules and details on all contract documents for additional information for mechanical and plumbing connections. Provide labor and materials for a complete and operable system.

H. Provide equipment overcurrent protection and feeder sizes for equipment furnished by this or other trades or by Owner per actual equipment nameplates and installation instructions.

I. Provide WP/WR maintenance receptacle within 25 ft of each outdoor and roof mounted mechanical unit. Coordinate installation locations with final equipment layout provided by Mechanical Contractor. Provide GFI branch circuit to nearest panelboard, UON on drawings.

1.3 INTERFACING

A. Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall insure that coordination is effected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

1. Connection of all controls to equipment.
2. Electrical power connections to electrically operated (or controlled) equipment.
3. Electrical provisions for all equipment provided by other trades or suppliers within this contract.
4. Contractor is to provide conduit whips and back boxes, as needed, to power systems furniture.
5. Coordination of connection of Telecommunications (voice, data, video) lines to Owner’s existing or new service.
6. Connection of utility electrical service to Owner's existing or new services.

1.4 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

G. Sides of cable, basket and ladder trays shall not be obstructed with special attention to pipes, ductwork, raceways, equipment, cables, etc.

END OF SECTION 260508

DIVISION 26 - ELECTRICAL

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER, CONDUCTORS, CABLES, SPLICING DEVICES AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. This section of the Specifications covers all of the electrical power, lighting, and control power (line voltage) conductors, but does not include communications, data or signal system conductors, which are specified separately in these specifications.

C. All conduits installed without conductors shall have a 200 lb. test nylon string installed for future use, tied off securely at each end.

D. No more than 40% conduit fill is permitted for any conduit system, including video, intercom, data, power or other signal circuits unless specifically indicated otherwise on the plans.

E. No more than seven conductors (six current-carrying and one ground) shall be installed in a conduit except for switch legs and travelers in multi-point switching arrangements. Multi-wire branch circuits with a shared neutral are not allowed.

F. If multiple circuits are pulled in a single homerun, a dedicated neutral shall be provided for each phase conductor. In these cases, a maximum of seven conductors (six current carrying and one ground) are permitted in a single conduit. Conductors shall be derated per NEC.

G. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. The contractor shall ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. The contractor shall review the painting requirements for all disciplines and shall provide cabling protection as required. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, the contractor shall provide alternate options for cable colors and shall provide submittals for such cabling to engineer for approval.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Coordinate paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire Company.
3. American Insulated Wire Corp.; a Leviton Company.
4. Belden Inc.
5. Cerro Wire LLC.
6. Encore Wire Corporation.
7. General Cable Technologies Corporation.
8. General Cable Corporation.
9. Senator Wire & Cable Company.
10. Southwire Company.

B. All conductors shall be 98% conductive annealed copper unless otherwise noted, UL listed and labeled. Comply with ANSI/NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation:

1. Comply with ANSI/NEMA WC 70/ICEA S-95-658.
2. Lighting and receptacle branch circuits shall be Type THW, THHN or THWN insulation.
3. All feeders shall be Type THW or THWN of the size as shown on the Contract Drawings.
4. THHN wiring shall only be installed in overhead, dry or damp locations.
5. THWN or THW wiring shall be used for all circuits pulled in underground or other wet locations.

D. Conductor sizes indicated on drawings are based upon 75 degree C rating.

E. Minimum branch circuit or feeder size shall be not less than #12 AWG copper wire or of the sizes shown on the drawings.

F. Conductors #10 AWG and smaller sizes of wire shall be solid. Conductors #8 AWG and larger sizes shall be stranded.

G. Conductors for fire alarm wiring shall be stranded and in full compliance with NEC 760. All fire alarm conductors shall be installed within conduit and enclosed junction boxes.

H. All wire on the project shall be new, in good condition, and shall be delivered in standard coils or reels.

I. The color of the wire shall be selected to conform to Section 210-5 of the latest edition of the National Electrical Code. Power conductors of all sizes shall follow the color coding scheme listed under PART 3, IDENTIFICATION below.

J. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible.

K. Conductors for main ground from neutral bus, equipment grounding bus, building steel, grounding grid and main cold water pipe connection shall be bare copper.

L. All conductors shall be identified by color code and by means of labels placed on conductors in all junction boxes and at each terminal point with Brady, Ideal, T & B or approved equivalent labels indicating source, circuit number or terminal number.

M. Branch wiring and feeder conductors that are greater than 50' in length shall be increased at least one size to compensate for voltage drop. All circuits shall be installed and sized for a maximum 2% voltage drop. As calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.

N. No aluminum conductors shall be used.

O. MC cable and AC cable shall not be permitted.

2.2 SPLICING DEVICES & CONNECTORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M; Electrical Products Division.
2. AFC Cable Systems, Inc.
3. Burndy
4. Gardner Bender.
5. Hubbell Power Systems, Inc.
6. Ideal Industries, Inc.
7. ILSCO.
8. NSi Industries LLC.
9. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
10. Reliable
11. T&B
12. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Splicing devices for use on #10 AWG and smaller conductors shall be pressure type such as T&B "Sta-Kon".

D. Wire nuts shall be spring pressure type, insulation 600V, 105°C insulation, up to #8 AWG. Greater than #6 AWG shall be a compression type connection, 600V insulation, cold shrink tubing, taped to restore full insulation value of the wire being spliced.

E. Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using #10 AWG or smaller conductors.

F. Splices, where necessary, shall be made with hydraulically-set "Hy-press" or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.

G. Large connectors (lugs) at terminals shall be mechanical type, hex-head socket or crimp-on style, installed per the manufacturer's recommendations.

H. Underground connections made between bare ground wires or to ground rods shall be exothermically welded, "Cadweld" or equivalent.

I. No aluminum splicing devices or connectors shall be used.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION MATERIAL APPLICATIONS

A. Feeders: Copper Stranded.

B. Branch Circuits: Copper. Solid for #10 AWG and smaller; stranded for #8 AWG and larger.

C. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible stranded.

D. Lighting and receptacle branch circuits shall be Type THW, THHN or THWN insulation.

E. All feeders shall be Type THW or THWN of the size as shown on the Contract Drawings.

F. THHN wiring shall only be installed in overhead, dry or damp locations.

G. THWN or THW wiring shall be used for all circuits pulled in underground or other wet locations.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.2 INSTALLATION

A. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

B. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

C. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

D. The radius of bending of conductors shall be not less than eighteen times the outside diameter of the conductor insulation or more, if recommended by the manufacturer.

E. Conductors installed within environmental air plenums shall be per NEC. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Also, provide plenum-rated tie-wraps where plastic straps or other supports, etc., are installed in plenum areas.

F. Where indicated, systems and control conductors that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the access to or operation of equipment or removal of ceiling tiles. Nylon tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans. Refer to the drawings for support requirements and details on routing exposed communications conductors.

G. Conductors for isolated power systems shall be installed in as short a run of conduit as practicable. No pulling soap shall be used on conductors in isolated power systems.

H. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment to ensure compliance. Use particular caution when installing twisted pair data cable or fiber optic cables -- forces permitted for pulling in are typically very low for these cable types.

I. All cables and wiring, regardless of voltage, installed in manholes or cable vaults shall be routed in such a manner to provide a minimum of 6 feet of slack cable for future splicing. Install cables along walls by utilizing the longer route from entry to exit. If both routes are symmetrical, provide a loop of cable secured to wall. All cables shall be tied to insulated cable supports on wall-mounted racks, spaced a maximum of three feet apart.

J. Where multi-wire branch circuits are allowed on the drawings, the phases and neutral shall be wire-tied together in the panelboard and in all pull boxes.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductors at each outlet with at least 12 inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Perform insulation resistance (megger) testing for all bus duct and feeders in accordance with NETA ATS. Testing may be witnessed by the Engineer and/or Commissioning agent. Schedule all tests with Architect with ample notice.
3. Megger tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment. Minimum acceptable (temperature corrected) resistance is 25 megaohms for 120-300 volt rated equipment and 100 megaohms for 600 volt rated equipment and wiring.
4. Test instruments shall be calibrated to national standards within the last 12 months.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors #3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Test and Inspection Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Results that comply with requirements.

3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

F. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

G. Submit test results to Architect and Engineer for approval

3.5 IDENTIFICATION

A. Color coding distribution voltage conductors, 600 volt or less

B. Conductor jackets, in all sizes of cable, shall be provide in black, white, red, blue, green, yellow, brown, orange and gray from the manufacturer. Tapped ends shall not be acceptable.

1. Conductors shall be color coded as follows:

a. 120/208 Volt Conductors

1) Phase A: Black
2) Phase B: Red
3) Phase C: Blue
4) Neutral: White
5) Ground: Green
6) Isolated Ground: Green/Yellow

b. 277/480 Volt Conductors

1) Phase A: Brown
2) Phase B: Orange
3) Phase C: Yellow
4) Neutral: Gray or White with Brown tracer
5) Ground: Green
6) Isolated Ground: Green/Yellow

c. Note: Further identify isolated power conductors with ½" wide purple tape at all terminations and junctions.

2. Fire Alarm Wiring: Red
3. Signal voltage wiring color coding shall be consistent throughout the project and shall match existing equipment and standards where applicable. Color coding for each system shall be unique.
4. Conductors within enclosures that may be energized when enclosure disconnect is off - yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.
5. DC Wiring: Positive: Light Blue
Negative: Dark Blue

C. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

END OF SECTION 260519

DIVISION 26 - ELECTRICAL

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Service Entrance Electrode Grounding System.
2. Underground distribution grounding.
3. Foundation steel electrodes.
4. Ground bonding common with lightning protection system.
5. Communications Grounding System.

B. All metallic conduit, raceways, cable trays, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.

C. The size of the equipment grounding conductors, grounding electrode conductors and service grounding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings. Where ungrounded conductor sizes are increased to minimize voltage drop, grounded conductor sizes shall be increased in the proper proportion.

D. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.

E. The service entrance main ground bus shall also be connected to the main cold metallic water pipe within three feet of where it enters the building, on both the house and street sides of the main shut-off valve with a properly sized bonding jumper. A properly sized bonding jumper shall also be provided to the frame of any steel structure utilized in the construction. The steel frame of the building (if any) shall be made electrically continuous.

F. All ground electrode systems shall be installed in accordance with manufacturer's recommendations, UL listings, ANSI standards, National Electrical Code and National Electrical Safety Code.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT DOCUMENTS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

B. In addition to items specified in Section 260501 "CLOSEOUT DOCUMENTS," include the following:

1. Instructions for periodic testing and inspection of grounding features at building master ground bus and electrodes based on NFPA 70B.
2. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
3. Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Listing and labeling: Provide products specified in this Section that are listed and labeled.

D. Comply with NECA’s “Standard of Installation.”

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:

1. Erico
2. ILSCO
3. Cadweld
4. Burndy
5. Therm-O-Weld
6. T&B
7. O.A. Co.
8. Lyncole XIT Grounding
9. Superior Grounding Systems
10. LEC Inc

2.3 CONDUCTORS

A. Comply with Specification Section 260519, LOW-VOLTAGE ELECTRICAL POWER, CONDUCTORS, CABLES, SPLICING DEVICES AND CONNECTORS.

B. Ground Bus-Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar per EIA/TIA standards.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with four (2) rows of 9/32-inch holes spaced 1-1/8 inches apart. Minimum length of 18” or as indicated on Contract Drawings
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600V. Lexan or PVC, impulse tested at 5000 V.

C. Ground wires and cables shall be of the AWG sizes shown on the Contract Drawings or shall be sized in accordance with the prevailing codes. All ground wires and cables shall be copper.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar per EIA/TIA standards.

E. All grounding fittings shall be heavy cast bronze or copper of the mechanical type except for underground installations or interconnection of grounding grid to cable, columns and ground electrodes, which shall be thermically welded type as manufactured by Cadweld, Burndy Co., Therm-O-Weld, or approved equivalent.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long, molecularly bonded copper to high-strength steel core, copper thickness per UL/ANSI.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with non-hazardous electrolytic chemical salts.

1. Termination: Factory-attached #4/0 AWG bare conductor at least 48 inches long.
2. Backfill Material: Electrode manufacturer’s recommended material.

2.6 CHEMICAL GROUNDING ELECTRODE SYSTEM:

A. The ground electrode system shall be as specified herein. The system shall not require maintenance throughout the expected life span of the materials.

B. Ground system shall be an electrolytic rod type, as manufactured by Lyncole XIT Grounding, Superior Grounding Systems, LEC, Inc. (Chem-Rod), or approved equivalent. Electrode(s) shall be placed as shown on the plans, installed exactly per manufacturer's recommendations. Electrodes shall be installed vertically, 12 feet of overall length (or length as indicated), set in a drilled hole and backfilled per manufacturer's instructions with a special clay slurry surrounding the rod. Provide a concrete protection box with cast iron grate for the top of the rod termination. Ground system shall be per the following:

1. Manufacturer: Lyncole XIT Grounding (or approved equivalent).
2. Source: Lyncole XIT Grounding, 22412 S. Normandie Ave., Torrance, CA 90502 1-800-962-2610
3. Shaft Configuration: Straight.
4. Shaft Length: 12 feet (or as otherwise indicated).
5. Listings: U.L.-467J, ANSI 633.8.
6. Material: Type K Copper.
7. Construction: Hollow tube, 2.125" O.D., chemical filled with non-hazardous metallic salts.
8. Weight 3.5 lbs. per foot of length, nominal.
9. Ground Wire Termination: Exothermic ("Cadweld" by Contractor) connection to 4/0 conductor, with U-bolt with pressure plate provided as test point.
10. Average Life Expectancy: 25 Years.
11. Model Number: K2-(length)CS.
12. Provide grounding system with the following components: protective box, backfill material. Box to be concrete with cast iron, tamper-resistant lid, backfill to be "Bentonite" clay.

C. Installation of Pipe Ground System:

1. Pipe ground systems shall be installed exactly as required by the system manufacturer. The Contractor shall be diligent to observe the excavation, sealing tape removal, slurry backfill and all other critical requirements.
2. Note: NEVER USE SAND OR ORDINARY EARTH AS A BACKFILL MATERIAL
3. Pipe grounding system shall be warranted unconditionally by the Contractor for a period of one year from the date of substantial completion.

PART 3 - EXECUTION

3.1 GENERAL

A. All metallic conduit, raceways, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest issue of the National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.

B. The size of the equipment shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings.

C. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.

D. All outlet, junction and pull boxes shall be grounded with pigtail to the equipment grounding conductor.

3.2 APPLICATIONS

A. Conductors: Install solid conductor for #10 AWG and smaller, and stranded conductors for #8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, #3/0 AWG minimum or as indicated on drawings, whichever is larger.

1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 18 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.3 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral bus and ground bus.

3.4 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Where NEC requires grounding for a separately derived system, ground according to NEC.

B. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.5 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide #1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

3.6 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Busway Supply Circuits
8. Computer and Rack-Mounted Electronic Equipment Circuits.

B. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate

conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

G. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide #4/0 minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-18-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Metal Poles Supporting Outdoor Lighting Fixtures: Install a copper-clad steel, 3/4 inch in diameter by 10 feet long, ground rod and a separate insulated equipment grounding conductor at each pole in addition to grounding conductor installed with branch-circuit conductors.

I. Ground Loop/Ring: Install ground-level, potential equalization conductor and extend around the perimeter of structure. Refer to sheet detail for additional requirements.

1. Bury ground ring not less than 24 inches from building foundation.
2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

3.7 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. All grounding conductors shall be protected from mechanical injury and shall be rigidly supported. Where ground conductors are run through flexible conduit and through panelboard switchboard or motor control center feeders, they shall be securely bonded to such conduit thru the use of grounding bushings at the entrance and exit. All connection of equipment shall be made with an approved type of solderless connection and same shall be bolted or clamped to equipment or conduit.

C. Equipment ground connections to GFI circuit breakers shall be carried and bonded to each outlet on the circuit. Provide a separate equipment grounding conductor with green color insulation.

D. Equipment grounding conductors shall be routed to lighting fixtures, devices, receptacles, electric heaters, furnace and other equipment. Equipment grounding conductors not exceeding #6 AWG in size shall be green. Those larger than #6 AWG shall be green (same color everywhere) taped 4" at each termination, pull and junction boxes.

E. Resistance to the grounding at the service entrance equipment shall be in accordance with the NEC for style of construction and shall not exceed five ohms as measured by the described testing method.

F. All circuits shall have a separate grounding conductor, except as otherwise noted.

G. When grounding systems are completely installed and all grading in the area of the service grounding electrode has been completed up to finish elevations, perform a fall-of potential or other approved test to determine actual system resistance to earth. Report results to the Engineer in writing. Refer to testing provisions in this section of specifications.

H. Where separately-derived systems are utilized as part of the power distribution network, the neutral leg of the secondary side of generators, transformers, etc., shall be connected to a grounding electrode in accordance with the manufacturer's recommendations.

I. The Contractor shall ensure that the ground return path thru building structural steel or other means is electrically continuous back to the service grounding electrode and is of adequate capacity and impedance to carry the maximum expected fault or other current. Where no electrically continuous steel building frame is available, the Contractor shall provide a properly sized ground bar and ground conductor routed back to the main facility ground bus.

J. Where a building's steel frame is made electrically discontinuous by masonry breaks (as at firewalls, etc.), the Contractor shall provide an accessible thermically welded bonding jumper of #500Kcmil copper to bond the building steel frame sections together, making the entire steel frame electrically continuous. The installation of these bonding jumpers shall be reviewed by the Engineer prior to their being covered by construction.

K. Where lightning protection systems are utilized on the work, their electrodes and conductors shall be electrically segregated from the building service ground, except where connections to structural elements are required for the proper installation of these systems. Lightning protection grounds shall only be utilized for lightning grounding applications, in accord with UL and manufacturer's recommendations.

L. Grounding connections shall never be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans.

M. Where dielectric fittings are utilized in piping systems, the piping system shall not be utilized as a ground path. Bonding jumpers shall not be utilized to bridge over such fittings. Piping systems shall not be utilized as ground paths except where specifically required by codes in the case of water piping.

N. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

O. At all metallic outlet, junction and pull boxes, bond the equipment grounding conductor to the box.

P. Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
3. Provide well access for testing at one (1) rod.

Q. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

R. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

S. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

T. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

U. Grounding for Steel Building Structure: Provide a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

V. Concrete-Encased Grounding Electrode (Ufer Ground): Provide and fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than #4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

W. Perform ground testing, log results, and provide reports of test points, test values, and procedure as required by engineer and/or local authority having jurisdiction. All systems shall be grounded to maintain leakage current below levels required by applicable codes and standards.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by four point fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.9 SERVICE GROUND TESTING PROCEDURE

A. The actual resistance to earth of the service grounding electrode shall be measured by the Contractor via the fall-of-potential method. This testing shall be accomplished after the grounding electrode has been completely installed and the finished grade is achieved.

B. The results of the testing shall be summarized in a written report by the Contractor, which shall be forwarded to the Engineer for review. The report shall also be included with the operation and maintenance manuals for the Owner's information and future reference. This report is to also contain a detailed description and illustrations of the testing procedure, along with the name and model number of the testing instrument(s).

C. For the actual testing, the Contractor shall follow the procedures outlined below. A self-contained instrument such as a "Megger" or "Ground OHMMETER" shall be used that

is designed to eliminate the influence of stray current effects on the accuracy of the measurements.

D. Connect one side of the instrument to the grounding electrode conductor where it connects to the facility main ground bus (point C1). Disconnect and isolate the grounding electrode conductor for the test.

E. Drive a copperweld reference electrode probe (point C2) into earth between 300 and 500 feet away from C1 and connect to measurement instrument.

F. Drive the movable grounding probe (C3) into earth at ten equally spaced intervals, in a straight line between C1 and C2 points and note the E/I=R resistance readings on a graph at each point.

G. The resistance measurements in OHMS taken from the flat part of the curve shall be averaged to determine the true grounding electrode resistance to earth.

H. At completion of testing, remove reference electrode C2 and all temporary wiring and connections.

I. If actual measurements of grounding electrode indicate a resistance greater than three OHMS, contact the Engineer for instructions. If deemed necessary by the Engineer, additional electrodes shall be placed and the measurement process repeated until the desired ground potential is achieved.

J. Record results for each step in the testing process and include a full report in close-out documentation.

END OF SECTION 260526

DIVISION 26 - ELECTRICAL

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.
   3. Isolation pads.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit

C. LFMC: Liquid-tight flexible metal conduit

D. GRS: Galvanized rigid steel conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.
5. Concrete Based for Equipment.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
7. Delegated-Design Submittal: For hangers and supports for electrical systems.
8. Include design calculations and details of trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which hangers and supports will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:
5. Lighting fixtures.
6. Speakers.
7. Sprinklers.
8. Access panels.
9. Projectors.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
2. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Device Box Mounting Brackets: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.
c. Unistrut; a division of Atkore.

F. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.
c. Unistrut; a division of Atkore.

G. Roof-mounted Raceway Support Blocking: Factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper B-Line, DURA-BLOK series components or a comparable product by one of the following:

a. Caddy Pyramid ST, ERICO International Corporation.
b. Unistrut; a division of Atkore.

H. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.
c. Unistrut; a division of Atkore.

I. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

J. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, or steel with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Solid, threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.3 VIBRATION ISOLATION PADS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Korfund Maxi-Flex Pads or a comparable product by one of the following:

1. Mason.
2. Unisorb.

B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except where requirements of this Section are more stringent.

B. Maximum Horizontal and Vertical Support Spacing for Raceway(s): Space supports for EMT and GRS as required by NFPA 70.

C. Minimum Hanger Rod Size for Raceway Supports: Minimum rod size shall be 1/4 inch in diameter.

D. Single Raceways:

1. For Raceways 1-1/4-inch and smaller: Install adjustable steel band hanger suspended on threaded rod.
2. For Raceways larger than 1-1/4-inch: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods. Size trapeze members, including the suspension rods, based on the support required for the size, and loaded weight of the conduits.

a. Secure raceway or cable to support with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

E. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods, where multiple raceways are run vertically or horizontally at the same elevations. Size trapeze members, including the suspension rods, based on the support required for the number, size, and loaded weight of the conduits. Space them as required for the smallest conduit to be supported. Size so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 SUPPORT INSTALLATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for installation requirements except where requirements of this Article are more stringent.

B. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.

C. Install Device Box Mounting Brackets supported between two studs. All device boxes shall attached to two studs, device box stabilizers shall not be acceptable.

D. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.

E. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings.

1. Install at least one independent support rod from box hanger to structure.

F. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.

1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work.

G. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.

H. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.

I. Locate raceways so as not to hinder access to mechanical equipment.

J. Do not secure conductors, raceways, or supports to suspended ceiling hanger rods or wires.

K. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

L. Mounting and Anchorage of Surface-Mounted or Recessed-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured, if possible. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Existing Concrete: Expansion anchor fasteners.
4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
5. To Light Steel: Sheet metal screws.
6. For Surface-Mounted Items 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 structure by means that meet seismic-restraint strength and anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means; slotted-channel rack solidly attached to structure or light-gauge metal framing at both ends is required.
7. For Recessed-Mounted Items in Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices to intermediate light-gauge metal framing members on each side of device or provide slotted-channel racks within hollow wall attached to structure by means that meet seismic-restraint strength and anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means.

M. Do not support any items (equipment, piping, conduit, etc.) exceeding 2 inches in diameter from the bottom of slabs. Where intermediate supports are required between structural members, use slotted steel channels support systems attached to beams or joists in order to avoid attachment to slabs.

N. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars. Verify reinforcing locations with Structural Engineer. X-Ray existing concrete structures as required.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 3 inches larger in all directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

DIVISION 26 - ELECTRICAL

SECTION 260533 - RACEWAYS AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This section is intended to specify the raceways, conduit, conduit fittings, hangers, junction boxes, splice boxes, specialties and related items necessary to complete the work as shown on the drawings and specified herein.

B. This section specifies basic materials and methods and is a part of each Division 26, 27 and 28 Sections that implies or refers to electrical raceways specified therein.

C. The types of raceways specified in this section include the following:

1. Steel electrical metallic tubing (EMT)
2. Galvanized rigid steel conduit (GRS or RMC)
3. Intermediate metal conduit (IMC)
4. Rigid aluminum conduit (RAC)
5. Flexible metal conduit (FMC)
6. Liquid-tight flexible metal conduit (LFMC)
7. Rigid nonmetallic conduit (RNC)
8. Metal wireways and auxiliary gutters.
9. Duct banks, and their construction.

D. All raceways, as listed above and otherwise specified herein shall be provided in compliance with latest editions of all applicable UL, NEMA, NEC and ANSI standards. All conduit, raceways and fittings shall be Underwriters Laboratories listed and labeled, or bear the listing of an agency acceptable to the local authority having jurisdiction.

E. Conduit and raceways, as well as supporting inserts in contact with or enclosed in concrete shall comply with the latest edition of all ACI standards and the equipment manufacturer's recommendations for such work.

F. The decision of the Engineer shall be final and binding in any case where a question or inquiry arises regarding the suitability of a particular installation or application of raceways, supports or materials, if other than outlined herein.

G. Minimum size of conduit shall be 3/4" trade size for power and 1” trade size for voice/data/TV, unless otherwise noted on the drawings. All conduit and raceways shall be sized for the number of conductors contained, in accord with the latest edition of the National Electrical Code or any other applicable standards.

H. The installer of raceway systems shall avoid the use of dissimilar metals within raceway installations that would result in galvanic-action corrosion.

I. PVC or other non-metallic conduit shall be rated for the maximum operating temperature that could be developed by the conductors it encloses, while in normal operation.

J. All empty conduit installed anywhere shall have pull-strings installed for future cabling installation. Coordinate with vendors and provide extra pull-strings as required to ensure that when cabling is pulled, conduit still pull-strings installed for future use.

K. Fire Alarm Cabling (conduit): All fire alarm conductors shall be installed within conduit and enclosed junction boxes. Provide a completely separate raceway system from power wiring or other raceway systems. All concealed conduit shall be manufactured red – no field painting will be accepted. Exposed conduit in finished spaces shall be painted to match adjacent finishes.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.4 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product data for raceways, conduits, outlet boxes, and wireways.

B. Shop Drawings:

1. Submit Shop Drawings of the complete metal surface raceway system.
2. Shop Drawings shall include sizes and lengths of raceways, inside corners, outside corners, end caps, raceway cover spacing, grounding, branch circuiting and wiring including locations of service entrances, receptacle types and manufacturers, receptacle spacing, and receptacle labeling with proper voltage, phase, circuit and panelboard designations as indicated on the Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. STEEL ELECTRICAL METALLIC TUBING

1. Electrical metallic tubing (EMT), of corrosion-resistant zinc coated cold rolled steel tubing shall be permitted for concealed installation in dry interior locations.
2. EMT shall not be installed underground, in concrete slabs or where exposed to physical damage. EMT shall be permitted for exposed work in mechanical and electrical rooms and other exposed structure areas where not subjected to physical damage, as determined by the Engineer. All exposed conduit and fittings located within 8’-0” of finished floor shall be rigid steel with threaded connectors.
3. Comply with ANSI C80.3 and UL 797.

D. GALVANIZED RIGID STEEL CONDUIT

1. Galvanized rigid steel conduit (GRS or RMC) shall have a zinc coating inside and outside by means of hot-dip galvanizing.
2. Use GRS where subject to physical damage for exposed work in mechanical spaces, within factory or other industrial work areas, for exposed fit-up work on machinery, for exposed exterior damp or wet location work, in hazardous atmospheres, in exterior underground locations where installed beneath roadways, where ells occur in underground PVC conduits, or where turning out of concrete encased duct banks, and at other locations as specifically called out on the drawings.
3. GRS shall be used for all building interior power wiring or cables of over 600 Volts.
4. GRS shall be delivered with plastic protectors on the threads.
5. GRS threads shall not have any coating which will reduce conductivity of the joint.

6. Couplings, bends, elbows and fittings shall be subject to the same requirements as for the straight lengths.
7. Comply with ANSI C80.1 and UL 6.
8. “Kwik-Couple” type fittings are not acceptable.

E. INTERMEDIATE METAL CONDUIT

1. Unless otherwise indicated on the drawings, intermediate metal conduit (IMC) may be used in any location in place of rigid galvanized steel conduit, as permitted by codes, and as approved by the Engineer.
2. Manufactured in conformance with UL standards.

F. RIGID ALUMINUM CONDUIT

1. Rigid aluminum conduit shall be permitted for installation indoors in dry locations only. Under no conditions shall it be cast into concrete slabs or pass thru construction where prolonged contact will degrade the aluminum.
2. All ells used in rigid aluminum conduit systems shall be rigid galvanized steel.
3. Manufactured in conformance with UL standards.
4. Comply with ANSI C80.5 and UL 6A.

G. FLEXIBLE METAL CONDUIT

1. Flexible metal conduit may be used only where required for connection to light fixtures, motors and other equipment subject to vibration. It shall be constructed of steel. It shall be installed with connectors designed for the purpose. All flexible metal conduit shall be installed as a single piece. No joints shall be installed. Flexible conduit shall not be used in wet or dusty locations or where exposed to oil, water or other damaging environments. An equipment grounding conductor or bonding jumper shall be used at all flexible conduit installations. Flexible metal conduit shall not be used in lengths over six feet for light fixture and three feet for other connections. Flexible metal conduit shall not be used in telephone, fire alarm, intercom, security, and other communication systems.
2. Comply with UL 1.

H. LIQUIDTIGHT FLEXIBLE METAL CONDUIT

1. Weatherproof flexible metal conduit shall be wound from a single strip of steel, neoprene covered, equivalent to "Liquatite" or "Sealtite" Type "UA". It shall be installed in such a manner that it will not tend to pull away from the connectors. Provide strain relief fittings equivalent to "Kellems" as required where subject to vibration. Flexible connections to motors in dusty areas shall be dust-tight, in areas exposed to the weather - weatherproof. Length shall not exceed 3' unless permitted by the Engineer.
2. Comply with UL 360.

I. RIGID NON-METALLIC CONDUIT

1. Polyvinylchloride (PVC) Conduit:
    a. PVC conduit shall be Type II, in conformance with NEMA TC2 and the following:
        1) Schedule 40 and 80, high impact.
        2) Suitable for use with 90ºC rated wire.

3) Conform to UL Standard 65l and carry appropriate UL listing for above and below ground use.

2. Rigid non-metallic conduit shall be constructed of PVC, nominally schedule 40 weight. If installation will enclose utility company provided conductors, verify exact type required and install in accordance with their standards, where more stringent than this specification in normal building conditions.
3. Rigid non-metallic conduit may be used in exterior wet or damp locations where installed underslab or underground. It shall not be run in interior locations, except with special permission from the Engineer for use in corrosive environments, and then only if protected from physical damage. No rigid non-metallic conduit may be installed in environmental air plenums or cast into above-grade concrete slabs. No rigid nonmetallic conduit may be installed in locations where the ambient temperature might exceed the rating of the raceway.
4. Where rigid non-metallic conduit is placed underground, as for feeder circuits, secondaries or branch circuit runs and where ell is made upward thru a slab on grade, transition the turning ell and the riser to rigid steel conduit to a height of 6" above the concrete slab.
5. Flexible non-metallic conduit shall not be used, except by special permission, obtained in writing from the Engineer.
6. Provide equipment grounding conductors of copper, sized as required by codes, in all circuits installed in rigid nonmetallic raceways.
7. Manufactured in conformance with UL standards.

J. RACEWAY FITTINGS

1. Fixture whips shall be 1/2" flexible, with clamp-on steel fittings at each end, six foot maximum length, with insulated throat bushings at each end and bonding locknuts. Wiring thru fixture whips shall be #12 AWG, with #12 AWG ground bonded to outlet at source end.
2. Raceway fittings (or condulets) shall be of gray iron, malleable iron or heavy copper-free cast aluminum. They shall be furnished in proper configurations, avoiding excessive plugged openings. Any openings that are left shall be properly plugged. All coverplates shall be gasketed with neoprene or similar approved materials, rated for the environment. Wiring splices within are not permitted.
3. Where required, raceway fittings shall be provided in explosion-proof configurations rated for the atmosphere. Place conduit seal off fittings at each device in accord with applicable codes. Seal off fittings shall be packed with wadding, and poured with an approved non-shrink sealing compound.
4. Where conduit transitions in a run from a cold to a warm environment, (such as at a freezer, refrigerator or exterior wall) sealoff fittings shall be placed on the warm side immediately at the boundary to prevent migration of condensation within raceway systems.
5. Conduit bodies, junction boxes and fittings shall be dust tight and threaded for dusty areas, weatherproof for exterior locations and vapor tight for damp areas. Conduit fittings shall be as manufactured by Crouse Hinds, Appleton, Killark or approved equivalent. All surface mounted conduit fittings as with "FS", "FD", "GUB" Types etc., shall be provided with mounting hubs.
6. Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with

swivel ball joint and #14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs weight. Fixtures shall be installed plumb and level. Cover pendants shall be finished to match fixtures.

7. UL listed expansion/deflection fitting shall be provided at all locations where a raceway/conduit crosses a structural joint intended for expansion, contraction or deflection. Other approved means may be acceptable with permission of the Engineer. Provide copper ground bonding jumpers across expansion fittings.
8. Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.
9. Fittings for EMT conduits 2-1/2" and smaller shall be of steel, compression type. Fittings for sizes larger than 2-1/2" shall be setscrew, with two setscrews each side. Conduit stops shall be formed in center of couplings. All EMT connectors and couplings shall be of formed steel construction. All connectors shall be insulated throat type.
10. Indentation or die-cast fittings shall not be permitted in any raceway system.
11. Compression type fittings shall be utilized for EMT conduit installed in damp or dusty locations, or where otherwise indicated.
12. All conduit fittings shall be securely tightened. All threaded fittings shall engage seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.
13. Comply with NEMA FB1 and UL 514B.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireways of painted steel construction shall be corrosion-resistant, moisture and oil resistant where indicated or necessary. Wireways shall be furnished in nominal sizes of 2 ½ " X 2 ½ ", 4" X 4", 6"" X 6", 8" X 8" or 12" X 12", as indicated on plans. Furnish with hinged covers on all runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation. Provide knockouts on all runs, unless otherwise indicated or prohibited by codes.

E. Provide wireways with hangers of same manufacturer, installed so as to allow unobstructed access to wireway interior. Install at not to exceed 8'-0" centers, closer

as needed at fittings and turns. Use ¼ " rod hangers minimum for up to 4"X 4", 3/8 " rod minimum up to 8"X 8", ½ " rod minimum for 12" X 12".

F. Wireway Covers: Furnish with continuous hinged covers on all runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation.

G. Finish: Manufacturer's standard enamel finish.

2.3 DUCT BANKS

A. Duct banks are defined as a raceway or raceways installed in underground locations, enclosed in a steel-reinforced concrete envelope. They shall be installed where indicated on the drawings or otherwise required.

B. All concrete used in duct bank construction shall be 3000 PSI minimum 28 day compressive strength unless otherwise noted, in accordance with latest A.C.I. standards. Testing of concrete shall be the responsibility of the Contractor, as directed by the engineer. Place concrete against undisturbed earth, or provide forming as needed.

C. Duct bank raceways shall receive a minimum of 3" concrete cover all sides. Minimum size of any duct bank shall be 12" x 12" square, in cross section. In all cases, local and national codes shall apply to duct bank construction where they exceed the requirements of this specification.

D. Each corner of duct bank shall receive a minimum No. 4 steel reinforcing bar with 2" minimum concrete cover on all sides. Lap bars fifteen diameters at all splices. Reinforcing steel shall be rigidly supported during pour and vibration, and shall be constructed to ASTM standards.

E. Support for encased raceways shall be as recommended by raceway manufacturer, spaced 8'-0" maximum on centers, rigidly fastened to prevent floating of ducts during concrete pours. Supports shall be of a material compatible with the raceway, and shall be of the interlocking type, forming a rigidly braced installation. Provide base type and intermediate type spacers to suit conduit configurations and sizes.

F. Where rigid nonmetallic raceways leave concrete duct banks, a transition to rigid steel conduit shall be made 18" inside the concrete envelope. Under no circumstances shall PVC, EB or similar ducts exit concrete envelope, except where duct bank ties into a manhole wall. Provide bell ends at such terminations and towel duct bank rebars 4" into manhole wall with grout. Refer to details on drawings, as applicable. Slope all raceways within duct bank systems such that they shall drain into manholes or pull boxes. Provide proper drainage at manholes or pull boxes to prevent water accumulation.

G. Where ducts transition thru manholes, pull boxes or at terminating end, each duct shall be specifically identified. A nomenclature as shown on the drawings or as agreed upon by the installer and engineer shall be utilized to identify each individual duct. A permanent means of identifying each duct, such as engraved lamacoid plates or stamped metal tags shall be used.

2.4 SUPPORTS AND HANGERS

A. Coordinate installation of Supports and Hangers with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Supports and hangers shall be installed in accord with all applicable codes and standards. They shall be corrosion - resistant, galvanized or furnished with an equivalent protective coating. All electrical raceways shall be hung independently from the building structure with UL listed and approved materials. Hangers and supports depending from the support systems of other trades work shall not be permitted, except with specific approval in writing from the Engineer. The use of tie wire for support or fastening of any raceway system is prohibited. Perforated metal tape shall not be used for raceway support.

C. No raceway shall be installed on acoustic tile ceiling tees, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.

D. Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are not permitted for supports.

E. The installing contractor shall provide all necessary supports and braces for raceways, in a rigid and safe installation, complying with all applicable codes.

F. Individual conduits routed on building walls or equipment shall be secured by two- hole galvanized malleable iron or stamped steel pipe strap or "minerallac" 2-piece straps. The straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.

G. Supports may not be fastened to roof decking on drive pins.

H. Individual conduits run on building steel shall be secured by means of clamp supports similar and equal to those manufactured by the C.C. Korn Company, Elcen Co., B-Line or approved equivalent. Provide korn clamps, bulb-tee, flange clamps, beam clamps, "minerallacs", etc.

I. Where feasible, vertical and/or horizontal runs of conduit shall be grouped in common hangers on "trapezes" of channel stock as manufactured by "Unistrut" or equivalent, 1-5/8" minimum depth. Utilize conduit clamps appropriate to the channel.

J. Channel strut systems for supporting electrical equipment or raceways shall be constructed of 16 gauge minimum hot dip galvanized steel with 9/16" diameter holes on 8" centers, with finish coat of paint as manufactured by Unistrut, B-Line, Kindorf, or approved equivalent.

K. The minimum diameter of round all-thread steel rods used for hangers and supports shall be 1/4", 20 threads per inch. All-thread rod shall be furnished with a corrosion-resistant finish.

L. Welding directly on conduit or fittings is not permitted.

M. Provide riser support clamps for vertical conduit runs. Riser support clamps shall be of heavy gauge steel construction. Install riser support clamps at each floor level penetration, or as otherwise required.

N. Provide conduit cable support clamps for vertical conductor runs as required or indicated on plans. Clamps to be insulating wedging plug, with malleable iron support ring. Install within properly sized and anchored junction box.

O. Spring steel clips and fittings such as those manufactured by HITT-Thomas, Caddy-Erico, or approved equivalent, with black oxide finish are permitted in any indoor dry location for concealed work, where acceptable to the local authority having jurisdiction.

P. Raceways shall be securely and rigidly fastened in place at intervals specified here-in-before with wall brackets, conduit clamps, approved conduit hangers, or beam clamps. Fastenings shall be made by wood screws or screw type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat treated or spring steel tension clamps on steel work. Bolts, screws, etc. used in securing the work shall be galvanized and of ample size for the service. Assembly bolts, nuts, washers, etc., shall be zinc or cadmium coated. Raceways shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joists shall avoid cutting the main reinforcing bars.

Q. The use of perforated iron straps or wire for supporting conduits will not be permitted.

R. Where conduits are installed in groups on a common steel channel type support, each conduit shall be secured by Korns, Unistrut, Kindorf clamps or equal.

S. Rigid conduits, where they enter panelboards, cabinets or pull boxes shall be secured in place by galvanized, double locknuts (one inside and one outside) and non-metallic bushings. All bushings shall have insulating material which has been permanently fastened to the fittings. Bushings for conduit 1-1/2 inches trade size and larger, which are used for power distribution, shall be complete with grounding lug and shall be bonded to the box by means of bare copper wire.

2.5 FIRESTOPPING MATERIALS

A. All conduits and cables penetrating fire rated floors, walls and ceilings shall be firestopped. Firestopping assembly must be UL listed. All corridor walls, storage room walls and mechanical room walls are to be considered minimum one-hour fire rated. The Level 02, Level 03 and Penthouse floor slabs shall also be considered minimum one-hour rated. Refer to Architectural drawings for additional rating requirements.

B. Provide shop drawings indicating penetration detail for each type of wall and floor construction. Shop drawings must be specific for each individual type. (i.e., one-hour fire rated gypsum wall board with insulated metal pipe penetration.)

C. 3M fire protection products are listed below. Equivalent products may be submitted if they are UL listed.

D. The manufacturer of the firestopping materials must provide on site training for the contractor. The training session shall demonstrate to the contractors the proper installation techniques for all the firestopping materials. The training session shall be four hours minimum. Contact the Engineer prior to conducting this training session.

E. Firestopping materials to include but not limed to the following:

1. 3M fire barrier FS-195 wrap/strip.
2. 3M fire barrier CP 25 caulk.
3. 3M fire barrier MP moldable putty.
4. 3M fire barrier RC-1 restricting collar with steel hose clamp.
5. 3M fire barrier damming materials.
6. 3M fire barrier CS-195 composite sheet.
7. 3M fire barrier fire dam 150 caulk.

8. Steel sleeves.

2.6 SPECIALTIES

A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the NEC and other applicable codes.

C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

D. Nylon pull strings shall be provided in all empty conduit and in all conduit installed for other trades. Pull strings shall be left securely tied off at each end.

E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

F. All outlet, junction and pull boxes shall be grounded with pigtail to the equipment grounding conductor.

G. All fire alarm raceways in concealed areas, data/mechanical/electrical rooms and above ceilings shall be red. Exposed fire alarm raceways shall match adjacent finishes.

H. All junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings shall be identified with panel and circuit designation on outside of covers. All junction, outlet and pull boxes in exposed areas shall be identified with panel and circuit designation on inside of covers.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC
2. Concealed Conduit, Aboveground: GRC
3. Underslab Conduit: Concrete encased RNC

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Concealed in Ceilings and Interior Walls and Partitions: EMT, IMC or GRC
2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
3. Damp or Wet Locations: GRC
4. Exposed, Not Subject to Physical Damage: GRC, IMC or EMT. Raceway locations include the following:

a. Electrical Rooms

5. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:

   a. Mechanical rooms (below 8’-0”).
   b. Gymnasiums.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. PVC conduit and plastic molding are not acceptable except in caustic environments.

H. Aluminum is not acceptable in caustic environments.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

C. Horizontal runs of conduit between outlet boxes in walls shall not be permitted.

D. This Contractor shall lay-out and install all conduit systems so as to avoid any other service or systems, the proximity of which may prove injurious to the conduit, or conductors which it confines. All conduit systems, except those otherwise specifically shown to the contrary, shall be concealed in the building construction or run above ceilings. Size of all conduit shall conform to Annex C, of the National Electrical Code, unless otherwise shown on the Contract Drawings.

E. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

F. Support conduit within 12 inches of enclosures to which attached.

G. No conduit shall be installed in or below poured concrete slabs except with permission of the architect or engineer. Conduit shall be held at least 12" from flues, steam or hot water pipes.

H. All conduits in slab, under slab and in areas subject to abuse shall be shall be galvanized rigid steel with threaded fittings or rigid PVC Conduit encased in 3" (minimum) and steel reinforced concrete with dye identification.

I. Intermediate grade conduit will not be acceptable in place of galvanized rigid steel conduit.

J. All exposed conduit shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart. Randomly routed conduits will not be acceptable.

K. Conduit shall be installed in such a manner so as to insure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90° bends.

L. Junction boxes shall be installed so that conduit runs will not exceed 50', or as shown on the Contract Drawings. Junction boxes shall be sized per NEC, Article 370.

M. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the NEC, and NECA "Standard of Installation", complying with recognized industry practices.

N. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

O. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.

P. Complete installation of electrical raceways before starting installation of cables or wires within raceways.

Q. Bushings shall be provided on conduits to protect cables transitioning from conduits to cable tray pathway.

R. Provide plastic bushings on the end of all conduit stub-ups.

S. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the NEC, and NECA "Standard of Installation", complying with recognized industry practices.

T. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

U. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.

V. Raceways installed in exterior locations shall receive one coat of primer, two coats finish paint after preparation of galvanizing, color selected by Architect. Exposed raceways in painted interior areas shall be similarly painted.

W. Conduits, cables, raceways, and enclosures under metal-corrugated sheet roof decking shall not be located within 1-1/2” of the roof decking, measured from the

lowest surface of the roof decking to the top of the conduit, cable, raceway, or box. GRS is acceptable to route tight to bottom of roof deck.

X. Conduits, cables, raceways, and enclosures are not permitted in concealed locations of metal-corrugated sheet decking type roofing.

Y. All conduit, tubing, raceways, ducts and duct banks shall be installed in such manner as to insure against collection of trapped condensation and raceway runs shall be arranged so as to be devoid of traps.

Z. Where conduits pass through exterior concrete walls of facilities, the entrance shall be made watertight. This shall be done by providing pipe sleeves in the concrete with l/2" minimum entrance seal.

AA. All necessary precautions to prevent the lodgment of dirt, plaster, or trash in all conduit or tubing, fittings and boxes during construction shall be taken. All conduit in floors, concrete or below grade shall be swabbed free of debris or moisture before wires are pulled.

BB. Liquid-tight flexible steel conduit shall be used for connections to all vibrating equipment, including motors and transformers, with a minimum of 18-inches of flex looped to avoid restraining equipment vibrating.

CC. Stub-ups to Above Recessed Ceilings:

1. Use EMT for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

DD. Grounding bushings and bonding jumpers shall be used on conduit terminations at all junction boxes, pull boxes and cabinets to maintain grounding integrity of conduit system.

EE. Do not install conduits or raceways on exterior facades or within wall cavities.

FF. All conduit and PVC conduits installed below grade or below slabs (where indicated) shall be concrete encased.

GG. Do not drill into bar joists to support raceways or cables.

HH. All utilities and underground conduits shall be surveyed and recorded on as-built drawings.

II. All exterior conduits and raceways shall be painted.

JJ. All floor slabs and concrete walls shall be x-rayed before cutting.

KK. Contractor must maintain a minimum 12” clear space above, 6” below and a minimum 26” clear on one side of all cable trays and wireways (both new and existing).

LL. Absolutely no “LB’s” are allowed in any communications conduit installation.

MM. Conduit ends at a wireway will be mechanically fastened, have plastic bushings, and be wire bonded to the wireway.

NN. Underground electric, cable TV, telephone service or other rigid steel conduit and underfloor rigid steel conduit below the concrete floor slab shall be painted with two coats of bitumastic paint, such as "Asphaltum".

OO. All underground or underfloor conduits shall be swabbed free of all moisture and debris before conductors are pulled.

PP. At least two (2) 1” and three (3) 3/4” conduits shall be stubbed from flush-mounted panelboards into the nearest accessible area for future use. Provide suitable closures for these stubs. Identify each stub with a suitable hang tag.

QQ. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

RR. All underground conduits shall be buried to minimum depth of 24" from the top of the concrete encasement or raceway to finished grade, unless otherwise noted on plans. Observe minimum burial requirements of local utility company where their standards or regulations apply. Conduits containing primary power conductors, (higher than 600 volts to ground) shall be 48" to top below finished grade, unless otherwise noted on plans. Conduits containing secondary power conductors, (600 volts and less to ground) shall be 36" to top below finished grade, unless otherwise noted on plans.

SS. Provide uni-strut racks where multiple conduits are supported at one location.

TT. Provide separate a completely separate raceway system of conduits, pull-boxes, etc. for each emergency power branch and for normal power for complete separation per NEC.

UU. Where existing panels are flush-mounted in walls, contractor shall cut, patch, and repair existing construction as required for concealed conduit entry for new connections to those panels.

VV. Expansion-Joint Fittings:
1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.4 SPECIALTIES

A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the NEC and other applicable codes.

C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

D. Pulling lines shall be left in all open conduit systems and shall be non-metallic, left securely tied off at each end cap any unused conduits.

E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

F. All metal boxes, junction boxes and pull boxes shall be grounded with pigtails to the equipment grounding conductor.

G. All empty raceways inside switchgear and open spaces shall be capped.

H. All fire alarm raceways shall be red. Painted red conduit will not be accepted.

I. All junction and pull boxes shall be identified with panel and circuit number on covers.

END OF SECTION 260533

DIVISION 26 - ELECTRICAL

SECTION 260535 - CABINETS, OUTLET BOXES AND PULL BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes: Boxes, enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 CABINETS, OUTLETS AND PULL BOXES

A. Cabinets for lighting and power, telephone, pull boxes, outlet boxes, or any other purposes specified or shown on the Contract Drawings, shall be constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing. Boxes assembled with sheet metal screws will not be accepted. Pull boxes shall include all boxes used to reduce the run of conduit to the required number of feet or bends, supports, taps, troughs, and similar applications and shall also be constructed as specified above.

B. All cabinets and boxes for NEMA 1 and 1A application shall be provided with knockouts, as necessary, or shall be cut in the field by approved cutting tools which will provide a clean, symmetrically cut opening. All boxes, except panelboards, shall be provided with code gauge fronts with hex head or pan head screw fasteners. Fronts for panelboards shall be as specified for panelboards.

C. Ceiling outlet boxes shall be galvanized steel, 4" octagonal, not less than 2 1/8" deep, with lugs or ears to secure covers, and those for use with ceiling lighting fixtures shall be fitted with 3/8" fixture studs fastened to the back of the boxes, where applicable. Provide adequate support with at least a 2 x safety factor for the anticipated fixture weight.

D. Special size concealed outlet boxes for clocks, speakers, alarms, TV, etc., shall be provided by the manufacturer of the equipment.

E. The location of outlets, as shown on the drawings, shall be considered as approximate only. It shall be incumbent upon this Contractor to study the general building drawings,

with relation to spaces surrounding each outlet, in order to make his work fit the work of others and in order that when the devices or fixtures are installed, they will be symmetrically located and will not interfere with any other work or equipment. Any change in fixture or layout shall be coordinated with and approved by the Engineer before this change is made. Regardless of the orientation shown on the drawings, all devices shall be easily accessible when installed.

F. All outlets, pull boxes, junction boxes, cabinets, etc., shall be sized per the current edition of the National Electrical Code.

G. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

H. Outlet boxes and junction or pull boxes shall be threaded for rigid-threaded conduit, dust-tight vapor-tight or weatherproof as required for areas other than for NEMA 1 or 1A application. These shall be as manufactured by Crouse-Hinds, Appleton, Killark, or approved as equivalent.

I. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

J. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

K. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

L. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

M. NEMA 1 or 1A outlet boxes or pull or junction boxes shall be as manufactured by Appleton, Steel City, T & B, or approved equivalent.

1. Outlet boxes for switches, receptacles, etc., concealed in walls shall be galvanized steel, 4” x 4” x 2 1/8” deep with plaster cover for the number of devices as required and to be flush with finished wall. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or other masonry which will not be covered with plaster or in walls covered by wood wainscot or paneling, deep sectional masonry boxes shall be used and they shall be completely covered with the plates or lighting fixtures. This Contractor shall cooperate with the brick layers, block layers and carpenters to insure that the outlet boxes are installed straight and snugly in the walls. Receptacles shall be set vertically in walls.

N. Unless otherwise noted on the drawings or in the specifications, outlet boxes shall be installed at the following heights to centerline of box:

Wall Switches, Control Stations	3'-10"
Convenience Outlets	1'-6"
Above Counter Convenience Outlets	Bottom at 2" above top of backsplash
TV Outlets	1'-6"

TV Outlets - At Wall Brackets ..... 7'-2"
Desk Telephones..... 1'-6"
Wall-Mounted Telephone..... 4'-6"
Weatherproof Outlets..... 2'-2"
Disconnects, Branch Panelboards ..... 5'-0" max. to centerline
Fire Alarm Manual Stations..... 3'-10"
Fire Alarm Audio and/or Visual Unit…80" AFF to bottom of device or 6" below ceiling, whichever is lower

Note: Contractor is to refer to Architectural elevations and coordinate device mounting heights, quantities, and locations.

O. Outlet boxes mounted in glazed tile, brick, concrete block or other types of masonry walls shall be mounted above or below the mortar joint. Do Not Split The Mortar Joint.

P. Boxes for more than two (2) devices shall be for number of devices required and shall be one piece. No ganging of single switch boxes will be allowed.

Q. Outlets provided shall have only the holes necessary to accommodate the conduit at the point of insulation and shall be rigidly secure in position. Boxes with knockout removed and openings not used shall be replaced or provided with a listed knockout closure.

R. Exterior outlets shall be die-cast aluminum, weather-proof with gasketed covers and baked on grey enamel finish, per ANSI 61.

S. Boxes up to 4-11/16 square size shall be fastened to their mounting surface with two fasteners of proper size. Larger sizes shall be fastened with four fasteners, minimum.

T. Openings for conduit entrance in cabinets and boxes shall be prefabricated, punched, drilled and/or reamed. The use of a cutting torch for this purpose is prohibited.

U. Aluminum is not acceptable in caustic environments.

2.2 DATA/VOICE OUTLETS

A. Outlet boxes shall be 5” square by 2-7/8” deep with single or double-gang with raised extension ring.

B. All communications outlets shall be fed with at least (1) 1-1/4” inch EMT conduits, with an absolute minimum number of bends from the outlet to the cable tray, wire way or homerun directly to the Telecommunications room. Pull boxes must be installed after every 270 degrees of bend (including offsets) or 100 feet of the conduit run.

C. When mounting the outlet box in a steel studded wall, use a back brace.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

C. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Install electrical boxes as required for splices, taps, wire pulling, equipment connections.

E. Do not install flush mounting boxes back-to-back in walls; install with minimum 6-inches separation. Install with 24-inches separation in acoustic rated walls.

F. Do not fasten boxes to ceiling support wires or other piping systems.

G. Support all boxes independently of conduit.

H. Grounding bushings and bonding jumpers shall be used on conduit terminations at all junction boxes, pull boxes and cabinets to maintain grounding integrity of conduit system.

3.2 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260535

DIVISION 26– ELECTRICAL

SECTION 260544 – EXCAVATION, TRENCHING, BACKFILLING AND GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Each Contractor shall include all excavating, filling, grading and related items required to complete his work as shown on the drawings and specified herein.

B. Electrical distribution lines and underground telephone or TV cables shall, in no case, be placed in the same trench with sanitary, storm, domestic or fire protection water lines. Telephone or cable TV services shall, in all cases, be placed in a separate trench with minimum two feet separation from electrical power lines.

C. Depths of bury shall be:

1. 48" minimum to top of primary ducts, unless otherwise noted.
2. 42" minimum to top of secondary ducts, unless otherwise noted.
3. 36" minimum to top of branch exterior circuits, unless otherwise noted.
4. 36” minimum to top of telephone/communication/misc. ducts, unless otherwise noted.

1.3 SUBSURFACE DATA

A. Subsurface investigations have been made and the results shown on the drawings. The information was obtained primarily for use in preparing foundation design. Each Contractor may draw his own conclusions therefrom. No responsibility is assumed by the Owner for subsoil quality or conditions other than at the locations and at the time investigations were made.

B. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavation to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating.

1.4 BENCH MARKS AND MONUMENTS

A. Maintain carefully all bench marks, monuments and other referenced points. If disturbed or destroyed, replace as directed.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 EXCAVATION

A. Each Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation for his work.

B. Excavate trenches to sufficient width and depth for proper installation of the work and where required, smooth the bottom on the trench with hand tools in strict accordance with OSHA Guidelines.

C. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Architect. Any damage to existing structures, exterior services or rock intended for bearing, shall be corrected at the responsible Contractor's expense.

D. Keep trenches free from water while construction therein is in progress. Under no circumstances lay conduit or cable in water. Pumping or bailing water from this Contractor's trenches, which is required during construction shall be accomplished at his expense.

E. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, etc. Each Contractor shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage, or any other damage incurred in the course of excavation, shall be borne by the responsible Contractor. Restore all disturbed areas to original condition.

3.2 BACKFILL

A. Concrete for concrete encasement shall cure a minimum of 3 days prior to backfill.

B. Backfill shall be accomplished with clean debris free earth and the backfill compacted to 95% standard Proctor in 6” lifts so as to avoid earth sinks along the trench. The responsible Contractor will be required to return to the project and fill any sunken areas along the route of his work.

C. Backfill trenches only after conduit and cable have been inspected by Agencies, Engineer and Owner, tested, and locations of pipe lines have been recorded on record drawings. Provide at least one week's written or fax notification to all parties of impending work that needs to be reviewed.

D. The backfill below paved areas shall be sand and brought to proper grade in 6” lifts compacted to 98% standard Proctor to receive the sub-base and paving. No paving shall be placed on uncompacted fill.

E. The backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260548–ELECTRICAL SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions, General Mechanical Provisions and Division 1 Specifications Sections, apply to this section.

1.2 MANUFACTURERS

1.2.1 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:

Mason Industries
Vibration Eliminator Co., Inc.
Vibration Isolation Co., Inc.

All Seismic restraint devices; isolators, calculations and seismic design shall be provided by a single vibration isolator manufacturer as listed above. All seismic design shall be prepared and stamped by a Professional Structural Engineer licensed in the state where the work will be performed, with a minimum of 5 years experience.

1.3 SUMMARY

1.3.1 This Section includes vibration isolators, vibration isolation bases, and seismic restraints and snubbers for mechanical and electrical equipment, duct and piping systems.

Drawings and calculation
Certification of seismic restraint designs
Installation supervision

1.3.2 All seismic design shall be prepared and stamped by a Professional Structural Engineer licensed in the state where the work will be performed, with a minimum of 5 years experience. All work shall comply with applicable codes and standards. Reference ASCE7-10 Chapter 13 for requirements.

1.4 PROJECT CONDITIONS

1.4.1 Seismic Design Category: C

1.4.1.1 Building components with an Ip of 1.5 shall include, but not be limited to, Life Safety components. These components shall include but not be limited to fire alarm devices, emergency lighting.

1.5 APPLICABLE CODES AND STANDARDS

1.5.1 The adopted Local/State Building Code with amendments.

1.5.2 All standards referenced by adopted codes.

1.5.3 ASCE 7-10 Chapter 13.

1.6 SUBMITTALS

1.6.1 Product Data: Indicate types, styles, materials, and finishes for each type of isolator and seismic restraint specified. Include load deflection curves.

1.6.2 Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.

1.7 SEISMIC RESTRAINT SUBMITTALS

1.7.1 Shop Drawings: Show designs and calculations, prepared and stamped by a licensed professional engineer, as required for work of this project.

1.7.2 Design Calculations: Calculations for design and selection of seismic restraints for equipment, emergency generators, conduit systems, cabling systems, etc., stamped by a licensed professional engineer.

The following equipment shall be required to have calculations if serving systems which are required to be seismically braced.:

-Transformers
-Light Fixtures
-Large Equipment Enclosures

1.7.3 Analysis must include calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/ or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in listed building codes acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.7.4 Seismic Restraint Details: Detail fabrication and attachment of restraints and Snubbers.

1.7.5 Concrete Pad Details: Show required concrete pad size and location for equipment. Show locations of required pad anchors and stud wedge anchors.

1.7.6 Where wall, floors, slabs, or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for conduit, cable trays, cable rings, etc. must be included and approved before the condition is accepted for installation.

Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

1.8 SEISMIC RESTRAINT QUALITY ASSURANCE

1.8.1 Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who has a minimum of 5 years experience in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 SEISMIC CONTROLS

2.1.1 Thrust Restraints: Combination spring and elastomeric restraints with coil spring and elastomeric insert in compression. Factory set for thrust.

2.1.2 Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.

2.1.3 Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2.1.4 Minimum Additional Travel: 50 percent of the required deflections at rated load.

2.1.5 Elastomeric Element: Molded, oil-resistant rubber or neoprene.

2.1.6 Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

2.1.7 Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges.

2.1.8 Manufactured Seismic Snubbers: All-directional, double-acting snubbers

2.1.9 Construction: Interlocking steel members restrained by ¾-inch-(19-mm-) thick, replaceable, shock-absorbing neoprene insert. Maintain 1/8inch (3mm) clearance in all directions between rigid and resilient surfaces.

2.1.10 Fabricated Seismic Snubbers: Welded structural-steel designed and fabricated to restrain equipment or vibration isolation bases from excessive movement during a seismic event. Design to resist gravity forces identified by authorities having jurisdiction.

2.1.11 Construction: Welded steel shapes conforming to ASTM A 36 (ASTM A 36M)

2.1.12 Resilient Components: ¾ inch-(19-mm-) thick, replaceable, shock-absorbing neoprene insert.

2.1.13 Flexible Stainless Steel Hose: Hoses shall be installed on equipment side of shut-off valves horizontally and parallel to the equipment shafts wherever possible.

2.1.13.1 Construction: Stainless steel braid and carbon steel fittings.

2.1.13.2 Connection: Less than 3": Male nipples.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Install and anchor seismic-control products according to manufacturer's written instructions and authorities having jurisdiction.

3.1.2 Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.

3.1.3 Filled concrete inertia bases, after installing base frame, with 3000-psig (20.7-Mpa) concrete, and trowel to a smooth, hard finish. Cast-in-place concrete is specified in open parts of the specifications.

3.1.4 Isolated conduit, cable trays, etc. as follows (All are required to be braced):

3.1.4.1 Horizontal isolation: The first three hangers in the main lines near the mechanical equipment shall be precompressed spring and neoprene type. Floor supported piping shall rest on spring type isolators. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3",1 ½" deflection for pipe sizes up to and including 6", and 2 ½" deflection thereafter.

3.1.4.2 Riser isolation: Risers shall be suspended from spring and neoprene hangers or supported by floor spring isolators, all-directional acoustic pipe anchor, and pipe guide. Steel springs shall be a minimum of 0.75" except in those expansion locations where additional deflection is required to limit load changes to +25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.2 SEISMIC CONTROL

3.2.1 All electrical systems listed below are to be seismically restrained. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical (equipment not listed must still be braced as required per applicable code).

3.2.2 Vibration Isolation Bases: Mount equipment on structural-steel bases or concrete inertia bases as required.

3.2.3 Component Importance Factor is 1.5 for the following Mechanical and Electrical Systems (All other Systems shall have a Component Importance Factor of 1.0):

3.2.3.1 Fire Protection System, and all other complete system components required to operate these systems,

3.2.3.2 Interior natural gas piping and gas-fired appliances, and all other complete system components required to operate these systems,

3.2.3.3 Emergency lighting systems.

3.2.3.4 Fire Alarm System.

3.2.3.5 Electrical connections, equipment, etc. associated with all mechanical equipment required to be braced.

3.2.3.6 Also, the interrelationship of components and their effect on each other shall be considered so that the failure of any essential or non-essential architectural, mechanical or electrical component shall not cause the failure of another essential architectural, mechanical or electrical component.

3.2.4 Snubbers: Install the required number of seismic snubbers on each spring-mounted piece of equipment. Locate snubber as close as possible to the vibration isolators and bolt to supporting structure.

3.2.5 Manufacturer shall provide installation instructions, drawings and trained field supervision to ensure proper installation and performance. Visit the project site before installation is begun and instruct installers in correct installation procedures for vibration isolation, seismic restraints and concrete pads. Observe installation of other work related to vibration isolation and seismic work, including concrete pad installations; and, after completion of other related work(but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover the following:

3.2.5.1 Equipment installations (performed as work of other sections) on vibration isolators and Seismic restraints.

3.2.5.2 Conduit connections including flexible connections.

3.2.5.3 Passage of conduit and cable trays which is to be isolated through walls and floors.

3.2.6 Do not start-up equipment until inadequacies have been corrected in manner acceptable to Vibration Isolator and Seismic Controls Manufacturer.

3.2.7 Spacing for restraints shall be as follows, except where lesser spacing is required to limit anchorage loads:

3.2.7.1 Ductwork and electrical services (conduit, bus ducts, cable trays, and ladder trays) transverse restraints shall occur at 30’ intervals (or at both ends of the duct run if less than specified interval) and longitudinal restraints shall occur at 60’ intervals (with at least one restraint per duct run). Transverse restraints shall be installed at each duct/electrical services turn and at each end of a duct/electrical run.

END OF SECTION

DIVISION 26 - ELECTRICAL

SECTION 260553 - IDENTIFICATIONS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.2 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES”

F. Provide warning signs for the enclosures of electrical equipment including pad-mounted transformers, pad-mounted switches, and switchgear having a nominal rating exceeding 600 volts.

1. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.
2. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field. Sign shall be Panduit No. PASO710D72 or approved equal.

2.3 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.4 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

C. Retain paragraph below to specify type of label for identifying outdoor equipment if specified in "Identification Schedule" Article.

D. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 CABLE TIES

A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Clear

B. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Clear

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Cable Ties: For attaching tags.

1. Indoors: Plenum rated.
2. Outdoors: UV-stabilized nylon.

G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

H. Equipment, disconnect switches,switchboards, panelboards, transformers, motor starters, variable frequency drives, special device plates, and similar materials shall be clearly marked as to their function and use. Markings shall be applied neatly and conspicuously to the front of each item of equipment with 1/2" black lamacoid plate (or equivalent) with white letters 1/4" high unless otherwise specified.

I. All receptacle cover plates shall be marked with their panel and circuit number with clear, machine, printed adhesive labels. Circuit number shall also be hand written inside outlet box with black permanent marker.

J. The Contractor shall provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc. controlled by each switch, breaker, fuse, etc. These directories are to be inserted into plastic cardholders on back door in each panel. Provide electronic Excel files of all directories to owner as part of Close-out Documentation. Any existing panels which are affected by this contractor’s work shall also be provided with new directories. Descriptions to be approved by the Owner.

1. EXAMPLE:

a. LIGHTS, ROOM 100
b. RECEPTION, ROOM 200

K. Electrical distribution equipment, including branch circuit panelboards switchboards, shall be provided with a black lamacoid plastic plate with 1/2" white letters for panel designation and 1/4" white letters showing voltage and feeder information. Branch circuit switches shall be designated as to function. Electrical distribution equipment labels shall indicate the source they are fed from, and the circuit number at that source. Clearly indicate the exact label legend to be furnished with each panelboard and switchgear on the shop drawings for each item of equipment prior to submission of shop drawings. Refer to drawings for further details.

L. Lamacoid plates shall be located at center of top of trim for branch circuit panels, switchboard, and centered at side for branch circuit switches. Fasten with self-tapping stainless steel screws or other approved method.

M. Verify identity of each item before installing identification products

N. All junction boxes utilized for fire alarm circuits, connections, devices, etc. shall have the cover painted red.

O. All device coverplates which are not engraved shall have clear adhesive labels with panel and circuit number type-written in black lettering.

P. All systems requiring room names and/or numbers for labeling or programming shall use the Owner's actual room name and numbering scheme, not floor plans. All reprogramming shall be included as required to accommodate construction phasing.

Q. All junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings shall be identified with panel and circuit designation on outside of covers. All junction, outlet and pull boxes in exposed areas shall be identified with panel and circuit designation on inside of covers.

R. The inside of all junction and backboxes shall be marked with panel and circuit number in permanent marker.

S. All identifications shall be consistent with the owner's standard practices, especially within existing facilities. Where the requirements here-in are in conflict with such standard practices, the contractor shall notify the engineer in writing prior to ordering any material for clarification.

T. Identification shall consist of all UPPER CASE LETTERS.

U. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

V. Apply identification devices to surfaces that require finish after completing finish work.

W. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification devices.

X. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

Y. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

Z. Fire alarm system: Install a nameplate on the fire alarm panel to indicate the panelboard and circuit number supplying the fire alarm system.

AA. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.

BB. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

CC. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

DD. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

EE. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

FF. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

GG. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer and load shedding.

HH. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

II. Labeling Instructions:

1. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
2. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
3. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
4. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

DIVISION 26 - ELECTRICAL

SECTION 260573 - ELECTRICAL STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Provide a short-circuit, component protection, arc-flash hazard analysis, and protective device coordination study for the electrical distribution system beginning with all power sources and ending with the lowest level power, lighting and receptacle panels, and motor control equipment.

B. This Section includes computer-based, fault-current, arc-flash and overcurrent protective device coordination studies. Hand calculations are not acceptable. Protective devices shall be set based on results of the protective device coordination study.

C. Electrical Studies shall be performed by the Low-Voltage Switchboard manufacturer. All Electrical Studies required by this specification shall be completed within five (5) weeks from award of project. The Electrical Contractor shall provide all required data to Low-Voltage Switchboard manufacturer within one (1) week and the manufacturer will have four (4) weeks to complete the studies.

D. A licensed professional engineer employee of the Low-Voltage Switchboard manufacturer shall provide electrical power system studies for the project using the latest version of one of the approved software packages. The software model files shall be submitted with the report. The analysis shall follow the latest IEEE 1584 guidelines.

E. Studies specified herein must be submitted and approved prior to release of any affected equipment. Revisions to equipment or devices necessary to meet study recommendations shall be at the Manufacturer’s expense.

F. All adjustments and settings recommended by these studies shall be made prior to any testing.

G. The analysis shall be submitted to the engineer of record prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

1.3 PURPOSE

A. The study shall calculate the worst case available short circuit current at each point in the electrical distribution system considering all power sources under all permissible system operating and switching modes. The study shall be performed in accordance with Part 3 of this specification. The overcurrent protective devices shall have an interrupting and/or withstand rating equal to or greater than the available short circuit current at the applicable time band (1/2, 5, or 8 cycle) at the point of application. Discrepancies shall be noted and called to the attention of the Architect/Engineer.

B. The overcurrent protective devices shall be analyzed for adequate short circuit rating. This analysis shall identify any potential insufficient equipment ratings of existing equipment based on actual available utility values.

C. The study shall also include an arc flash hazard analysis for all electrical equipment. The analysis shall determine the flash protection boundary, incident energy, and required level of Personal Protective Equipment (PPE) for workers at the electrical equipment. The arc flash protection boundary and incident energy shall be determined based upon a working distance as defined in per IEEE 1584, based on system voltages. The electrical distribution equipment shall be field marked with this information in accordance with NFPA 70E.

D. The above study shall use equipment designation (labeling) that is consistent with the electrical system diagrams. Equipment shall be readily identifiable without the use of a cross reference list.

1.4 SUBMITTALS

A. Product Data: Computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:

1. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

    a. Coordination-study input data, including completed computer program input data sheets.
    b. Study and Equipment Evaluation Reports.
    c. Coordination-Study Report.
    d. Short Circuit Study and Coordination Study including all input data.
    e. Study recommendations for device settings, fuse types/ sizes and Equipment Evaluation findings.
    f. Report shall include any identified recommendations for improvements or suggestions for correction of deficiencies for consideration by the Architect/Engineer.
    g. Arc-Flash Hazard Calculations and list of data for Labels, including any recommendations to reduce any PPE Category 4 or higher hazard level to a PPE Category 3 or lower hazard level.

2. The results of the study shall be summarized in report form, for review and approval by the Architect/Engineer.

3. The results of all studies shall include the following:

   a. Descriptions, purpose, basis, and scope of study.
   b. Fault current calculations including definition of terms and guide for interpretation of computer printout.
   c. Tabulations of protective device and equipment ratings versus maximum calculated short circuit duties, and commentary regarding same.
   d. Flash hazard analysis report for newly installed and directly impacted existing electrical equipment. Based on the worst case resulting in Greatest Personnel Hazard.
   e. Time versus current curves with tabulations of overcurrent protective device settings and selective coordination analysis and commentary regarding same.
   f. The above studies shall be submitted to the Architect/Engineer for review and comment, before any labels are printed.
   g. If power company review and/or approval of device settings or fuse types/sizes is required, appropriate data shall be submitted to the power company for review and/or approval. The results of the power company review and /or approval shall be forwarded to the Architect/Engineer and included in the study report.

E. The studies must bear the signature/seal of the Professional Electrical Engineer in the state where the project is located.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 (power system analysis) for general study procedures.

E. Comply with IEEE 1584 (guide for performing arc flash hazard calculations) for Arc Flash calculation procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Discrepancies shall be noted and called to the attention of Architect/Engineer.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.

g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Data shall be obtained for the power sources (campus 12 kV system and generators), impedance components (transformers, cables and busway), overcurrent protective devices (fuses, circuit breakers and relays) and other relevant equipment such as automatic transfer switches. Cable data (length, quantity per phase, size and type) shall be provided by the electrical contractor. Assumptions should only be used when the actual data is not available and the assumptions should be clearly listed in the report. Assumptions shall be kept to a minimum.

C. A one line riser diagram shall be provided as part of the analysis and shall clearly identify individual equipment buses, bus numbers used in the analysis, cable information (length, quantity per phase, size and type), overcurrent device information (manufacturer, type and size), transformers, motors, transfer switches, generators, etc.

D. The one line and analysis shall use a numbering scheme where each bus begins with a three-digit number followed by a description (e.g., 102 MDPA or 103 ELEV DISC) and each connected circuit breaker or fuse shall have a corresponding designation (e.g., 102-1 MAIN CB, 102-2 ELEVATOR FDR or 103-1 ELEV DISC CB).

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus
2. Medium-voltage switch and transformers
3. Distribution panelboards
4. Branch circuit panelboards
5. Variable Frequency Drives
6. Fused and non-fused disconnects
7. Low-voltage transformers
8. Individual circuit breakers
9. Automatic transfer switches
10. Generator
11. Combination starter/disconnects

B. Study electrical distribution system from normal and alternate emergency power sources throughout electrical distribution system for Project, using approved computer software program. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10
b. ANSI C57.12.22
c. ANSI C57.12.40
d. IEEE C57.12.00
e. IEEE C57.96

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.
4. Circuit Breakers: IEEE c37.13.

E. Study Report: Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

G. A table shall be included which lists the calculated short-circuit currents (rms symmetrical three phase), equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment at each bus.

H. Any inadequacies shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
3. Device settings shall protect transformers according to IEEE C57.12.91, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

H. A table shall be included which lists the recommended settings of each circuit breaker and relay.

I. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

J. Deficiencies in protection and/or coordination shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

K. The electrical engineer that performed the study shall be responsible to set the circuit breakers according to the analysis once the report has been approved by the engineer of record.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The analysis shall consider multiple possible utility scenarios as well as multiple system configurations where appropriate such as normal and emergency transfer switch positions and different main-tie-main configurations.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system. This includes all switchboards, switchgear, motor-control centers, panelboards, busway and splitters.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment locations. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and

the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendation for arc flash energy reduction

M. The Arc Flash Hazard Analysis shall include recommendations for reducing Arc Flash Incident Energy (AFIE) levels and enhancing worker safety.

N. Results of the Arc Flash Hazard Analysis shall be submitted in tabular form and shall include the following information for each bus location: bus name, protective device name, bus voltage, bolted fault, arcing fault, trip/delay time, equipment type, working distance, arc flash boundary, incident energy and protective clothing category.

3.6 ARC FLASH WARNING LABELS

A. Arc flash labels shall be furnished and installed by the contractor of the Arc Flash Hazard Analysis.

B. The labels shall be 4 inches high by 6 inches wide and printed on a Brady THTEL-25-483-1-WA label type or similar. The arc flash label shall be formatted similarly to the examples shown below (Figure 1) and include the wording indicated in the table (Table 1) for each PPE category.

C. After labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the Owner and after any system changes, upgrades or modifications have been incorporated in the system.

D. The label shall include the following information, at a minimum:

1. Arc Flash Incident Energy
2. Location designation
3. Nominal voltage
4. Arc Flash protection boundary

5. Hazard risk category
6. Incident energy
7. Working distance
8. PPE category
9. PPE clothing description
10. PPE equipment description
11. Voltage
12. Glove class
13. Shock protection boundaries according to NFPA 70E
14. Analysis date
15. Building number
16. Equipment name and the upstream tripping device.
17. Engineering report number, revision number and issue date.

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. Provide arc flash labels for all electrical equipment including, but not limited to, the following:

1. For each 208-volt panelboard, one arc flash label shall be provided.
2. For each 208-volt distribution panelboard, one arc flash label shall be provided.
3. For each low-voltage switchboard, one arc flash label shall be provided.
4. For each fused or non-fused disconnect switch, one arc flash label shall be provided.
5. For each variable frequency drives, one arc flash label shall be provided.
6. For each combination starter/disconnects, one arc flash label shall be provided.
7. For each fused or non-fused disconnect switch and individual circuit breakers, one arc flash label shall be provided.
8. For each low-voltage transformer, one arc flash label shall be provided.

Figure 1. Example arc flash labels.

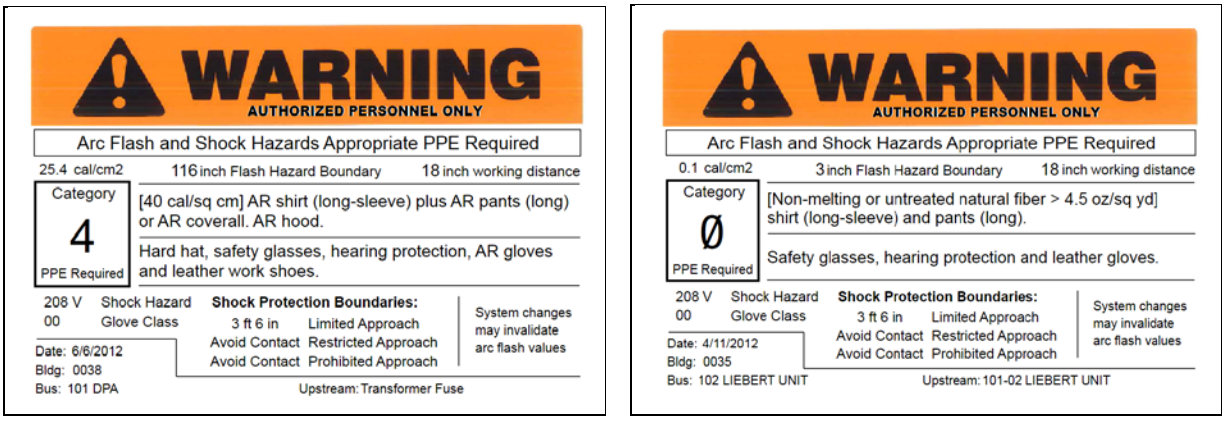

Table 1. Wording for the PPE related arc flash label fields.

Incident Energy (calories/cm^2)	PPE Category	PPE clothing	PPE equipment
0 - 1.2	0	[Non-melting or untreated natural fiber > 4.5 oz/sq yd] shirt (long-sleeve) and pants (long).	Safety glasses, hearing protection and leather gloves.
greater than 1.2 - 4	1	[4 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR faceshield.	Hard hat, safety glasses, hearing protection, leather gloves and leather work shoes.
greater than 4 - 8	2	[8 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR balaclava and AR face shield or AR hood.	Hard hat, safety glasses, hearing protection, leather gloves and leather work shoes.
greater than 8 - 25	3	[20 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR hood.	Hard hat, safety glasses, hearing protection, AR gloves and leather work shoes.
greater than 25 - 40	4	[40 cal/sq cm] AR shirt (long-sleeve) plus AR pants (long) or AR coverall. AR hood.	Hard hat, safety glasses, hearing protection, AR gloves and leather work shoes.
greater than 40	X	Arc Flash Energy Exceeds the Rating of Category 4 PPE	Do not work on energized equipment

3.7 INSTALLATION/START-UP

A. The Electrical Contractor shall install equipment and protective devices in accordance with the approved short circuit and selective coordination study.

B. The Electrical Contractor shall field mark equipment with flash hazard analysis data as required in accordance with codes and standards.

C. The Manufacturer's engineer shall set all adjustable overcurrent and/or timing devices in accordance with the approved study results, and then test the devices.

D. The Manufacturer performing the study shall provide assistance to the installing Electrical Contractor during start-up of electrical system and equipment as needed.

END OF SECTION 260573

DIVISION 26 - ELECTRICAL

SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 – GENERAL:

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 RELATED WORK

A. Division 22 - Plumbing
B. Division 23 – Mechanical
C. Division 26 - Electrical
D. Division 27 – Communications
E. Division 28 – Electronic Safety and Security

1.2 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1-1996

C. ASHRAE Guideline 0-2005

D. ACG Commissioning Guideline – 2005

1.3 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the Owner/Operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system’s installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for

beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 - PRODUCTS

2.1 Not used.

PART 3 - EXECUTION

3.1 ROLES OF THE COMMISSIONING AGENCY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of Electrical systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high-quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional

Performance Test results may be used in determining the start of the warranty period for Electrical systems and subsystems.

I. The CA will review operating and maintenance materials for Electrical systems.

J. The CA will review phasing plans as provided by the CM relating to temporary use of Electrical equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.2 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

Main Normal Distribution
Lighting Control Systems
Lighting Control Programs and Interface with BAS.
Emergency Lighting
PV System
Energy Metering System/ Energy Dashboard
Fire Alarm and Interface Items with HVAC and BAS.

3.3 ELECTRICAL COMMISSIONING PLAN

A. Commissioning Team

1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:

Program Manager (PrM)
Facilities Management Division (FMD)
Commissioning Agent (CA)
Design Team (DT)
Construction Manager (CM)
Mechanical Contractor (MC)
Controls Contractor (CC)
Test and Balance Contractor (TABC)
Electrical Contractor (EC)

B. Basis of Design Document

1. The Basis of Design Document (BoD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BoD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.

2. The CA will review the BoD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings

1. Commissioning meetings will be held in conjunction with progress meetings as necessary. The CA will be on site for the Cx meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)

1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists

1. The CA will write SVC's based on the BoD. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS*. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

F. Start-Up

1. Start-up of major Electrical systems will be witnessed the CA. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting Electrical equipment.
2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-

authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Controls Monitoring

1. Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

H. TAB Monitoring

1. The preliminary TAB report set-up will be reviewed prior to Electrical equipment start-up, in order to assure that the final TAB report format and content is acceptable.
2. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.
3. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

I. Functional Performance Tests (FPT)

1. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See *SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS* above.

2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.

3. The Functional Performance Tests shall include Electrical, Lighting and related equipment.

   a. The Electrical trade representative will demonstrate to the CxA: main power disconnect switch and feeder disconnect switches over current ground fault sensor trip settings by the primary injection method and in accordance with NETA-ATS Section 7.6, switchboard assemblies megger tested in accordance with NETA-ATS Section 7, switchboard metering instrumentation tests in

accordance with NETA-ATS Sections 7.10 and 7.11, and switchboard single phase monitor tests for operation upon loss of a phase.

b. The Electrical trade representative, with the CxA present, will field test for power operation for the emergency generator and transfer switches.

c. Lighting controls will be tested under relevant operating conditions.

d. A remote connection to energy metering system, energy dashboard, PV system, or any other system should be provided to the CA prior to system start-up for use as a tool to determine completion and accuracy of systems. CA in conjunction with the CT will ensure that all systems function properly through FPT's and through trend verification of systems.

4. Deferred Testing

a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.

b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

5. Rescheduled Functional Performance Test

a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, their time will be billed to the contractor as an additional fee.
b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed for the commissioning personnel's return trip.

J. Building Turn-Over / Owner Orientation / User Training

1. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going Electrical related problems are being addressed and corrected in a timely and efficient manner.
4. The CA will assist the owner/user with warranty issues.

5. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.4 RESPONSIBILITIES OF TEAM MEMBERS

A. Construction Manager (CM)

1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Electrical commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the electrical commissioning program as described in the contract documents.
3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
4. Coordinate inclusion of commissioning activities in the construction schedule.
5. Facilitate resolution of deficiencies identified by observation or performance testing.
6. Involve CA in selection of the air balancing contractor.
7. Assist the CA in monitoring the duct leakage testing.

B. Electrical Contractor (EC)

1. Include cost for commissioning requirements in the contract price.
2. Review design for provision of power to the Electrical equipment.
3. Attend commissioning meetings scheduled by the CA.
4. Verify proper installation and performance of all Electrical services provided.
5. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of equipment.
6. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
7. Provide an Electrical system technician to assist during verification and performance testing.
8. Participate in the Functional Performance Tests as required to achieve design intent.
9. Participate in the off-season mode testing as required to achieve design intent.
10. Participate in O&M Training as required by project specifications.

END OF SECTION 260800

DIVISION 26 - ELECTRICAL

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DESCRIPTION OF WORK

A. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.

B. Branch panelboards shall be as indicated on the drawings and as specified herein. The lighting panelboards shall be of the dead-front, quick-make, quick-break, bolt-on circuit breaker type, with trip indicating and trip free handles. All circuits shall be clearly and properly numbered and shall be provided with thermal magnetic protection.

C. The panelboards shall be enclosed in code gauge, galvanized steel cabinets with smooth finished hinged doors without visible external fasteners and heavy chrome locks. Provide baked-on grey enamel finish, in accord with ANSI 61. Panels shall be constructed in accord with Federal Specification W-P-115B Type 1 Class 1, UL67, UL50, NEMA P31, and NFPA 70. Locks shall all be keyed alike.

D. Each door shall have a directory card inside, covered with a plastic shield, with typewritten circuit numbers and description indicated. Room numbers shall be coordinated with final room numbers as selected by Owner, not numbers on Contract Documents.

E. Panelboard trim for surface or flush panels shall be double-hinged type, to allow exposure of dead-front breaker portion behind locked door, with screw-fastened gutter trim that is hinged to allow full access to wiring gutters.

F. Special Note: The room numbers used to fill out the panel directories shall match the actual final name and numbering scheme selected by the Owner. They shall not be filled out per the construction drawing numbering scheme, unless the Contractor is directed to do so by the Architect or Engineer.

G. Branch panelboards shall be surface or flush mounted as indicated on the Contract Drawings. Flush panels trims shall be tight to wall and interior barriers, with no gaps allowing access to live parts. Oversize trims will not be acceptable.

H. Note: Where mounted in groups, align top of trim or tub for all panels in an area. Exact mounting height of topline shall be as directed by the Engineer.

I. All main bus and connections thereto in panelboards shall be copper. All bus bars shall extend full length of panelboards.

J. All panelboards shall have full size un-insulated copper ground busses and insulated full neutral busses.

K. All panelboards shall be provided with an integral SPD per Specification 264313, Surge Protection for Low-Voltage Electrical Power Circuits.

1.4 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. GFCI: Ground-fault circuit interrupter

1.5 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. Submit final version after load balancing.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for panelboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each panelboard cabinet lock. All panelboard keys shall match.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate space available for panelboards including clearances between panelboards and adjacent surfaces and other items. Furnish and install equipment to comply with NEC clearances.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager no fewer than 14 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.
3. Comply with NFPA 70E.

1.12 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All panelboards, finishes, and all of its component parts, and controls shall have an unconditional one (1) year warranty. Warranty shall include finishes and all components to be free from defects in materials and workmanship for a period of one (1) year from date of Owner's acceptance. Replacement of panelboards, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace surge suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.

B. Enclosures: Flush- and surface-mounted cabinets. Box width shall not exceed 20" wide. Rated for environmental conditions at installed location.

1. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Kitchen and Catering Areas: NEMA 250, Type 4X, Stainless Steel.

C. Type 1 Boxes

1. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvanized steel is not acceptable.
2. Boxes shall have removable end walls. End walls shall not be provided with concentric knockouts. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes: Panels, Back Boxes and Trim: Galvanized Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
8. All lock assemblies shall be keyed alike.

D. Incoming Mains Location: Top and bottom to match feeder conduit entry. Feeders routed through the side gutters to reach the top or bottom main breakers from the opposite end of the panel are not acceptable.

E. Phase, Neutral, and Ground Busses:

1. Material: Fully plated, hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Extend full length of panelboard and adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box. Provide where show on drawings.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Provide when supplied by K rated transformers.
5. Split Bus: Vertical buses divided into individual vertical sections.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus-Configured Terminators: Mechanical type.
3. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
5. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike. For doors, more than 36 inches high, provide two latches, keyed alike.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Interior:

1. Continuous main current ratings, as indicated on associated drawings.
2. Short circuit rating as shown on the schedules.
3. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing shall be plated copper. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
5. A solidly bonded copper equipment ground bar shall be provided.
6. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.
7. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting space.
8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA/UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

4. Siemens.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Circuit breakers shall be CSA and UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules.
2. Molded case branch circuit breakers shall have bolt-on type bus connectors.
3. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
4. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red indicator appearing in the clear window of the circuit breaker housing.
5. The exposed faceplates of all branch circuit breakers shall be flush with one another.
6. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors.
7. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
8. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
9. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
10. Instantaneous trip.
11. Long- and short-time pickup levels.
12. Long- and short-time time adjustments.
13. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
14. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
15. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
16. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
17. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    f. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four (4) 1-inch and two (2) 1-1/4”-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Each door shall have a directory card inside, covered with a plastic non-yellowing shield. Directory Card to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer to create directory in Microsoft Excel; handwritten directories are not acceptable. Digital versions to be provided to Owner.

B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553.

C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553.

3.4 QUALITY CONTROL/STARTUP: Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Section 019113 Commissioning.

A. Functional Performance Tests: System functional performance testing is part of the Commissioning Process as specified in Section 019113. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

B. Demonstration and Training: Training of the owner's operation and maintenance personnel is required in cooperation with the Commissioning Authority. The instruction shall be scheduled in coordination with the Commissioning Authority after submission and approval of formal training plans.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour

services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 262416

DIVISION 26 - ELECTRICAL

SECTION 262726 - WIRING DEVICES AND PLATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This section of the specifications covers all wiring devices and cover plates, standard, weatherproof and dust-tight.

B. Wiring devices, listed by manufacturer and catalogue numbers are to establish the quality and type required. Equivalent devices of other manufacturers will be acceptable with prior approval of the Engineer. Submit cutsheets and/or samples of each type ten days prior to bid date for review and written approval to bid. Insofar as possible, standard application or special application devices shall be by one manufacturer.

C. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge-suppression units.
4. Isolated-ground receptacles.
5. Tamper-resistant receptacles.
6. Weather-resistant receptacles.
7. Snap switches and wall-box dimmers.
8. Cord and plug sets.
9. Floor service outlets, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

C. TVSS: Transient voltage surge suppressor.

1.4 ADMINISTRATIVE REQUIREMENT

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
2. Leviton Mfg. Company Inc. (Leviton).
3. Pass & Seymour/Legrand (P&S).
4. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Straight-Blade Receptacles

1. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
2. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

a. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

3. Tamper-Resistant, Shutter-Type Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

D. SPD Receptacles

1. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.

   a. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   b. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

2. Duplex SPD Convenience Receptacles: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
3. Isolated-Ground, Duplex Convenience Receptacles:

   a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
   b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.3 DEVICES

TYPE	**RATING**	**CONFIGURATION**	**COLOR**	**VENDOR - CAT. #**
RECEPTACLE, DUPLEX **PREMIUM GRADE**	125V, 20A	NEMA 5-20R	!	HUBBELL 5352 LEVITON or P & S Equal
	* USE WHERE ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHERE ON DEDICATED 15A CKT., OR WHERE MORE THAN ONE RECEPTACLE ON A CIRCUIT			
RECEPTACLE, SAFETY SHUTTER TYPE DUPLEX	125V, 20A	NEMA 5-20R	!	HUBBELL LEVITON or P & S equal
RECEPTACLE, DUPLEX GFI WITH AUDIBLE ALARM	125V, 20A	NEMA 5-20R	!	P & S 2095 TRAN LEVITON or HUBBELL equal
RECEPTACLE, DUPLEX, WEATHER RESISTANT, GFI	125V, 20A	NEMA 5-20R	!	HUBBELL # GFTR20 LEVITON OR P & S Equal
RECEPTACLE, SIMPLEX	125V, 20A	NEMA 5-20R	!	HUBBELL 5361

RECEPTACLE, SINGLE	250V, 20A	NEMA 10-20R	BLACK	HUBBELL 6810 LEVITON or P & S Equal
RECEPTACLE, SINGLE	250V, 30A	NEMA 6-30R	BLACK	HUBBELL 9330 LEVITON or P & S Equal
RECEPTACLE, SINGLE	250V, 50A	NEMA 6-50R	BLACK	HUBBELL 9367 LEVITON or P & S Equal
SWITCH, SINGLE POLE	120/277V, 20A	SPST	!	HUBBELL HBL-1221 LEVITON or P & S Equal
SWITCH, THREE-WAY	120/277V, 20A	3-WAY	!	HUBBELL HBL-1223 LEVITON or P & S Equal
NOTES: 1. PROVIDE MATCHING CAP (PLUG) FOR ALL RECEPTACLES 30 AMP RATED AND ABOVE AS REQUIRED FOR EQUIPMENT. 2. ALL RECEPTACLES SHALL BE BACK OR SIDE-WIRED, CLAMPING TYPE 3. RECEPTACLES SHALL BE TAMPER RESISTANT AND WEATHER RESISTANT AND MARKED ACCORDINGLY AS REQUIRED BY NEC ! SEE PART 2.5, COLOR.				

2.4 SMALL MOTOR CONTROL SWITCHES

A. For small line-to-neutral motor loads of 3/4 HP or less, single phase, rated at 120 or 277 volts, provide snap-type, HP rated motor starter switch with thermal overloads. Overload heaters sized to match the motor nameplate amperes and the ambient temperature shall be provided. Provide with NEMA 1, NEMA 3R or other enclosure suitable for the location and atmosphere. All manual starters in finished areas shall be in flush-mounted enclosures. If the motor to be controlled is not equipped with internal thermal overload protection, overload heaters sized to match the motor nameplate amperes and the ambient temperature shall be provided.

2.5 COLOR

A. Color of devices shall be as selected by the architect. Samples (devices, plates or both) may be required to be submitted with other architectural color items by the Contractor. The Contractor shall coordinate any such submission required with other trades, the Prime Contractor or as needed.

B. Where devices are controlling or supplying emergency power from a standby source, the device color shall be red, as with switch toggles or receptacle fronts. Plate color shall match others on normal power in the building unless otherwise noted.

C. Where surface finishes next to the devices vary in color or shade throughout the project, the Contractor may be required to provide lighter or darker plates and devices to more closely match wall finishes. These variations are considered to be included in the original contract for construction.

2.6 PLATES AND COVERS

A. Unless otherwise specified or noted, all wiring device plates and covers shall be stainless steel. Color shall be selected by Architect during shop drawing review.

B. Cover plates shall be of one manufacturer insofar as possible.

C. Weatherproof, while in use, plates for GFCI receptacles shall be cast aluminum, self-closing, gasketed, suitable for standard box mounting, UL listed for wet location use, cover closed. Vertical mounting - Hubbell WP26M, horizontal mounting - Hubbell WP26MH (die-cast zinc) or equivalent Leviton or P & S.

D. Weatherproof switch plates for toggle-handle switches shall be clear silicone rubber, for standard outlet boxes. Hubbell 1795 or equivalent P & S or Leviton.

E. Cover plates for computer, telephone or other system outlets shall be stainless steel.

F. All kitchen and food service area plates shall be smooth 304 stainless steel with foam gasket behind to help prevent water infiltration.

2.7 FLOOR BOXES

A. Manufacturers: Model numbers indicated on floor plans is basis-of-design. Subject to compliance with requirements, provide products by one of the following approved manufacturers:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand.
3. Square D/Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold/Legrand.

B. Description:

1. In general, floor boxes that are to contain multiple services such as power, data, voice, video, etc., shall be constructed of stamped steel and heavy thermoplastic with barriers or compartments to separate power from signal services per National Electrical Code.
2. Provide floor boxes with proper trim for carpet, wood, terrazo, tile or concrete floors, wiring slots, dust covers and proper device plates to hold outlets, jacks, etc. They shall be fully adjustable. Conduit rough-in shall be as required. All tops shall be capable of receiving an insert of the surrounding floor material.
3. Outlets for multi-service floor boxes shall be as specified elsewhere in these specifications.
4. Set boxes dead level with flooring and provide proper support by thickening concrete slab, welding angle iron across joists below or other approved means.

2.8 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

C. Description:

1. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
2. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.9 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.10 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. All wiring devices in dusty areas, exposed to weather and moisture shall be installed in Type "FS" conduit fittings having mounting hubs, with appropriate cover plates.

C. Devices that have been installed before painting shall be masked. No plates or covers shall be installed until all finishing and cleaning has been completed.

D. Provide GFCI duplex feed-thru style receptacles where indicated or required by the National Electrical Code, whether specifically called out or not. When a GFCI receptacle is on a circuit with other non-GFCI receptacles, it shall always be placed at the homerun point of the circuit and shall be wired to ground-fault interrupt protect the downstream outlets on that circuit unless specifically indicated to the contrary. Provide a "GFCI protected" label on each downstream outlet. GFCI receptacles shall audibly alarm when tripped.

E. All receptacles shall be installed with ground prong at bottom position.

F. All device face plates shall be labeled with panel and circuit designation by means of machine printed adhesive tape.

G. All device boxes shall have circuit number identified within the box.

H. Coordination for all receptacles except NEMA 5 Configuration: Contractor shall confirm receptacle configuration of all special purpose receptacles prior to installation and provide devices to match equipment. Contractor shall replace any incompatible receptacle discovered during owner move-in.

I. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

J. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

K. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. Use a torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than #12 AWG are installed on 15- or 20-A circuits, splice #12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
9. Install switches with “OFF” position down.

L. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

M. Dimmers:

1. Install slide type dimmers within terms of their listing. Dimmers shall match load type.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to NEC and manufacturers' device listing conditions in the written instructions.

N. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION: Comply with Division 26 Section "Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Wiring device will be considered defective if it does not pass tests and inspections.

C. Tests for Convenience Receptacles:

1. Line-Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare and submit test and inspection reports.

END OF SECTION 262726

DIVISION 26 - ELECTRICAL

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.
2. Spare fuse cabinet.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

a. Let-through current curves for fuses with current-limiting characteristics.
b. Time-current curves, coordination charts and tables, and related data.

c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with:

1. NEMA FU 1 – Low Voltage Cartridge Fuses.
2. NFPA 70 – National Electrical Code.
3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
4. UL 198E – Class R Fuses.
5. UL 512 – Fuseholders.

1.5 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three of each size and type.

C. Fuse Pullers: Two (2) for each size and type.

1.7 WARRANTY

A. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace fuses that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Owner’s acceptance.

1.8 PROJECT CONDITIONS

A. A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. LittleFuse

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.3 FUSE APPICATIONS

A. Circuits 601 to 6000 amperes shall be protected by current limiting BUSSMANN HI-CAP TIME DELAY FUSES KRP-C. Fuses shall employ "O" rings as positive seals between the end bells and the fuse barrel. Fuses shall be a time-delay type and must hold 500% of rated current for a minimum of 5 seconds, clear 20 times rated current in .01 seconds or less and be listed by Underwriter's Laboratories, Inc., with an interrupting rating of 200,000 amperes RMS symmetrical. The fuses shall be UL Class L.

B. Circuits 0 to 600 amperes shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses, LPN-RK (250 volts) or LPS-RK (600 volts). All dual element fuses shall have separate overload and short circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284NF melting point alloy and shall be independent of the short-circuit clearing chamber. The fuse shall hold 500% of rated current for a minimum of l0 seconds and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes RMS symmetrical. The fuses shall be UL Class RK1.

C. Motor Circuits - All individual motor circuits rated 480 amperes or less shall be protected by BUSSMANN LOW PEAK DUAL-ELEMENT FUSES LPN-RK (250 volts) or LPS-RK (600 volts). The fuses for 1.15 service factor motors shall be installed in rating approximately l25% of motor full load current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the Type KRP-C HI-CAP Time Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element Fuses LPN RK (250 volts) or LPS-RK (600 volts) installed in rating approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class RK1 or L.

D. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual Element fuses LPN-RK (250 volts) or LPS-RK (600 volts) as shown on the drawings. The fuses shall be UL Class RK1.

2.4 LIGHTING BALLAST/DRIVER/TRANSFORMER FUSES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussman, Inc. – GLR fuses with HLR holder.
2. Tracor, Inc.; Littelfuse, Inc. Subsidiary – LGR fuses with LHR-000 holder.
3. Ferraz Shawmut, Inc. – SLR fuses.

B. Provide each lighting ballast/driver/transformer with individual protection on the line side.

C. Provide fuse and holder mounted within or as part of the fixture.

D. Provide fuse size and type recommended by the fixture manufacturer.

2.5 SPARE-FUSE CABINET

A. Manufacturer: Bussmann #SFC-FUSE-CAB spare fuse cabinet or equal.

B. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

C. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

D. Finish: Gray, baked enamel.

E. Identification: "SPARE FUSES" in 1-1/2 inch high white letters on black lamicoid plate. Mount plate on exterior of door.

F. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION:

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Fuses shall be installed when equipment is ready to be energized, including thorough cleaning and tightening of all electrical connections.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to

energizing at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energizing of the circuit in which it is applied.

B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to insure retention of selective coordination, as designed.

C. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

D. Install spare-fuse cabinet(s). Locate in Main Mechanical/Electrical Room.

E. Upon completion of the building, the Contractor shall provide the Owner with spare fuses in Spare-Fuse Cabinet.

3.3 IDENTIFICATION

A. Install as part of the lamicoid identification labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 262813

DIVISION 26 - ELECTRICAL

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section includes:

1. Fusible Switches
2. Non-Fusible Switches
3. Individually Mounted Circuit Breakers
4. Combination Starter/Disconnect Switches
5. Enclosures.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter

B. HD: Heavy Duty

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

B. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches, circuit breakeres, accessory, and component indicated from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate space available for enclosed switches including clearances between enclosed switches and adjacent surfaces and other items. Furnish and install equipment to comply with NEC clearances.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All enclosed switches and circuit breakers, finishes, and all of its component parts, and controls shall have an unconditional one (1) year warranty. Warranty shall include finishes and all components to be free from defects in materials and workmanship for a period of one (1) year from date of Owner’s acceptance. Replacement of enclosed switches and circuit breakers, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace surge suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Siemens.

2.2 NON-FUSIBLE SWITCHES

A. All non-fusible safety switches shall be Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. All safety switches shall have switch blades that are fully visible in the "OFF" (open) position with the door open.

C. All safety switches shall have a factory installed ground lug.

D. All safety switches shall have a factory installed neutral lug, when a neutral is necessary.

E. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.

F. Switch mechanism shall be quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.

G. Provide the following Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 FUSIBLE SWITCHES

A. All fusible safety switches shall be Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. All safety switches shall have switch blades that are fully visible in the "OFF" (open) position with the door open.

C. All safety switches shall have a factory installed ground lug.

D. All safety switches shall have a factory installed neutral lug, when a neutral is required.

E. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.

F. Switch mechanism shall be quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.

G. Provide the following Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 INDIVIDUALLY MOUNTED MOLDED-CASE CIRCUIT BREAKERS

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

C. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.

D. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

F. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.5 COMBINATION STARTER/DISCONNECT SWITCHES

A. All combination starter/disconnect switches shall be full-voltage, non-reversing type.

B. All combination starter/disconnect switches shall have low-voltage protection, solid state overloads, Hands-Off-Auto selector switch and Red and Green pilot lights.

C. All combination starter/disconnect switches shall be Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Combination motor starters shall be rated in accordance with NEMA sizes and horsepower ratings. No starter shall be listed as a fractional size.

E. Contactor contacts shall be silver alloy, double break, and shall allow for inspection on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall allow for inspection utilizing standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.

F. Contactor coils shall be the encapsulated type, and shall be replaceable on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall be replaceable with standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.

G. Overload protection shall be provided by solid state electronic overload relay. Single-phase starters shall provide one- or two-leg overload protection; three-phase starters shall provide three-leg overload protection.

H. Combination starter shall be suitable for straight through wiring.

I. Switch mechanism shall be quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.

J. All safety switches shall have a factory installed ground lug.

K. All safety switches shall have a factory installed neutral lug, when a neutral is necessary.

L. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.

M. Provide the following Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers and combination starters for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices.

C. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 CLEANING

A. On completion of installation, inspect interior and exterior of enclosed switches and circuit breakers and combination starters. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Electrical Studies".

END OF SECTION 262816

DIVISION 26 - ELECTRICAL

SECTION 263213 - EMERGENCY STANDBY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

1.1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.

1.1.2 Division 16 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

1.2.1 Extent of standby generator system work is indicated by drawings and schedules.

1.2.2 Types of standby generator system equipment required for project include the following:

1.2.2.1 Turbo-charged diesel engine driven generators.

1.2.2.2 Automatic Transfer Switches, Batteries and Chargers.

1.2.3 Refer to Division 3 sections for concrete and grout work required in connection with engine generator sets; not work of this section.

1.2.4 Refer to Division 15 sections for fuel tanks, piping and accessories required in conjunction with engine generator units; not work of this section.

1.3 QUALITY ASSURANCE:

1.3.1 General Requirements: It is the intent of this specification to secure an emergency generator system that has been prototype tested, factory built, production tested, site tested, of the latest commercial design, together with all accessories necessary for a complete installation as shown on the plans and drawings, and specifications herein. The equipment supplied and installed shall meet the requirements of the National Electrical Code, along with all applicable local codes and regulations. All equipment shall be new, of current productions of a national firm. The standby generator set(s) including generator, controls, and transfer switch(es), shall be assembled as a matched unit so that there is a one-source responsibility for warranty, parts, and service without a local representative with factory-trained servicemen.

1.3.2 Manufacturers: Firms regularly engaged in manufacture of engine driven standby generator systems, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 10 years.

1.3.3 Installer: Qualified with at least 5 years of successful installation experience on projects with engine generator system installation work similar to that required for project.

1.3.4 NEC Compliance: Comply with applicable standby generator requirements of NEC including, but not limited to emergency and standby power generating systems, and health care facilities and Articles 230, 517, 700, 701, and 702.

1.3.5 NFPA Requirements: Comply with applicable requirements of NFPA No. 37, 99, 101, 110 pertaining to stationary combustion engines, health care facilities and life safety code.

1.3.6 UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches". Provide standby generator system components, including automatic transfer switches, which are UL listed and labeled with a circuit breaker mounted on the set.

1.3.7 ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators". Transfer switches shall comply with ICS 2.

1.3.8 IEEE Compliance: Comply with applicable portions of IEEE Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to standby power.

1.4 SUBMITTALS:

1.4.1 Submittal shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number, each required interconnection between the generator set, the transfer switch, and the FT-10 remote annunciator panel if it is included elsewhere in these specifications. Include manufacturer's standard product warranty (for not less than one-year period) for replacement of materials and equipment used in standby engine-driven generator system.

1.4.2 Maintenance Data: Submit maintenance instructions, including lubrication procedures, motor and drive replacement, and spare parts lists. Include this data in maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: Manufacturer: Subject to compliance with requirements, provide standby generator systems of one of the following (for each type of electric generator unit):

2.1.1 Cummins Power Generation

2.1.2 Caterpillar Tractor Co.

2.1.3 Kohler-Detroit Diesel

PART 3 - EQUIPMENT:

3.1 Provide generator as shown to meet the following specifications. Where specified equipment is required for each unit, provide as necessary.

3.1.1 The generator set shall operate at 1800 rpm and at a voltage of: 277/480 Volts AC, Three phase, Four-wire, 60 hertz.

3.1.2 The generator set shall be rated at 150 kW, 250 kVA at 0.8 PF, continuous standby rating, based on site conditions of altitude 2,000 ft. , ambient temperatures up to 122 degrees F (50 degrees C).

3.1.3 The generator set shall be UL 2200 listed and the rating shall be based on emergency/standby service.

3.2 Where bottom of equipment service access doors is located higher than 24” above ground level or equipment pad, the contractor shall provide an aluminum service access platform. The platform shall be the width of the serviceable opening and shall have stairs up to the platform. Provide protective railing around platform and stairs. Platform assembly shall comply with OSHA requirements.

PART 4 - ENGINE:

4.1 ACCEPTABLE ENGINE MANUFACTURERS

CUMMINS INC.

CATERPILLAR
DETROIT DIESEL

4.2 The engine shall be diesel, 4 cycle, radiator and fan cooled. Minimum displacement shall be 408 cubic inches. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Engine shall be current emission certified in order to provide the best available emission technology. Acceptable Engine accessories and features shall include:

4.3 An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

4.4 Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H_2O external static head. Radiator shall be sized based on a core temperature which is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.

4.5 Electric starter(s) capable of three complete cranking cycles without overheating.

4.6 Positive displacement, mechanical, full pressure, lubrication oil pump.

4.7 Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

4.8 An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.

4.9 Replaceable dry element air cleaner with restriction indicator.

4.10 Flexible supply and return fuel lines.

4.11 Engine mounted battery charging alternator, 35-ampere minimum, and solid-state voltage regulator.

4.12 Load center for service of all generator accessories. See floor plans for circuit ampacity and voltage.

4.13 Coolant heater

4.13.1 Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.

4.13.2 The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

4.13.3 The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

4.13.4 The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104°F (40°C) in a 40°F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

4.14 Provide vibration isolators, spring type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

4.15 Starting and Control Batteries shall be lead acid type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.

4.16 Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

4.17 A wall mounted, UL listed 10 amp voltage regulated battery charger shall be provided for each engine-generator set Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:

Loss of AC power - red light
Low battery voltage - red light
High battery voltage - red light
Power ON - green light (no relay contact)

4.18 Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses.

4.19 Line circuit breakers as seen on the drawings, 100% rated, solid state electronic trip.

PART 5 - GENERATOR:

5.1 The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade.

5.2 The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

5.3 A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

5.4 The sub transient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

PART 6 - CONTROLLER:

6.1 Generator set Control. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

6.2 The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

6.3 The generator set mounted control shall include the following features and functions:

6.3.1 Control Switches:

6.3.2 Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

6.3.3 EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting. One switch shall be provided on the generator control panel and an additional switch shall be provided adjacent to the automatic transfer switches served from the generator. Where automatic transfer switches are located in the same room with the generator, locate the switch in a location outside the room as approved by the owner and engineer.

6.3.4 RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

6.3.5 PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

6.4 Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

6.4.1 Analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.

6.4.2 Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.

6.4.3 Both analog and digital metering are required. The analog and digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.

6.5 Generator Set Alarm and Status Display:

6.5.1 The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The

generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:

- low oil pressure (alarm)
- low oil pressure (shutdown)
- oil pressure sender failure (alarm)
- low coolant temperature (alarm)
- high coolant temperature (alarm)
- high coolant temperature (shutdown)
- engine temperature sender failure (alarm)
- low coolant level (alarm or shutdown--selectable)
- fail to crank (shutdown)
- fail to start/overcrank (shutdown)
- overspeed (shutdown)
- low DC voltage (alarm)
- high DC voltage (alarm)
- weak battery (alarm)
- low fuel-daytank (alarm)
- high AC voltage (shutdown)
- low AC voltage (shutdown)
- under frequency (shutdown)
- over current (warning)
- over current (shutdown)
- short circuit (shutdown)
- ground fault (alarm)
- over load (alarm)
- emergency stop (shutdown)

6.5.2 Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

6.6 Engine Status Monitoring:

6.6.1 The following information shall be available from a digital status panel on the generator set control:

- Engine oil pressure (psi or kPA)
- Engine coolant temperature (degrees F or C). Both left and right bank temperature shall be indicated on V-block engines.
- Engine oil temperature (degrees F or C)
- Engine speed (rpm)
- Number of hours operation (hours)
- Number of start attempts
- Battery voltage (DC volts)
- Exhaust gas temperature for both left and right banks on V-block engines

6.6.2 The control system shall also incorporate a data logging and display provisions to allow logging of the last ten warning or shutdown indications on the generator set, as well as the total time of operation at various loads, as a percent of the standby rating of the generator set.

6.6.3 Provide remote alarm annunciators (number and location per plans) indicating engine status and alarms. Provide all necessary wiring and connections.

6.7 Engine Control Functions:

6.7.1 The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.

6.7.2 The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

6.7.3 The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in future paralleling applications without component changes.

6.7.4 The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

6.7.5 The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

6.8 Alternator Control Functions:

6.8.1 The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from mis operation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

6.8.2 Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445

6.8.3 Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

6.8.4 Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

6.8.5 An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage

exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

6.8.6 A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

6.8.7 The control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

PART 7 – OPERATION

7.1 Sequence of operation:

7.1.1 Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.

7.1.2 The generator set shall complete a time delay start period as programmed into the control.

7.1.3 The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:

7.1.4 The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.

7.1.5 The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.

7.1.6 The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

7.1.7 On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.

7.1.8 When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

7.1.9 On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

7.1.10 Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

7.2 Outdoor Weather-Protective Sound Attenuating Housing:

7.2.1 The generator set shall be provided with an outdoor enclosure. The generator set and enclosure package shall be listed under UL2200 and comply with the requirements of the National Electrical

Code for wiring materials and component spacing. Housing shall be assembled at the generator set factory and mounted to a sub-base tank, or lifting base and radiator cowling. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 122F. The housing shall have hinged side-access doors to facilitate access to service points. All doors shall include retainers to hold the door open during service. Doors must have locks to prevent unauthorized access to the generator set. Enclosure roof shall be cambered to prevent rain water accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure. The enclosure shall include provisions to allow for lifting with spreader bars.

7.2.2 Surfaces of all metal parts (including sheet metal) shall be primed and painted with the manufacturers standard color using a two step electrocoating paint process or similar. The painting process shall result in a coating that meets the following requirements:

7.2.2.1 Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.

7.2.2.2 Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.

7.2.2.3 Crosshatch adhesion, per ASTM D3359-93, 4B-5B.

7.2.2.4 Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.

7.2.2.5 Salt Spray, per ASTM B117-90, 1000+ hours.

7.2.2.6 Humidity, per ASTM D2247-92, 1000+ hours.

7.2.2.7 Water Soak, per ASTM D2247-92, 1000+ hours.

7.2.3 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.

7.2.4 Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.

7.2.5 A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.

7.2.6 The enclosure shall include the following maintenance provisions: Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves.

7.2.7 Air inlet shall include rain louvers.

7.2.8 Provide a factory mounted electrical AC distribution panel to feed the generator set and enclosure accessories. The provisions required include:

7.2.8.1 60-amp, 120/208-volt, single phase load center.

7.2.8.2 GFCI protected weather proof external 120-volt service receptacle.

7.2.8.3 All factory installed AC powered features pre-wired into load center.

7.2.9 The enclosure shall be insulated with non-hydroscopic materials.

7.2.10 Provide a sub-base fuel tank for the generator set, sized to allow for full load operation of the generator set for 96 hours. **Tank and generator shall fit in the area indicated on plans.** The sub-base fuel tank shall be UL142 listed and labeled. Installation shall be in compliance to NFPA37. The fuel tank shall be a double-walled, steel construction and include the following features:

7.2.10.1 Emergency tank and basin vents.

7.2.10.2 Mechanical level gauge.

7.2.10.3 Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.

7.2.10.4 Leak detection provisions, wired to the generator set control for local and remote alarm indication.

7.2.10.5 Low level float switch to indicate low fuel level, wired to generator set control for local and remote alarm indication. High float switch to annunciate tank full alarm.

7.2.10.6 Integral lifting provisions.

7.2.10.7 The fuel tank capacity shall be 96 hours gallons, and it shall be installed beneath the floor and shall be listed as a “primary containment aboveground tank for flammable and combustible liquids” in accordance with UL Standard No. 142 and mounted within a combined rupture basin/floor/underframe. The interstitial space between the tank and basin shall be monitored to indicate a rupture condition. Fuel tank will include drainage plumbing, supply/return lines, and supply valve control. Means shall be provided to prevent overfilling by sounding an alarm when the liquid level in the tank reaches 90 percent of capacity and by automatically stopping delivery of liquid to the tank when the liquid level in the tank reaches 95 percent of capacity. In no case shall these provisions restrict or interfere with the proper functioning of the normal vent or the emergency vent.

7.2.11 The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 73 dBA measured at 7 meters in a free field environment with a vertical radiator discharge. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.

7.2.12 The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and padlockable door latches shall be provided for all doors. Door hinges shall be stainless steel.

7.2.13 The enclosure shall be provided with an exhaust silencer which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a raincap and rainshield.

7.2.14 All sheetmetal shall be primed for corrosion protection and finish painted with the manufacturers standard color. All surfaces of all metal parts shall be primed and painted.

7.2.15 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

PART 8 - AUTOMATIC TRANSFER SWITCHES:

8.1 Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

8.2 The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided. Technicians specifically trained to support the product and employed by the generator set supplier shall service the transfer switches.

8.3 Codes and Standards

8.3.1 The automatic transfer switch shall conform to the requirements of the following codes and standards:

- CSA C22.2, No. 14 – M91 Industrial Control Equipment.
- CSA 282, Emergency Electrical Power Supply for Buildings
- EN55011, Class B Radiated Emissions
- EN55011, Class B Conducted Emissions
- IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991
- IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
- IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
- IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
- IEC 1000-4-6 Conducted Field Immunity
- IEC 1000-4-11 Voltage Dip Immunity
- NFPA20 – Fire Pumps. Transfer switches serving fire pumps shall be specifically listed and labeled for that application.
- NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
- NFPA99 – Essential Electrical Systems for Health Care Facilities
- NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
- IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
- NEMA ICS10-1993 – AC Automatic Transfer Switches.
- UL1008. The transfer switch shall be UL listed and labeled.

8.4 The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

8.5 Acceptable Manufacturers:

8.5.1 Cummins Power Generation – Model OTPC Non-bypass

8.5.2 Russelectric – Model RTSB Non-bypass

8.5.3 ASCO – 7000 Non-bypass

8.6 Switch Ratings:

8.6.1 Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.

8.6.2 Main contacts shall be rated for 600 Volts AC minimum.

8.6.3 Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).

8.6.4 Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings and at the specified voltage. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

8.7 Construction:

8.7.1 Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.

8.7.2 Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions.

8.7.3 Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

8.7.4 Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.

8.7.5 Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.

8.7.6 Transfer switches shall be 4-pole with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.

8.8 Connections:

8.8.1 Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

8.8.2 Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

8.9 Transfer switch Control:

8.9.1 Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

8.9.1.1 High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.

8.9.1.2 High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.

8.9.1.3 “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.

8.9.1.4 “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.

8.9.1.5 “RESET/LAMP TEST” pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.

8.9.2 The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool or an operator display panel.

8.9.3 Security Key Switch to allow the user to inhibit adjustments, manual operation or testing of the transfer switch unless key is in place and operated.

8.9.4 Analog AC meter display panel, to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor. The display shall be color-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.

8.9.5 Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:

8.9.6 Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.

8.9.7 Display source status, to indicate source is connected or not connected.

8.9.8 Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.

8.9.9 The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:

- Set nominal voltage and frequency for the transfer switch.
- Adjust voltage and frequency sensor operation set points.
- Set up time clock functions.
- Set up load sequence functions.
- Enable or disable control functions in the transfer switch, including program transition.
- Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.

8.9.10 Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The

control shall also log total operating hours for the control system.

8.9.11 Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.

8.9.12 Display information for other transfer switches in the system, including transfer switch name, real time load in KW on the transfer switch, current source condition, and current operating mode.

8.9.13 Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.

8.10 Internal Controls:

8.10.1 The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.

8.10.2 Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:

8.10.2.1 Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).

8.10.2.2 Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).

8.10.2.3 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.

8.10.2.4 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.

8.10.2.5 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.

8.10.2.6 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).

8.10.2.7 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.

8.10.2.8 Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.

8.10.3 All transfer switch sensing shall be configurable from a Windows 95, 98, or NT PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel.

Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED lamps.

8.10.4 The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.

8.10.5 The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).

8.10.6 The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device for load shedding purposes. On receipt of this signal, the transfer switch shall switch to a neutral position when connected to source 2. If source 1 is available when the load-shed signal is received, the transfer switch shall connect to source 1.

8.10.7 The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.

8.10.8 The transfer switch shall provide a relay contact signal prior to transfer or retransfer. The time period before and after transfer shall be adjustable in a range of 0 to 50 seconds.

8.10.9 The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +70C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards

8.10.10 The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

8.11 Control Interface:

8.11.1 The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.

8.11.2 Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

8.11.3 Transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.

8.11.4 The transfer switch shall be provided with a network communication card, and configured to allow LonMark compliant communication with the transfer switch and paralleling gear.

8.11.5 The transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.

8.11.6 The transfer switch shall be provided with a network communication card, and configured to allow LonMark compliant communication with the transfer switch and paralleling gear.

8.12 Enclosure:

8.12.1 Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70. The cabinet door shall include permanently mounted key type latches.

8.12.2 Transfer switch equipment shall be provided in a NEMA 1 or better enclosure.

8.12.3 Enclosures shall be the NEMA type specified. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

8.13 OPERATION: Open Transition Sequence of Operation:

8.13.1 Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.

8.13.2 Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:

8.13.3 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

8.13.4 When the control system senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.

8.13.5 The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.

8.13.6 On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.

8.13.7 The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

8.13.8 Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

8.13.9 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

8.13.10 When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.

8.13.11 At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

8.13.12 OTHER REQUIREMENTS

8.13.12.1 Factory Testing. The transfer switch manufacturer shall perform a complete operational test on

the transfer switch prior to shipping from the factory. A certified test report shall be available on request. Test process shall include calibration of voltage sensors.

8.13.12.2 Service and support

8.13.12.3 The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

8.13.12.4 The transfer switch shall be serviced by a local service organization that is trained and factory certified in both generatorS set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

8.13.12.5 The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

PART 9 - EXECUTION

9.1 INSTALLATION OF ENGINE GENERATOR SYSTEMS:

9.1.1 Install standby engine generator sets as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine generator sets fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of standby engine generator systems and accessories.

9.1.2 Coordinate with other work, including fuel tanks, piping and accessories, as necessary to interface installation of standby generator system work with other work.

9.1.3 Install units on vibration isolators in accordance with Division-15 section; comply with manufacturer's indicated installation method if any.

9.1.4 Connect fuel oil piping to standby generator equipment as indicated, and comply with manufacturer's instructions where not otherwise indicated.

9.1.5 Align shafts of engine and generator within tolerances recommended by equipment manufacturer.

PART 10 - GROUNDING:

10.1 Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for system components as indicated.

PART 11 - TESTING:

11.1 Manufacturer shall provide a factory trained service engineer to supervise entire testing procedure. Generators and paralleling equipment must be factory tested as a complete system prior to shipping to job site.

11.2 Upon completion of installation of engine generator system and after building circuitry has been energized with normal power source, test engine generator to demonstrate standby capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance; otherwise, replace defective components and proceed with retesting.

11.3 Contractor to fill fuel tanks to capacity and run generator under full building load for a minimum of 2 hours and record results. Generator shall be capable of delivering full capacity while operating in an ambient temp. of 24 degrees F. Factory test data showing run-test loads is not acceptable. Fuel tanks shall be re-filled before turned over to Owner.

11.3.1 Record Fuel consumption, coolant temperature, lube oil pressure, output voltage (each phase), output current (each phase), room temperature at 15 minute intervals.

11.3.2 Verify motor starting ability by use of largest connected motor and the load bank.

11.4 The complete automatic transfer switch system and generator control system shall be tested as to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

PART 12 - TRAINING OF OWNER'S PERSONNEL:

12.1 Provide services of manufacturer's technical representative for 8-hours to instruct Owner's personnel in operation and maintenance of the engine generator system.

12.2 Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date. Obtain receipt that training has been accomplished.

PART 13 - 5-YEAR COMPREHENSIVE WARRANTY:

13.1 For standby power applications only, the complete electrical power system (generator set, controls and associated switches, switchgear and accessories), as provided by the single-source manufacturer, shall be warranted by said manufacturer against defects in materials and workmanship for a period of five years or 1500 hours, whichever occurs first from the date of system start-up. Said coverage shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment, per the manufacturer's standard published limited warranty. There shall be no deductibles applied to said warranty.

END OF SECTION

DIVISION 26– ELECTRICAL

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

D. Section includes lightning protection for structures.

E. The Electrical Contractor shall provide the necessary labor, materials, services necessary to provide the complete lightning protection system as specified herein. This work shall include, but is not necessarily limited to Conductors, Air Terminals, Connectors, Splicers, Ground Rods, Rod Clamps, Ground Plates, Bonding Plates and Surge Arrestors.

F. Connections as required to existing lightning protection, where applicable.

G. This is a performance based specification. It is the Contractors' responsibility for a complete and functional system as described in the specification drawings.

1.3 ACTION SUBMITTALS

H. Product Data: For each type of product indicated.

I. Shop Drawings: For air terminals and mounting accessories.

J. Dimensional layout drawing of the lightning protection system, along with details of the components to be used in the installation.

K. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

L. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

M. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

N. Field quality-control reports.

O. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

P. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

Q. Ground rods.

R. Bond and interconnection locations.

1.5 QUALITY ASSURANCE

S. Installer Qualifications:

T. Certified by UL and LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

U. A firm with at least 3 years of success installation experience on projects with lightning protection work similar to that required for project.

V. System Certificate:

W. UL Master Label.

X. LPI System Certificate.

Y. UL Master Label Recertification.

Z. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

AA. Manufacturers: First regularly engaged in manufacturer of lightning protection equipment, of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than 5 years. The firm shall be a member of and certified by the Lighting Protection Institute of America or listed member of Underwriters Laboratories.

BB. ANSI/NFPA Compliance: Comply with NEC and NFPA No. 780, "Lightning Protection Code", as applicable to materials and installation of lightning protection components and wiring.

CC. ANSI Compliance: Comply with applicable portions of ANSI C2 and C62.2 pertaining to lightning (surge) arrestors.

DD. UL Compliance: Comply with UL 96, "Lightning Protection Components" pertaining to design, materials and sizing of lightning protection components. Provide components, which are UL listed and labeled.

1.6 COORDINATION

EE. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

FF. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

GG. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: Subject to compliance with requirements, provide products by one of the following:

HH. A/C Lightning Protection Co., Inc.

II. East Coast Lightning Equipment Inc.

JJ. ERICO International Corporation.

KK. Harger.

LL. Heary Bros. Lightning Protection Co. Inc.

MM. Independent Protection Co.

NN. Preferred Lightning Protection.

OO. Robbins Lightning, Inc.

PP. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

QQ. Provide lightning protection system components of types, sizes, ratings for class of service indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information and as required for a complete installation. Where more than one type of component meets requirements, selection is Installer's option. Where type or material is not otherwise indicated comply with NFPA 78 and UL 96 standards.

RR. Comply with UL 96 and NFPA 780.

SS. Roof-Mounted Air Terminals: NFPA 780, Class copper unless otherwise indicated.

TT. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.

UU. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.

VV. Main and Bonding Conductors: Copper.

WW. Main Conductors: Copper cable; strand dia. 0.064"; 0.095#/ft.; 98,600 circular mils.

XX. Secondary Conductors: Copper cable; strand dia. 0.064"; 10 strands.

YY. Ground Rods: Copper-clad steel, 3/4 inch in diameter by 10 feet long.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install lightning protection systems as indicated in accordance with equipment manufacturer's written instructions, in compliance with applicable requirements of NFPA 70, NFPA 780, UL96A and with UL's lightning protection standards to ensure that lightning protection systems comply with requirements.

B. Coordinate with other work, including electrical wiring and roofing work as necessary to interface installation of lightning protection system with other work.

C. Install conductors with direct paths from air terminals to ground connections avoiding sharp bends and narrow loops.

D. Install arrestors as close as practical to equipment they are protecting. Install appropriate unit at main electrical service entrance equipment.

E. Install lightning protection components and systems according to UL 96A and NFPA 780.

F. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

G. Conceal the following conductors:

H. System conductors.

I. Down conductors.

J. Interior conductors.

K. Conductors within normal view of exterior locations at grade within 200 feet of building.

L. All down-leads shall be concealed within walls and foundations to below grade. Coordinate with other trades as required to sequence installation to avoid coring, cutting, patching, etc.

M. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

N. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

O. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

P. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

Q. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

R. Grounding:

S. Provide dedicated ground rods at down conductors.

T. Bond ground rods to the ground loop at each down conductor.

U. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

V. Bury ground ring not less than 24 inches from building foundation.

W. Bond ground terminals to the ground loop.

X. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

3.4 TESTING

A. Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by driving additional

ground rods. Provide to the Owner and the Engineer a certificate of compliance upon completion of testing.

END OF SECTION 264113

DIVISION 26 - ELECTRICAL

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section includes integral panelboard mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. The Contractor shall provide the necessary labor, materials, wiring and services necessary to provide the complete electrical surge protection systems as specified herein.

C. Provision of Surge Suppression Units at certain points in the power distribution network and on telephone and television service lines.

D. Proper installation of surge suppression unit(s), in accord with shop drawings. Wiring routing, grounding and all connections shall be in exact accord with manufacturer's recommendations.

1.3 DEFINITIONS

A. MCOV: Maximum continuous operating voltage.

B. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

C. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

D. OCPD: Overcurrent protective device.

E. SCCR: Short-circuit current rating.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data, for each type of product, on surge protection systems and components as part of shop drawing submissions. Indicate all

capacity ratings, clamp times, maximum capacities, physical construction and listing agency approvals. Submittals shall include UL 1449, 3rd Edition Listing documentation verifying:

1. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.
2. Short Circuit Current Rating (SCCR).
3. Voltage Protection Ratings (VPRs) for all modes.
4. Maximum Continuous Operating Voltage rating (MCOV). The MCOV shall be a tested value per UL1449 3rd Edition, section 37.7.3. MCOV values bases solely on the components used in the construction of the SPD will not be accepted.
5. I-nominal rating (I-n).
6. Type 1 or Type 2 Device Listing.
7. Manufacturer shall provide written test report showing the SPD can survive a single surge at its rated value without the use of circuit breakers or fuses.
8. kA rating per phase.
9. kA rating per mode.

B. Submittals shall also include the following:

1. Line drawings detailing dimensions and weight of enclosure.
2. Listing and rating of all modes of protection in each type of SPD required.
3. Breaker sizes used for SPD service disconnects.
4. Wiring diagram showing all manufacturer installed wiring including wire size, type, routing, and exact length of conductors.
5. Listing of equipment where each type of SPD is installed.

C. Maintenance Data: Submit maintenance instructions for surge suppression system. Include this data in Operation and Maintenance manuals.

1.5 QUALITY ASSURANCE

A. STANDARDS – Most Recent Edition of

1. Underwriters Laboratories: UL1449, 3RD Edition
2. ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002
3. National Electrical Code: Article 285

B. Manufacturer shall be regularly engaged in production of surge protection equipment of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than three years.

C. LISTING REQUIRMENTS: Comply with NEC and NFPA requirements, as applicable to materials and installation of surge protection components and wiring. Surge protection equipment shall be UL listed and labeled for its intended use. “Manufactured in accordance with” is not equivalent to UL listing and does not meet the intent of this specification. Where applicable, equipment shall comply with ANSI standards for such equipment. All equipment shall be tested per IEEE testing standards listed in this section.

D. SPECIAL NOTE: The physical routing, length, and connections of the unit's phase, neutral and ground conductors are critical to the performance of surge suppression units. All wiring shall be installed by the manufacturer prior to shipping equipment and shall not exceed three feet of length.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: All surge suppression equipment shall be unconditionally warranted by the Contractor for a period of ten (10) years from the date of substantial completion. If longer manufacturer's warranties are offered, they shall be made available to the Owner. Note these extended warranties in the Operations and Maintenance Manuals.

B. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

A. MANUFACTURERS: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens

2.2 BUILDING ELECTRICAL SERVICE SURGE PROTECTION DEVICES

A. Provide UL listed and labeled lightning and transient surge protection devices (SPD's), installed where shown on the drawings and in accord with the manufacturer's recommendations. The surge protection devices shall be shunt type and poly-phase, with the ability to conduct high energy transients from line to neutral and neutral to ground.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchgear short-circuit rating.

C. Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.

D. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.

E. Internal Device Overcurrent Protection (Fusing): All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I^2T capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated I^2T characteristic of the fusing is exceeded, the fusing shall be capable of opening in less

than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200kA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored, to provide indication of suppression failure. Conductor level fuses or circuit breakers internal or external to the surge suppression units are not acceptable as meeting this requirement.

F. SPD shall be UL labeled as Type 1 or Type 2, intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls.

G. Each MOV shall be individually fuse-protected to avoid cascading faults. This shall be certified by Manufacturers letter of compliance.

H. SPD shall be UL labeled with 20kA nominal (I-n) (verifiable at UL.com) for compliance with UL 96A Lightning Protection Master Label and NFPA 780.

I. SPD shall provide surge current paths for all modes of protection: L-L, L-N, L-G, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.

J. UL 1449, 3rd Edition Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	700V	700V	1200V	700V
480Y/277	1200V	1200V	1800V	1200V

Note : Numerically lower values are allowed/preferred; out-dated Suppressed Voltage Ratings (SVRs) shall not be submitted.

K. UL 1449, 3rd Edition Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

L. Units shall be provided integral to panelboards, distribution panelboards and switchboard.

M. For each SPD, provide unit function status indicators. These indicators may be mounted in the face of the equipment panel or remotely, immediately adjacent to the panel. Provide minimum one green L.E.D. per phase illuminated for normal operation, red L.E.D. for trouble/fault or reduction of surge suppression capacity.

N. Proposed substitutions for the manufacturer's model numbers listed here shall meet or exceed the current published performance data for the units listed, and shall be submitted to the Engineer ten working days prior to bid for review.

2.3 MAIN SERVICE SWITCHBOARD SURGE SUPPRESSION

A. Main service entrance switchboard units shall be installed as indicated on the contract documents and shall be heavy duty type. All units shall be 3 phase, 4 wire and shall have the following surge current capability (single pulse rated): Line to Neutral 300,000 amperes; Line to Ground 300,000 amperes; Line to Line 300,000 amperes; and Neutral to Ground 300,000 amperes. Per phase surge current rating shall be 600kA minimum. All MOV's shall be individually fused. The unit shall have a NEMA designed

and certified safety interlocked integral disconnect switch with an externally mounted manual operator.

B. Provide an audible alarm with silence switch to alarm at unit on malfunction. Provide a surge counter for each unit to indicate each suppression operation of the unit. Provide with self-diagnostic test function.

C. Provide integral fused disconnecting means for each surge protection device. Integral disconnect shall be able to withstand the single surge rating of the SPD.

D. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental over-current controls.

2.4 PANELBOARD SURGE SUPPRESSION

A. Branch and distribution panelboard units shall be installed as indicated on the contract documents and shall be as manufactured by distribution equipment manufacturer. All units shall be 3 phase, 4 wire and shall have the following surge current capability (single pulse rated): Line to Neutral 100,000 amperes; Line to Ground 100,000 amperes; Line to Line 100,000 amperes; and Neutral to Ground 100,000 amperes. Per phase surge current rating shall be 200kA minimum. All MOV's shall be individually fused.

B. Provide 60A circuit breaker in panel being protected for unit disconnecting means. Utilize #3 AWG wire for connection to panelboard. Maximum wire length is three feet.

C. SPD shall be UL labeled as Type 1 or Type 2.

D. Provide a surge counter for each unit to indicate each suppression operation of the unit. Provide with self-diagnostic test function.

2.5 TELEPHONE AND TELEVISION SURGE SUPPRESSION

A. As a part of this section of work, the Contractor shall provide U.L. listed lightning and surge arrestors on the incoming telephone, video, and television service lines.

B. Arrestors shall be U.L. listed, properly grounded per N.E.C., and shall be located at the service entrance points for each cable. Also provide surge arrestors of the proper type for copper cables that are installed between buildings by the Contractor.

C. Arrestors for telephone lines shall be RJ-45 in/out, complete with RJ-45 jumpers as needed. Provide quantity as required, connecting one to each phone line. Provide two spare units to Owner for future use.

D. Arrestors for coaxial lines shall be 25 to 250 MHZ on cable T.V. lines (with BNC jacks in/out or as required by antenna connectors).

E. Provide a ground lug for individual surge suppression unit installations, with the recommended ground wire size routed back to the building main electrical ground.

F. Where multiple surge suppression units are installed, as at service entrance locations, provide a ground bar, copper with multiple tapped holes and a properly sized ground lead routed back to the building main electrical ground.

2.6 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

2.7 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs as indicated and in accordance with equipment manufacturer's written instructions, in compliance with applicable requirements of NFPA, local prevailing codes and with UL lightning and power surge protection standards to ensure that surge suppression systems comply with requirements.

D. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

E. Use crimped connectors and splices only. Wire nuts are unacceptable.

F. Wiring: Power Wiring: Comply with wiring methods in Section 260519.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

DIVISION 26 - ELECTRICAL

SECTION 265113 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Interior Luminaires
2. Building Mounted Exterior Luminaires
3. Exit Signs
4. Lamps, Ballasts and Drivers
5. Luminaire Supports and Accessories

1.3 DESCRIPTION OF WORK

A. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all luminaries, including power wiring, control wiring and accessories, in accordance with the contract documents.

B. Contractor shall coordinate with Vendors and other trades, in advance of installation work, to define all infrastructure and installation requirements. Contractor shall coordinate all infrastructure requirements with all approved lighting equipment prior to infrastructure installation. This includes, but not limited to, appropriately sized, positioned, and located junction boxes, structural supports, feeds, power conduits and control conduits, and remote code-compliant power-supply enclosures.

C. Contractor shall provide all luminaires, as herein specified, complete with lamps, drivers, power supplies, ballasts and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

D. All luminaires, items, equipment and parts furnished and specified herein shall bear the “UL Approved” label (or other NRTL label) to indicate compliance with UL requirements. All luminaires shall be manufactured in strict accordance with the appropriate and current requirements of the National Electrical Code as verified by Underwriters Laboratories, Inc. (UL), or tested to UL standards by other nationally recognized testing laboratory (NRTL) as acceptable to Building Officials and Code

Administrators International (BOCAI); the International Conference of Building Officials (ICBO); or other relevant code authority recognized by the local jurisdiction within which the project is being constructed. Such a listing shall be provided for each luminaire type, and the appropriate label or labels shall be affixed to each luminaire in a location as required by code or law. All luminaires shall be UL/NRTL listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations, as required.

E. All available finishes and colors, for each luminaire, shall be submitted to the Architect for selection during shop drawing review. Premium finishes shall be provided at no additional cost premium.

F. Specifications and drawings are intended to convey all salient features, functions and characteristics of the luminaires only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper execution and completion of the luminaries, shall be included, the same as if they were herein specified or indicated on the drawings.

G. The Owner, Architect and Engineer shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the light fixtures. The responsibility of accurately fabricating the light fixtures to the fulfillment of the specification rests with the Contractor.

H. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an un-switched power line and wired in accord with applicable codes and the manufacturer's recommendations.

I. Refer to architectural details as applicable for recessed soffitt fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

J. Pre-manufactured flexible wiring systems are not permitted for this project.

K. In accordance with the above and the criteria established herein, the Contractor is responsible for assuring the final design, fabrication and installation which fulfills the requirements of the Contract Documents.

1.4 CODES: Materials and installations shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State and local codes and regulations.

1.5 REFERENCE STANDARDS: The publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. The publications may be referred to in the text by the basic designation only.

A. Any references in this specification to lighting mounted in, on, or to the exterior of the building or site are additionally governed by Specification Section 265619 EXTERIOR LIGHTING.

B. American National Standards Institute (ANSI):

1. ANSI C62.41 - Recommended Practice in Low Power Circuits

2. ANSI C78 Series - Physical and Electrical Characteristics of High-Intensity Discharge Lamps
3. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
4. ANSI C81 Series - Electric Lamp Bases and Holders
5. ANSI C82.77 - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
6. ANSI E1.20 - Remote Device Management Over DMX512 Networks
7. ANSI/IES RP-16-10 - Nomenclature and Definitions for Illuminating Engineering

C. Certified Ballast Manufacturers Association (CBM): Requirements for Ballast Certification.

D. Federal Communications Commission (FCC):

1. Code of Federal Regulations (CFR), Title 47, Part 18
2. Part 15 Class B: Radio Frequency Devices, Commercial Rated

E. Entertainment Services and Technology Association: ESTA E1.3 - Entertainment Technology - Lighting Control System - 0 to 10V Analog Control Protocol

F. International Electrotechnical Commission (IEC):

1. IEC 61000-3-2 - Harmonic Current Emissions
2. IEC 61347-1 - General and Safety Requirements for Lamp Control Gear
3. IEC 61347-2-13 - Particular Requirements for Electronic Control Gear for LED Modules
4. IEC 61547 - EMC Immunity Requirements
5. IEC 62384 - DC and AC Supplied Electronic Control Gear for LED Modules - Performance Requirements
6. IEC 62386-101 - Digital Addressable Lighting Interface - Part 101: General Requirements – System
7. IEC 62386-102 - Digital Addressable Lighting Interface - Part 102: General Requirements - Control Gear
8. IEC 62386-207 - Digital Addressable Lighting Interface - Part 207: Particular Requirements for Control Gear - LED Modules (device type 6)

G. Illuminating Engineering Society of North America (IESNA):

1. IES HB-10, IES Lighting Handbook – Tenth Edition
2. IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products, LM-79-08.
3. IES Approved Method for Measuring Lumen Maintenance of LED Light Sources, LM-80-08.
4. IES Approved Method for the Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature, LM-82.
5. IES Projecting Long Term Lumen Maintenance of LED Light Sources, TM-21.
6. IES ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information, LM-63.

H. Institute of Electrical and Electronic Engineers (IEEE): C62.41-91 - Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

I. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC), National Fire Protection Association
2. NFPA 101 - Life Safety Code, National Fire Protection Association

J. National Electrical Manufacturer's Association (NEMA):

1. NEMA FA1, - Outdoor Flood Lighting Equipment
2. NEMA SH5, - Tubular Steel, Aluminum and Prestressed Concrete Roadway Lighting Poles
3. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays, or Systems
4. NEMA SSL3- High-Power White LED Binning for General Illumination
5. NEMA SSL7A - Phase Cut Dimming for Solid State Lighting: Basic Compatibility
6. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronics
7. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

K. OSHA 29CFR1910.7 – Luminaires shall be listed by National Recognized Testing Laboratory Approved by United States Department of Labor.

L. Underwriters Laboratories, Inc. (UL):

1. Underwriters Laboratories (UL) Standards
2. Underwriters Laboratories (UL) Standard for Class 2 Power Units
3. Underwriters Laboratories Safety Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750
4. UL 1310 - UL Standard for Safety Class 2 Power Units
5. UL 1598 - Luminaries
6. UL 924 - Standard for Emergency Lighting and Power Equipment

1.6 ACRONYMS AND DEFINITIONS

A. CCT: Correlated color temperature

B. CRI: Color-rendering index. A measure of the degree of color shift that objects undergo when illuminated by a lamp, compared with those same objects when illuminated by a reference source of comparable correlated color temperature (CCT)

C. CU: Coefficient of utilization

D. IECC: International Energy Conservation Code

E. LER: Luminaire efficacy rating, which is calculated according to NEMA LE 5.

F. Lumen: Delivered output of luminaire.

G. Light Fixture (Luminaire): Complete lighting unit consisting of a lamp(s) and driver(s)/ballast(s) (when applicable) together with the parts designed to distribute the light, to position and protect the lamp(s), and to connect the lamps to the power supply.

H. NRTL: Nationally Recognized Testing Laboratory

I. SPD: Surge Protection Device

J. RCR: Room cavity ratio.

K. UL: Underwriters Laboratory

L. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

M. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.7 EQUAL MANUFACTURERS

A. Manufacturers listed as “Equal” to the Basis of Design on the light fixture schedule shall submit product cutsheets to the Engineer ten (10) days prior to bid for final written approval. This written approval will only be issued in addendum form. “Equal” fixtures shall be of equal or better quality and performance to the fixture(s) listed with manufacturer’s model numbers. Burden of proof shall be on the Contractor, Vendor and manufacturer.

B. Upon request by Engineer, the Contractor shall submit manufacturer’s computerized horizontal illumination levels using AGI32 software in footcandles at workplane (30" above finished floor), taken every 3 feet in every room and area. Include average maintained footcandle levels and maximum and minimum ratio.

1.8 SUBMITTALS

A. Submittal data shall be in accordance with Division 01 SUBMITTAL Specification Section, IECC and as specified herein.

B. Eight (8) copies of light fixture factory shop drawings and cuts, showing fixture dimensions, photometric data and installation data shall be submitted to the Engineer for review 15 days after project award date. (Verify shop drawing quantities with the Architect.)

C. Data, drawings and reports shall employ the terminology, classifications and methods prescribed by IESNA HB-10, as applicable, for the lighting system specified.

D. When catalog data and/or shop drawings for luminaires are submitted for approval, photometric data from an independent testing laboratory or one participating in the NIST National Voluntary Laboratory Accreditation Program (NVLAP) shall be included with the submittal, indicating average brightness and efficiency of the luminaire specified in specification or as shown on the drawings. Coefficient of utilization data is unacceptable.

E. Product data lacking sufficient detail to indicate compliance with contract documents will be rejected.

F. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. All available finishes and colors for each luminaire type shall be submitted to the Architect for selection during review.
4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for light fixtures.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
6. Distribution data according to IESNA classification type as defined in IESNA HB-10.
7. Amount of shielding on luminaires.

1.9 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and NEMA unless more stringent requirements are specified or indicated.

D. Where groups of luminaire types exhibit the same list of acceptable Manufacturers, such as downlights, accents, and wall washers, the intent is to have a final installation with the same Manufacturer’s equipment across the groupings as specified for consistency of optics, aesthetics, and similarity of maintenance procedures. Mixing/matching across groups is unacceptable. This also applies to multi-phased projects with single or multiple, but related luminaire types exhibiting the same list of acceptable Manufacturers, except where products have subsequently been discontinued or significantly redesigned in size, appearance, lamping, or gear.

1.10 COORDINATION: Coordinate layout and installation of lighting fixtures with all other construction that penetrates ceilings or is supported by them, including HVAC equipment, plumbing, fire-suppression system and partition assemblies. Refer to Architects reflected ceiling plan (RCP) for locations of all ceiling devices.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING: The Contractor shall provide, receive, unload, uncrate, store, protect and install lamps, luminaires and auxiliary equipment, as specified herein, in accordance with respective manufacturers' project conditions of temperature and humidity and with appropriate protection against dust and dirt. Lamps for miscellaneous equipment shall be provided and installed by the Contractor according to equipment manufacturers’ guidelines. All products shall be stored in manufacturer's unopened packaging until ready for installation.

1.12 EXTRA MATERIALS

A. Furnish the following extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing content:

1. Single Sided Exit Sign: Furnish at least five (5) of each type.
2. Double Sided Exit Sign: Furnish at least five (5) of each type.
3. LED Drivers: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.
4. LED Lamps/Boards: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.

1.13 WARRANTIES

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order

to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All luminaries, finishes, poles and all of its component parts, and controls shall have an unconditional five (5) year warranty. Warranty shall include all light fixtures, lamps, drivers, poles, finishes and all components to be free from defects in materials and workmanship for a period of five (5) years from date of Owner's acceptance. Replacement of luminaries, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. LED drivers: The warranty period shall not be less than ten (10) years from the date of substantial completion. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

PART 2 - PRODUCTS:

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide one of the approved products indicated on the Light Fixture Schedule.

B. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of Design for each light fixture type shall be the first fixture manufacturer and model number for each type listed. Refer to Specification Section 260500, paragraph EQUAL MANUFACTURERS for additional requirements.

C. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

D. All luminaires shall be DLC (Design Lights Consortium) Certified.

E. The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous environment requirements of this project. Calculations (with AGi32 or other such software) are generally performed to determine luminances, luminance ratios, and horizontal and vertical illuminances and respective ratios and to assess glare and reflected glare. In some instances, virtual reality "images" have been generated (with AGi32 or other such software) to assist the Lighting Designer, the Architect and/or the Owner in assessing the lighting quality of the space(s). Equipment and/or manufacturers which have been shown to comply with established criteria, including ASHRAE/IES 90.1 and IES guidelines and normal-power lighting requirements as applicable by ordinance, code, Federal law, mandate, or directive,

and/or intended LEED certification or other building-rating system, and other lighting standards as deemed appropriate for this specific project is specified herein.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Comply with the requirements specified in the Articles below and the Light Fixture Schedule.

B. Complete luminaires shall be in accordance with NFPA 70, NEMA, and UL 1598 listed and labeled.

C. Provide luminaires complete with lamps of number, type, and wattage indicated.

D. Ballasts, drivers, or transformers, unless otherwise specificied, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

E. Unless otherwise specified, a dedicated means of connecting light source to power shall be used in all luminaires unless otherwise specified and shall meet all UL requirements. LED modules shall be field replaceable.

F. Recessed fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

G. Luminaires shall be entirely factory wired by the luminaire manufacturer in accordance with code and UL requirements and shall be furnished fully compatible with the project electrical wiring and controls system for smooth, continuous, dimming or on/off flicker-free operation.

H. Provide in-line fuse-holders with fuses sized per manufacturer's recommendation for each fixture.

I. Exterior building mounted light fixtures shall be UL classified for damp or wet locations as applicable and shall be complete with gaskets, cast aluminum outlet box and grounding. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

J. Provide all luminaires with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor and ground accordingly upon installation.

K. All luminaires shall be provided with a ground wire and grounded accordingly upon installation.

L. All luminaires supplied for recessing in suspended ceilings shall be supplied with pre-wired junction boxes, unless otherwise specified.

M. Provide "maximum wattage label" on all light fixture based on the specified maximum wattage indicated on the light fixture schedule.

N. Metal parts: Free of burrs, sharp corners and sharp edges.

O. Doors, frames and other internal access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers and other components from falling accidently during maintenance and when secured during operating position.

P. Mounting Frames and Rings: If ceiling system and luminaire type requires, each recessed and semi-recessed luminaire shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed as coordinated by Contractor. The frames and rings shall be one piece and of sufficient size and strength to sustain the weight of the luminaire and maintain plumb.

Q. Pendant Supports: Contractor shall be responsible for coordination with Manufacturer, Architect, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within ceilings to support pendant mounted lighting equipment for a secure, neat, square, plumb appearance. Pendants shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

R. Wall Bracket (Sconce) Supports: Contractor shall be responsible for coordination with Manufacturer, Architect, Structural Engineer and related trades to ensure that proper and adequate structural reinforcement is provided within walls to support wall mounted lighting equipment for a secure, neat, square, plumb appearance. Wall brackets shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

S. All lenses or other light diffusing elements shall be removable for access to lamp and electrical and electronic components and luminaire cleaning, however, they must otherwise be positively and securely held in-place, unless otherwise specified.

T. There shall be no light leaks between the lens and the lens frame. All lens door or holder trim flanges shall fit plumb and flush with the ceiling or wall surface. There shall be no light leaks around the interface between lens door or holder trim flanges and the ceiling or wall.

U. Ballasts, drivers, or transformers, unless otherwise specificied, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

V. Unless otherwise specified, a dedicated means of connecting light source to power shall be used in all luminaires unless otherwise specified and shall meet all UL requirements. LED modules shall be field replaceable.

W. Recessed luminaires mounted in an insulated ceiling shall be listed for use in insulated ceilings or provisions made to maintain code-compliant air-space around luminaires in accordance with Vendors' instructions.

X. Unless otherwise specified, luminaire closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

Y. Unless otherwise specified, luminaires with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vapor tight luminaires shall have pressure clamping devices in lieu of the latches.

Z. Yokes, brackets and supplementary supporting members necessary for mounting lighting equipment shall be furnished and installed by the Contractor and approved by the Architect. All materials, accessories, and any other equipment necessary for the

complete and proper installation of luminaires, lamps, ballasts/neon transformers included in the contract shall be furnished and installed by the Contractor. All yokes, brackets and supplementary supports shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with all lamps, globes, lenses, lens frames or doors etc. in place.

AA. All connections shall be fixed rigid by screws, rivets and/or soldering. Screws and rivets shall not be visible except as necessary for maintenance and/or aesthetic appearance. Soldering shall be ground smooth to a clean, contiguous surface. All connections shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

BB. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal and the luminaire styling. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.

CC. For steel and aluminum luminaires, all screws, bolts, nuts and other fastening and latching hardware shall be a cadmium or equivalent plated. For stainless steel luminaires, all hardware shall be stainless steel. For all bronze luminaires, all hardware shall be bronze.

DD. Extruded aluminum frames and trims shall be rigid and manufactured from quality aluminum without blemishes in the installed product. Miter cuts shall be accurate; joints shall be flush and without burrs and cut alignment maintained with the luminaire located in its final position.

EE. Outdoor Luminaires: Luminaires shall be suitably gasketed and vented according to manufacturer's instructions. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

FF. Luminaires in Hazardous Areas: Luminaires shall be suitable for installation in flammable atmospheres (Class and Group) as defined in NFPA 70 and shall comply with UL 844.

GG. Product procurement and coordination: Contractor shall:

1. Order products according to application
2. Confirm the proper and complete catalog number with distributor and agent.
3. Ensure wiring, driver, etc meets the specifications and proper requirements.
4. Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.

HH. Each light fixture shall be packaged with complete instructions and illustrations on how to install.

II. Each light fixture box, container, etc shall be labeled at the factory with the type designation as indicated on the Light Fixture Schedule.

2.3 LUMINAIRE REFLECTORS AND TRIMS

A. Alzak cones, reflectors, baffles and louvers shall be warranted against discoloration.

B. All cones, reflectors, baffles and louvers shall be removable for lamp access and luminaire cleaning; however, they must otherwise be positively and securely held in-place.

C. All trims, reflectors and canopies shall fit snugly and securely to the ceiling or wall so that no light leak occurs.

D. Trims shall be self-flanged and white, unless otherwise specified.

E. For trimless or flangeless luminaires, Contractor shall coordinate with other Trades to achieve a trimless/flangeless installation acceptable to the Architect. Where ceilings are drywall or plaster, this involves Level 5 finishes or as otherwise directed by the Architect. In drywall, plaster, wood, or stone ceilings, special luminaire collars and exacting coordination are required of Contractor.

2.4 LIGHT EMITTING DIODE (LED) ELECTRONIC DRIVERS: The electronic driver shall at a minimum meet the following characteristics:

A. LED drivers shall comply with NEMA SSL 1, NFPA 70, and UL 8750 unless otherwise specified.

B. All LED luminaires shall use drivers integral to luminaires or as otherwise required by the luminaire manufacturer.

C. Driver shall comply with UL 1310 Class 2 requirements for dry and damp locations, NFPA 70 unless specified otherwise. Drives shall be designed for the wattage of the LEDs used in the indicated application. Drivers shall be designed to operate on the voltage system to which they are connected.

D. LED driver shall withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.

E. LED driver shall tolerate ±10 percent supply voltage fluctuation with no adverse effects to driver or LEDs.

F. LED driver forward voltage (Vf) shall be matched to LED board.

G. LED driver shall exhibit no visible change in light output with a variation of ±10 percent line voltage input.

H. Drivers for luminaires controlled by dimming devices shall be as specified herein and equipped for dimming and conform to the recommendations of the manufacturer of the associated dimming devices to assure satisfactory operation of the lighting system. Contractor shall coordinate all wiring infrastructure to accommodate final-selected drivers and controls systems for smooth, continuous, and flicker-free operation.

I. Flicker: The flicker shall be less than 5 percent at all frequencies below 1000 Hz and without visible flicker. Drivers shall meet or exceed NEMA 410 driver inrush standard.

J. Power factor shall be 0.95 (minimum).

K. Class A Sound Rating.

L. Current crest Factor of 1.5 or less.

M. LED driver total harmonic distortion (THD) shall be less than 20 percent for drivers unless otherwise specified. For dimming drivers, THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

N. All LED luminaires shall be fused on the primary side of the driver as recommended by the respective luminaire manufacturers.

O. All LED drivers shall be suitably sized to accommodate the LED array consistent with industry standards, including IEC standard 60929 Annex E.

2.5 LIGHT EMITTING DIODE (LED): The light emitting diodes shall as a minimum meet the following characteristic:

A. LED modules shall be manufactured by Cree, GE, Philips, Osram, Niche, or Xicato.

B. LED lamps shall comply with ANSI C78.1.

C. Chromacity of LED lamps shall comply with ANSI C78.377A and NEMA SSL-3.

D. Light emitting diodes shall be tested under IES LM-80 standards.

E. Color Rendering Index (CRI) shall be 84 (minimum).

F. Color temperature of 3,500K, or as indicated on light fixture schedule.

G. Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).

H. Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

I. Provide light fixture types that the LED boards and drivers can be re-placed from the bottom and below ceiling. Trim for the exposed surface of flush-mounted fixtures shall be white or as indicated on light fixture schedule.

J. For color consistency, lamp maintenance consistency and for light output consistency, mixed lamps of the same lamp type from different manufacturers is unacceptable. Use the same brand and date code for all lamps except as otherwise specified. Contractor shall be responsible for coordinating all lamps and brand among all luminaire Vendor(s) and Contractor's respective distributor(s).

2.6 SUSPENDED LUMINAIRES

A. Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended fixtures shall have twin-stem hangers. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Rods shall be a minimum 0.18 inch diameter.

B. All suspended luminaires with a weight in excess of 150 pounds shall be fitted with safety cable of sufficient strength and length to meet all UL safety cable load-bearing requirements. Cable shall exhibit a finish (but not painted) compatible with that of the metal finish of the stem/chain/suspension-cable assembly or alternatively finished in black as approved by Architect. Shop drawings shall indicate luminaire weight. Contractor shall coordinate structural support/attachment requirements including independent structure for safety cable attachment with Vendor, Architect, and Structural Engineer and all respective trades. Safety cable shall exhibit sufficient length to wrap tightly and entirely around structural member at least twice before attachment subject to Vendor confirmation of UL requirements and pending Structural Engineer review. Contractor shall provide labor necessary for the stem/chain-assembly-wiring-threading and safety-cable-attachment as instructed by Vendor.

2.7 DOWNLIGHT FIXTURES AND COMPONENTS

A. Downlights shall be listed for thru-branch circuit wiring, recessing in ceilings and damp locations. Where installed in plaster or drywall or other inaccessible ceiling types, they shall be UL listed for bottom access.

B. Provide with tool-less hinged junction box access cover and thermal protection.

C. Provide telescoping channel bar hangers that adjust vertically and horizontally.

2.8 EXIT SIGNS

A. General requirements: UL 924, NFPA 70, AND NFPA 101. Exit signs shall use no more than 5 watts. Housing shall be made of die-cast aluminum. Provide stencil face and red lettering.

B. Provide single or double face as scheduled, indicated on plans or as required by the local Authority Having Jurisdiction. Adjust installation position if required for clear visibility, in accordance with applicable codes.

C. Provide directional arrows (chevrons) as indicated on floor plans and to suit the means of egress or as required by the local Authority Having Jurisdiction.

2.9 LUMINAIRE SUPPORT HANGERS AND COMPONENTS

A. Wires: ASTM A641/A641M, Class 3, soft temper, galvanized regular coating, 0.1055 inches in diameter (12 gage).

B. Straps: Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

C. Rod Hangers: Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.10 FUSING: All luminaires shall be fused.

2.11 QUIPMENT IDENTIFICATION

A. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

B. Factory-Applied Labels: Provide labeled luminaires in accordance with UL 1598 requirements. All light fixtures shall be clearly marked for operation of specific LED’s and drivers according to proper type. The following characteristics shall be noted in the format "Use Only _____":

1. LED or lamp type, and nominal wattage
2. Driver or ballast type
3. Correlated color temperature (CCT) and color rendering index (CRI)
4. All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Drivers and ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.12 FACTORY APPLIED FINISH: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Architect's reflected ceiling plan (RCP) shows actual locations of all light fixtures, diffusers and system devices. Report to the Architect/Engineer any conflicts. Do not scale plans for exact location of lighting fixtures.

B. Install luminaires in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", and NEMA standards.

C. Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.

D. Installed luminaires shall be provided with protective covering by Contractor until such time as the space(s) is cleaned and ready for occupancy.

E. Align, mount and level the luminaires uniformly. All luminaires shall be installed plumb/true and level as viewed from all directions. Luminaires shall remain plumb and true without continual adjustment.

F. The Contractor shall coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, pipes, steel, etc. Avoid interference with and provide clearance for equipment.

G. Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed.

H. Recessed and semi-recessed fixtures shall be independently supported from the buildings structure by a minimum of four wires per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires for lighting fixture support in this section. Lighting fixtures installed in suspended ceilings shall also comply with the requirements of Division 09 Specification Sections GYPSUM BOARD, ACOUSTICAL PANEL CEILINGS and SUSPENDED DECORATIVE WOOD GRIDS. Support lay-in ceiling light fixtures as follows:

1. Support fixtures with four (4) wires, with one (1) at each corner. Hanger wires shall be installed within 15 degrees of plumb or additional support shall be provided. Wires shall be attached to fixture body and to the building structure (not to the supports of other work or equipment).

2. Where building structure is located such that 15 degrees cannot be maintained, the Contractor shall provide “Uni-strut” or similar structure to meet this requirement.
3. Support Clips: All fixtures shall be furnished with hold down clips to meet applicable seismic codes. Provide four (4) clips per fixture minimum or the equivalent thereof in the installation trim. Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application. Contractor shall install clips per manufacturer’s requirements. If screws are required, they shall be provided.

I. Lighting Fixture Supports:

1. Shall provide support for all of the fixtures.
2. Shall maintain the fixture positions after cleaning and relamping.
3. Shall support the luminaires without causing the ceiling or partition to deflect
4. For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system.

J. Luminaires installed and used for working light during construction shall be replaced prior to turnover to the Owner if more than 3 percent of their rated life has been used. Fixtures shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer.

K. All lamps shall be seasoned for a minimum of 12 hours and a maximum of 100 hours in full-on mode without dimming prior any dimming and prior to turn-over to Owner. All lamps used for convenience lighting during construction for periods collective operation longer than 100 hours and any lamps which have failed/burned-out shall be replaced with identical new lamps, which shall then be seasoned as described above, immediately prior to the date of substantial completion as determined by the Architect.

L. Suspended fixtures shall hang plumb and shall be located with no obstructions within the 45 degree range in all directions. The stem, cable, canopy and fixture shall be capable of 45 degree swing. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown.

M. Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, a finishing ring painted to match the ceiling, shall be used to conceal the junction box.

N. Rigidly align continuous rows of light fixtures for true in-line appearance.

O. Exit Signs and Emergency Lighting Units: Wire exit signs ahead of the switch to the un-switched emergency lighting life-safety branch circuit located in the same room or area.

P. Light fixture whips shall be supported from the building structure. Do not clip to lay-in ceiling support wires.

Q. Exterior Fixtures:

1. Exterior building mounted light fixtures shall not be installed until after the building exterior has been rinsed clean of any corrosive cleaning materials. Damaged fixtures shall be replaced by the Contractor at no cost.
2. Provide exterior rated waterproof junction boxes for all fixtures and splices.
3. Utilize weatherproof silicone filled wire nuts and seal all junction boxes and conduit with potting compound to create waterproof barriers. Inspect all splices and fixtures for continuity prior to potting.
4. Lubricate all threaded parts with a high temperature waterproof anti-seize lubricant, including lamp bases and sockets, to prevent seizing and corrosion.
5. All low-voltage wiring to be UV resistant, UL approved for use without conduit, stranded low-voltage wire (Q-Wire by Q-Tran or equal) for use in outdoor and underground applications, gauge as appropriate to avoid voltage drop.
6. Track Lighting: The Electrical Contractor shall allow for all track lighting to be wired with individual home runs (not looped) so invisible feeds (no junction box at end of track) may be utilized.

R. Transformers (applies to all transformers including (but not limited to) low voltage, neon, remote ballast, LED power supplies, exterior locations):

1. Electrical Contractor to locate all transformers (including low voltage, neon, remote ballasts, led power supplies, etc.) near fixtures in a well-ventilated and accessible location. Transformers must be installed (per codes) in accessible areas large enough to dissipate the heat of the transformer. Temperatures should not exceed 100°F (38°C).
2. Transformers should be mounted as close to the load/feed lamp holders as practical to keep the secondary feeds as short as possible.
3. Electrical Contractor to determine wire size according to load and wire length to eliminate voltage drop. If voltage drop is a problem after installation, the Electrical Contractor is responsible for reinstallation (at no additional cost) of transformer and wire to solve problem.
4. Electrical Contractor to label front of transformer with load name and load location. For example: “Large Display Case @ Entry to Main Dining Room.”

S. Light fixture locations in mechanical and electrical equipment rooms/areas, as indicated on floor plans, are approximate. Locate light fixtures to avoid equipment, ductwork, and piping. Locate around and between equipment to maximize the available light. Coordinate mounting heights and locations of light fixtures to clear equipment. Request a meeting with the Engineer if uncertain about an installation. All suspended light fixtures shall be mounted square and plumb.

T. Contractor shall be responsible for sealing all luminaires for wet locations (i.e. all knock-outs, all pipe and wire entrances, etc.) to prevent water wicking.

U. Coordinate between the electrical and ceiling trades to ascertain that approved luminaires are furnished in the proper sizes, with the proper flange details, and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.

V. All reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.

W. Handle all reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting alzak cones and specular reflectors and other decorative elements with care during installation or lamping to avoid fingerprints or dirt deposits.

X. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags.

3.2 GROUNDING

A. Bond luminaires and metal accessories to the grounding system per National Electrical Code.

B. Ground noncurrent-carrying parts of equipment including luminaires, mounting arms, brackets, and metallic enclosures. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.3 IDENTIFICATION

A. Light fixtures served from multiple power sources, such as emergency fixtures fed from emergency transfer relay, shall have the following label affixed to it:

1. "DANGER - ELECTRICAL SHOCK HAZARD - LIGHT FIXTURE HAS MULTIPLE POWER SOURCES"

3.4 CLEANING

A. At completion of each phase and the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturer.

B. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

C. All fingerprints, dirt, tar, smudges, drywall mud and dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens/louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any.

3.5 TESTING AND ADJUSTMENT

A. The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

B. All adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Architect. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.

C. Contractor shall coordinate with Architect to establish the number of two-member crews required for aiming and adjusting. All aiming and adjusting shall be performed after the entire installation is complete for each phase or area. The Contractor shall be responsible for notifying the Architect of appropriate time for final luminaire adjustment.

D. All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

E. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.

3.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data in accordance with Division 01 Specification Section SUBMITTALS and OPERATION AND MAITENANCE, IECC and as specified herein, showing all light fixtures, control devices and all interconnecting control wire, conduit and associated hardware.

B. Contractor shall be responsible for obtaining from his supplying light fixture manufacturers, for each type of light fixture, a recommended maintenance manual including, tools required, types of cleaners to be used and replacement parts identification list.

C. Provide at least three (3) CDs/DVDs with high resolution PDF files of all equipment product data for Owner's use in equipment identification and maintenance with recommended maintenance manuals including, at a minimum:

1. Vendor and local representative's contact information
2. Tools required
3. Types of cleaners to be used
4. Replacement parts identification lists
5. Equipment product data (high-quality reproducible copies)
6. Warranty documentation

3.7 FIELD QUALITY CONTROL:

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

B. Dimming Drivers. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

D. Inspect each light fixture for damage. Replace damaged light fixtures at no cost to the Owner.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to four (4) visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265113

DIVISION 26 - ELECTRICAL

SECTION 265619 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Exterior Luminaires
2. Lamps, Ballasts and Drivers
3. Luminaire Poles, Supports and Accessories

1.3 DESCRIPTION OF WORK

A. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all luminaries, including power wiring, control wiring and accessories, in accordance with the contract documents.

B. Contractor shall coordinate with Vendors and other trades, in advance of installation work, to define all infrastructure and installation requirements. Contractor shall coordinate all infrastructure requirements with all approved lighting equipment prior to infrastructure installation. This includes, but not limited to, appropriately sized, positioned, and located junction boxes, structural supports, feeds, power conduits and control conduits, and remote code-compliant power-supply enclosures.

C. Contractor shall provide all luminaires, as herein specified, complete with lamps, drivers, power supplies, ballasts and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

D. All luminaires, items, equipment and parts furnished and specified herein shall bear the “UL Approved” label (or other NRTL label) to indicate compliance with UL requirements. All luminaires shall be manufactured in strict accordance with the appropriate and current requirements of the National Electrical Code as verified by Underwriters Laboratories, Inc. (UL), or tested to UL standards by other nationally recognized testing laboratory (NRTL) as acceptable to Building Officials and Code Administrators International (BOCAI); the International Conference of Building Officials (ICBO); or other relevant code authority recognized by the local jurisdiction within

which the project is being constructed. Such a listing shall be provided for each luminaire type, and the appropriate label or labels shall be affixed to each luminaire in a location as required by code or law. All luminaires shall be UL/NRTL listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations, as required.

E. All available finishes and colors, for each luminaire, shall be submitted to the Architect for selection during shop drawing review. Premium finishes shall be provided at no additional cost premium.

F. Specifications and drawings are intended to convey all salient features, functions and characteristics of the luminaires only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper execution and completion of the luminaries, shall be included, the same as if they were herein specified or indicated on the drawings.

G. The Owner, Architect and Engineer shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the light fixtures. The responsibility of accurately fabricating the light fixtures to the fulfillment of the specification rests with the Contractor.

H. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an un-switched power line and wired in accord with applicable codes and the manufacturer's recommendations.

I. Refer to architectural and civil details as applicable for recessed step fixtures, fixtures mounted in walkways or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades.

J. In accordance with the above and the criteria established herein, the Contractor is responsible for assuring the final design, fabrication and installation which fulfills the requirements of the Contract Documents.

1.4 CODES: Materials and installations shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State and local codes and regulations.

1.5 REFERENCE STANDARDS: The publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. The publications may be referred to in the text by the basic designation only.

A. Any references in this specification to lighting mounted in, on, or to the exterior of the building or site are additionally governed by Specification Section 265113 INTERIOR LIGHTING.

B. American Association Of State Highway And Transportation Officials (AASHTO)

1. AASHTO LTS-5 (2009; Errata 2009; Amendment 1 2010; Amendment 2 2011) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

C. American National Standards Institute (ANSI):

1. ANSI C62.41 - Recommended Practice in Low Power Circuits

2. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
3. ANSI C81 Series - Electric Lamp Bases and Holders
4. ANSI C82.77 - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
5. ANSI C136.21 (2004; R 2009) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
6. ANSI C136.3 (2005; R 2009) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments
7. ANSI E1.20 - Remote Device Management Over DMX512 Networks
8. ANSI/IES RP-16-10 - Nomenclature and Definitions for Illuminating Engineering

D. ASTM International (ASTM)

1. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
2. ASTM B108/B108M - Standard Specification for Aluminum-Alloy Permanent Mold Castings
3. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus

E. Certified Ballast Manufacturers Association (CBM): Requirements for Ballast Certification.

F. Federal Communications Commission (FCC):

1. Code of Federal Regulations (CFR), Title 47, Part 18
2. Part 15 Class B: Radio Frequency Devices, Commercial Rated

G. Entertainment Services and Technology Association: ESTA E1.3 - Entertainment Technology - Lighting Control System - 0 to 10V Analog Control Protocol

H. International Electrotechnical Commission (IEC):

1. IEC 61000-3-2 - Harmonic Current Emissions
2. IEC 61347-1 - General and Safety Requirements for Lamp Control Gear
3. IEC 61347-2-13 - Particular Requirements for Electronic Control Gear for LED Modules
4. IEC 61547 - EMC Immunity Requirements
5. IEC 62384 - DC and AC Supplied Electronic Control Gear for LED Modules - Performance Requirements
6. IEC 62386-101 - Digital Addressable Lighting Interface - Part 101: General Requirements – System
7. IEC 62386-102 - Digital Addressable Lighting Interface - Part 102: General Requirements - Control Gear
8. IEC 62386-207 - Digital Addressable Lighting Interface - Part 207: Particular Requirements for Control Gear - LED Modules (device type 6)

I. Illuminating Engineering Society of North America (IESNA):

1. IES HB-10, IES Lighting Handbook – Tenth Edition
2. IES RP-8 – Roadway Lighting
3. IES Approved Method for Life Performance Testing of General Lighting Incandescent Filament Lamps, LM-49.

4. IES Approved Method for Electrical and Photometric Measurements of General Service Incandescent Filament Lamps, LM-45.
5. IES Approved Method for Life Testing of High Intensity Discharge Lamps, LM-47.
6. IES Approved Method for Photometric Measurements of High Intensity Discharge Lamps, LM-51.
7. IES Approved Method for Photometric Testing of Indoor Luminaires Using High Intensity Discharge Lamps, LM-46.
8. IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products, LM-79.
9. IES Approved Method for Measuring Lumen Maintenance of LED Light Sources, LM-80.
10. IES Approved Method for the Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature, LM-82.
11. IES Projecting Long Term Lumen Maintenance of LED Light Sources, TM-21.

J. Institute of Electrical and Electronic Engineers (IEEE): C62.41-91 - Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

K. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC)
2. NFPA 101 - Life Safety Code

L. National Electrical Manufacturer's Association (NEMA):

1. NEMA FA1, - Outdoor Flood Lighting Equipment
2. NEMA SH5, - Tubular Steel, Aluminum and Prestressed Concrete Roadway Lighting Poles
3. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays, or Systems
4. NEMA SSL3- High-Power White LED Binning for General Illumination
5. NEMA SSL7A, - Phase Cut Dimming for Solid State Lighting: Basic Compatibility

M. NEMA 410, - Performance Testing for Lighting Controls and Switching Devices with Electronics

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

O. Underwriters Laboratories, Inc. (UL):

1. Underwriters Laboratories (UL) Standards
2. Underwriters Laboratories (UL) Standard for Class 2 Power Units
3. Underwriters Laboratories Safety Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750
4. UL 1310 - UL Standard for Safety Class 2 Power Units
5. UL 1598 - Luminaries
6. UL 924 - Standard for Emergency Lighting and Power Equipment

1.6 ACRONYMS AND DEFINITIONS

A. CCT: Correlated color temperature

B. CRI: Color Rendering Index. A measure of the degree of color shift that objects undergo when illuminated by a lamp, compared with those same objects when illuminated by a reference source of comparable correlated color temperature (CCT)

C. CU: Coefficient of Utilization

D. IECC: International Energy Conservation Code

E. LER: Luminaire efficacy rating, which is calculated according to NEMA LE 5.

F. Lumen: Delivered output of luminaire.

G. Light Fixture (Luminaire): Complete lighting unit consisting of a lamp(s) and driver(s)/ballast(s) (when applicable) together with the parts designed to distribute the light, to position and protect the lamp(s), and to connect the lamps to the power supply.

H. NRTL: Nationally Recognized Testing Laboratory

I. Pole: Luminaire support structure.

J. SPD: Surge Protection Device

K. RCR: Room Cavity Ratio

L. UL: Underwriters Laboratory

M. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

N. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

O. Pole: Luminaire support structure, including tower used for large area illumination.

P. Standard: Same definition as "Pole" above.

1.7 EQUAL MANUFACTURERS

A. Manufacturers listed as “Equal” to the Basis of Design on the light fixture schedule shall submit product cutsheets to the Engineer ten (10) days prior to bid for final written approval. This written approval will only be issued in addendum form. “Equal” fixtures shall be of equal or better quality and performance to the fixture(s) listed with manufacturer’s model numbers. Burden of proof shall be on the Contractor, Vendor and manufacturer.

B. Upon request, Contractor shall submit manufacturer’s computerized horizontal illumination levels using AGI32 software in footcandles, taken every ten (10) feet for the entire site. Include average maintained footcandle levels and maximum and minimum ratio.

1.8 SUBMITTALS

A. Submittal data shall be in accordance with Division 01 Submittal Specification Section, IECC and as specified herein.

B. Eight (8) copies of light fixture factory shop drawings and cuts, showing fixture dimensions, photometric data and installation data shall be submitted to the Engineer for review 15 days after project award date. (Verify shop drawing quantities with the Architect.)

C. Data, drawings and reports shall employ the terminology, classifications and methods prescribed by IESNA HB-10, as applicable, for the lighting system specified.

D. When catalog data and/or shop drawings for luminaires are submitted for approval, photometric data from an independent testing laboratory or one participating in the NIST National Voluntary Laboratory Accreditation Program (NVLAP) shall be included

with the submittal, indicating average brightness and efficiency of the luminaire specified in specification or as shown on the drawings.

E. Product data lacking sufficient detail to indicate compliance with contract documents will be rejected.

F. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture, including dimensions.
2. Emergency lighting units including battery and charger.
3. All available finishes and colors for each luminaire type shall be submitted to the Architect for selection during review.
4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for light fixtures.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
6. Dimensions, effective projected area (EPA), accessories, installation details and construction details.
7. Poles: Include dimensions, wind load determined in accordance with AASHTO, pole deflection, pole class, and other applicable information.
8. Distribution data according to IESNA classification type as defined in IESNA HB-10.
9. Amount of shielding on luminaires.

G. Shop Drawings: Including plans, elevations, sections, details, and attachment to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each filed connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

H. Pole and Support Component Certification Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-5 and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

1.9 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.10 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and NEMA unless more stringent requirements are specified or indicated.

D. Where groups of luminaire types exhibit the same list of acceptable Manufacturers, such as downlights, accents, and wallwashers, the intent is to have a final installation with the same Manufacturer’s equipment across the groupings as specified for consistency of optics, aesthetics, and similarity of maintenance procedures. Mixing/matching across groups is unacceptable. This also applies to multi-phased projects with single or multiple, but related luminaire types exhibiting the same list of acceptable Manufacturers, except where products have subsequently been discontinued or significantly redesigned in size, appearance, lamping, or gear.

E. Comply with IEEE C2, "National Electrical Safety Code."

F. Comply with NFPA 70.

1.11 COORDINATION: Coordinate layout and installation of lighting fixtures with all other construction including geothermal well field, sanitary, storm and domestic water.

1.12 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. The Contractor shall provide, receive, unload, uncrate, store, protect and install lamps, luminaires and auxiliary equipment, as specified herein, in accordance with respective manufacturers' project conditions of temperature and humidity and with appropriate protection against dust and dirt. Lamps for miscellaneous equipment shall be provided and installed by the Contractor according to equipment manufacturers’ guidelines. All products shall be stored in manufacturer's unopened packaging until ready for installation.

C. Luminaire Poles: Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Support poles to prevent distortion and arrange to provide free air circulation. Do not remove factory-applied pole wrappings until just before installing pole.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.13 EXTRA MATERIALS

A. Furnish the following extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing content:

1. LED Drivers: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.
2. LED Lamps/Boards: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.

1.14 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order

to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All luminaries, finishes, poles and all of its component parts, workmanship, and controls shall have an unconditional five (5) year on-site replacement warranty. Warranty shall include all light fixtures, lamps, drivers, poles, finishes and all components to be free from defects in materials and workmanship for a period of five (5) years from date of Owner's acceptance. On-site replacement includes transportation, removal, and installation of new products. Replacement of luminaries, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. LED drivers: The warranty period shall not be less than ten (10) years from the date of substantial completion. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

E. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
2. Warranty Period for Color Retention: Five years from date of Substantial Completion.
3. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide one of the approved products indicated on the Light Fixture Schedule.

B. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of Design for each light fixture type shall be the first fixture manufacturer and model number for each type listed. Refer to Specification Section 260500, paragraph EQUAL MANUFACTURERS for additional requirements.

C. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

D. All luminaires shall be DLC (Design Lights Consortium) Certified.

E. The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous environment requirements of this project. Calculations (with AGi32 or other such software) are generally performed to determine luminances, luminance ratios, and horizontal and vertical illuminances and respective ratios and to assess glare and reflected glare. In some instances, virtual reality "images" have been generated (with AGi32 or other such software) to assist the Lighting Designer, the Architect and/or the Owner in assessing the lighting quality of the space(s). Equipment and/or manufacturers which have been shown to comply with established criteria, including ASHRAE/IES 90.1 and IES guidelines and normal-power lighting requirements as applicable by ordinance, code, Federal law, mandate, or directive, and/or intended LEED certification or other building-rating system, and other lighting standards as deemed appropriate for this specific project is specified herein.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Comply with the requirements specified in the Articles below and the Light Fixture Schedule.

B. Complete luminaires shall be in accordance with NFPA 70, NEMA, and UL 1598 listed and labeled.

C. Provide luminaires complete with lamps of number, type, and wattage indicated.

D. Ballasts, drivers, or transformers, unless otherwise specificied, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

E. Unless otherwise specified, a dedicated means of connecting light source to power shall be used in all luminaires unless otherwise specified and shall meet all UL requirements. LED modules shall be field replaceable.

F. Luminaires shall be entirely factory wired by the luminaire manufacturer in accordance with code and UL requirements and shall be furnished fully compatible with the project electrical wiring and controls system for smooth, continuous, dimming or on/off flicker-free operation.

G. Provide in-line fuse-holders with fuses sized per manufacturer's recommendation for each fixture.

H. Exterior light fixtures shall be UL classified for wet location and shall be complete with gaskets and grounding. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

I. Provide all luminaires with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor and ground accordingly upon installation.

J. Doors, frames and other internal access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers and other components from falling accidently during maintenance and when secured during operating position.

K. All light fixtures shall be completely wired at the factory in accordance with applicable codes and UL.

L. Provide “maximum wattage label” on all light fixture based on the specified maximum wattage indicated on the light fixture schedule.

M. Metal parts: Free of burrs, sharp corners and sharp edges.

N. Unless otherwise specified, luminaire closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

O. Unless otherwise specified, luminaires with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vapor tight luminaires shall have pressure clamping devices in lieu of the latches.

P. Yokes, brackets and supplementary supporting members necessary for mounting lighting equipment shall be furnished and installed by the Contractor and approved by the Architect. All materials, accessories, and any other equipment necessary for the complete and proper installation of luminaires, lamps, ballasts/neon transformers included in the contract shall be furnished and installed by the Contractor. All yokes, brackets and supplementary supports shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with all lamps, globes, lenses, lens frames or doors etc. in place.

Q. All connections shall be fixed rigid by screws, rivets and/or soldering. Screws and rivets shall not be visible except as necessary for maintenance and/or aesthetic appearance. Soldering shall be ground smooth to a clean, contiguous surface. All connections shall provide a neat, square, plumb and level appearance, and shall not sag, droop, snake or otherwise appear out of plumb or alignment in finished installation with lamps, globes, lenses, lens frames or doors etc. in place.

R. All metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal and the luminaire styling. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.

S. For steel and aluminum luminaires, all screws, bolts, nuts and other fastening and latching hardware shall be a cadmium or equivalent plated. For stainless steel luminaires, all hardware shall be stainless steel. For all bronze luminaires, all hardware shall be bronze.

T. Extruded aluminum frames and trims shall be rigid and manufactured from quality aluminum without blemishes in the installed product. Miter cuts shall be accurate; joints shall be flush and without burrs and cut alignment maintained with the luminaire located in its final position.

U. Luminaires shall be suitably gasketed and vented according to manufacturer's instructions. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

V. Product procurement and coordination: Contractor shall:

1. Order products according to application
2. Confirm the proper and complete catalog number with distributor and agent.
3. Ensure wiring, driver, etc meets the specifications and proper requirements.
4. Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.

W. Each light fixture shall be packaged with complete instructions and illustrations on how to install.

X. Each light fixture box, container, etc shall be labeled at the factory with the type designation as indicated on the Light Fixture Schedule.

2.3 LUMINAIRE REFLECTORS AND TRIMS

A. Alzak cones, reflectors, baffles and louvers shall be warranted against discoloration.

B. All cones, reflectors, baffles and louvers shall be removable for lamp access and luminaire cleaning; however, they must otherwise be positively and securely held in-place.

2.4 LIGHT EMITTING DIODE (LED) ELECTRONIC DRIVERS: The electronic driver shall at a minimum meet the following characteristics:

A. LED drivers shall comply with NEMA SSL 1, NFPA 70, and UL 8750 unless otherwise specified.

B. All LED luminaires shall use drivers integral to luminaires or as otherwise required by the luminaire manufacturer.

C. Driver shall comply with UL 1310 Class 1 requirements for wet locations, NFPA 70 unless specified otherwise. Drives shall be designed for the wattage of the LEDs used in the indicated application. Drivers shall be designed to operate on the voltage system to which they are connected.

D. LED driver shall withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.

E. Operating temperature rating shall be between -40°F and 120°F.

F. Provide with integral 10kV surge suppression protection minimum. Surge protection shall be tested in accordance with IEEE/ANSI C62.41.2.

G. LED driver shall tolerate ±10 percent supply voltage fluctuation with no adverse effects to driver or LEDs.

H. LED driver forward voltage (Vf) shall be matched to LED board.

I. LED driver shall exhibit no visible change in light output with a variation of ±10 percent line voltage input.

J. Drivers for luminaires controlled by dimming devices shall be as specified herein and equipped for dimming and conform to the recommendations of the manufacturer of the associated dimming devices to assure satisfactory operation of the lighting system.

Contractor shall coordinate all wiring infrastructure to accommodate final-selected drivers and controls systems for smooth, continuous, and flicker-free operation.

K. Flicker: The flicker shall be less than 5 percent at all frequencies below 1000 Hz and without visible flicker. Drivers shall meet or exceed NEMA 410 driver inrush standard.

L. Power factor shall be 0.95 (minimum).

M. Class A Sound Rating.

N. Current crest Factor of 1.5 or less.

O. LED driver total harmonic distortion (THD) shall be less than 20 percent for drivers unless otherwise specified. For dimming drivers, THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

P. All LED luminaires shall be fused on the primary side of the driver as recommended by the respective luminaire manufacturers.

Q. All LED drivers shall be suitably sized to accommodate the LED array consistent with industry standards, including IEC standard 60929 Annex E.

2.5 LIGHT EMITTING DIODE (LED): The light emitting diodes shall as a minimum meet the following characteristic:

A. LED modules shall be manufactured by Cree, GE, Philips, Osram, Niche, or Xicato.

B. LED lamps shall comply with ANSI C78.1.

C. Chromacity of LED lamps shall comply with ANSI C78.377A and NEMA SSL-3.

D. Light emitting diodes shall be tested under IES LM-80 standards.

E. Color Rendering Index (CRI) shall be 84 (minimum).

F. Color temperature of 4,000K, or as indicated on light fixture schedule.

G. Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).

H. Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

I. For color consistency, lamp maintenance consistency and for light output consistency, mixed lamps of the same lamp type from different manufacturers is unacceptable. Use the same brand and date code for all lamps except as otherwise specified. Contractor shall be responsible for coordinating all lamps and brand among all luminaire Vendor(s) and Contractor’s respective distributor(s).

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.3 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.7 POLES

A. Provide poles designed for wind loading of 120 miles per hour determined in accordance with AASHTO LTS-5 while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be anchor-base type designed for use with underground supply conductors. Poles shall have oval-shaped handhole having a minimum clear opening of 2.5 by 5 inches. Handhole cover shall be secured by stainless steel captive screws. Metal poles shall have an internal grounding connection accessible from the handhole near the bottom of each pole. Scratched, stained, chipped, or dented poles shall not be installed.

2.8 STEEL POLES

A. Steel Poles: Provide square steel poles having a minimum 11-gage steel with minimum yield/strength of 48,000 psi and hot-dipped galvanized in accordance with ASTM A123/A123M factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Pole shall be anchor bolt mounted type. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening. Joint between shaft and base shall be welded. Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, and length. Base cover shall be cast 356-T6 aluminum alloy in accordance with ASTM B108/B108M.

B. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Square, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

2.9 ALUMINUM POLES

A. Aluminum Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall. Provide round aluminum poles manufactured of corrosion resistant aluminum alloys conforming to AASHTO LTS-5 for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3, 5) for cast alloys. Poles shall be seamless extruded or spun seamless type with minimum 0.188 inch wall thickness. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Tops of shafts shall be fitted with a round or tapered cover. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B108/B108M and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded. Base cover shall be cast 356-T6 aluminum alloy in accordance with ASTM B108/B108M. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel. Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

B. Poles: Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: Round, straight
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as luminaire.

2.10 BRACKETS AND SUPPORTS

A. ANSI C136.3, ANSI C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 1-1/4 inch secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

2.11 POLE FOUNDATIONS

A. Anchor bolts shall be steel rod having minimum yield strength of 50,000 psi and shall be galvanized in accordance with ASTM A153/A153M. Concrete shall be as specified in Division 03 Specification Section, CAST-IN-PLACE CONCRETE.

2.12 FUSING: All luminaires shall be fused. Fuse pole mounted fixtures at handhole.

2.13 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. Recessed, 12 inches above finished grade.
2. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, color to match pole, that when mounted results in NEMA 250, Type 4X enclosure.
3. With cord opening.
4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

2.14 EQUIPMENT IDENTIFICATION

A. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

B. Factory-Applied Labels: Provide labeled luminaires in accordance with UL 1598 requirements. All light fixtures shall be clearly marked for operation of specific LED’s

and drivers according to proper type. The following characteristics shall be noted in the format "Use Only _____":

1. LED or lamp type, and nominal wattage
2. Driver or ballast type
3. Correlated color temperature (CCT) and color rendering index (CRI)
4. All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Drivers and ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.15 FACTORY APPLIED FINISH: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install luminaires in accordance with luminaire manufacturer’s written instructions, applicable requirements of NEC, NECA’s “Standard of Installation”, and NEMA standards.

B. Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.

C. Do not scale plans for exact location of lighting fixtures.

D. Set luminaires plumb, square, and level in alignment with adjacent luminaires, and secure in accordance with manufacturers' directions and approved drawings.

E. Utilize weatherproof silicone filled wire nuts and seal all junction boxes and conduit with potting compound to create waterproof barriers. Inspect all splices and fixtures for continuity prior to potting.

F. Lubricate all threaded parts with a high temperature waterproof anti-seize lubricant, including lamp bases and sockets, to prevent seizing and corrosion.

3.2 POLE INSTALLATION

A. Poles: Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location. Install according to pole manufacturer's instructions. Alterations to poles after fabrication will void manufacturer's warranty and shall not be allowed

B. Excavation: Restrict excavation in size to that which will provide sufficient working space for installation of concrete forms. Should soil conditions at the bottom of the excavation be unsuitable as a foundation, as determined by the Architect, take the excavation down to firm soil and fill to required grade with concrete or satisfactory soil materials as directed. Perform excavations in a manner to prevent surface, subsurface, and ground water from flowing into the excavation. Use pumps or other dewatering

methods necessary to convey the water away from the excavation work below ground-water level.

C. Formwork: Construct forms of wood, plywood, steel, or other acceptable materials fabricated to conform to the configuration, line, and grade required. Reinforce formwork to prevent deformation while concrete is being placed and consolidated. Wet or coat formwork with a parting agent before placing concrete.

D. Concrete Pole Foundations: Set anchor bolts with exposed threaded ends vertically positioned in the concrete using a template supplied by pole manufacturer in accordance with the lighting standard manufacturer's recommendations. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

E. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

F. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet
3. Trees: 15 feet from tree trunk.

G. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

H. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Dig holes large enough to permit use of tampers in the full depth of hole.
2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

I. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

J. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch wide, unpaved gap between the pole or pole foundation and the edge of

adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

K. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Bond luminaires and metal accessories to the grounding system per National Electrical Code.

B. Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

C. At each pole and light bollard, provide a driven ground rod into the earth so that after the installation is complete, the top of the ground rod will be approximately 1 foot below finished grade.

D. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems.

1. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
2. Install grounding electrode for each pole unless otherwise indicated.

E. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.
4.

3.7 IDENTIFICATION

A. Light fixtures served from multiple power sources, such as emergency fixtures fed from emergency transfer relay, shall have the following label affixed to it:

1. “DANGER - ELECTRICAL SHOCK HAZARD - LIGHT FIXTURE HAS MULTIPLE POWER SOURCES”

3.8 CLEANING

A. At completion of each phase and the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturer.

B. Any lens, louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

C. All fingerprints, dirt, tar, smudges, mud, dust, etc. shall be removed by the Contractor from the luminaire bodies, poles, reflectors, trims, and lens/louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any.

3.9 TESTING AND ADJUSTMENT

A. The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

B. All adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Architect. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.

C. Contractor shall coordinate with Architect to establish the number of two-member crews required for aiming and adjusting. All aiming and adjusting shall be performed after the entire installation is complete for each phase or area. The Contractor shall be responsible for notifying the Architect of appropriate time for final luminaire adjustment.

D. All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

E. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.

3.10 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data in accordance with Division 01 Specification Section, IECC and as specified herein, showing all light fixtures, control devices and all interconnecting control wire, conduit and associated hardware.

B. Contractor shall be responsible for obtaining from his supplying light fixture manufacturers, for each type of light fixture, a recommended maintenance manual including, tools required, types of cleaners to be used and replacement parts identification list.

C. Provide at least three (3) CDs/DVDs with high resolution PDF files of all equipment product data for Owner’s use in equipment identification and maintenance with recommended maintenance manuals including, at a minimum:

1. Vendor and local representative’s contact information
2. Tools required

3. Types of cleaners to be used
4. Replacement parts identification lists
5. Equipment product data (high-quality reproducible copies)
6. Warranty documentation

3.11 FIELD QUALITY CONTROL

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

B. Dimming Drivers and ballasts. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

D. Inspect each luminaire for damage. Replace damaged luminaires at no cost to the Owner.

E. Fixtures showing dirt, dust or fingerprints shall be restored to like new condition or shall be replaced at no cost.

F. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

G. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

H. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
d. IESNA LM-64, "Photometric Measurements of Parking Areas."
e. IESNA LM-72, "Directional Positioning of Photometric Data."

I. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265619

DIVISION 27 - COMMUNICATIONS

SECTION 270536 – CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes: Ladder cable trays.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Field quality-control reports.

1.5 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. All cable trays, finishes, and all of its component parts shall have an unconditional one (1) year warranty. Warranty shall include finishes and all components to be free from defects in materials and workmanship for a period of one (1) year from date of Owner's acceptance. Replacement of cable tray, temporary support of cables, faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

1.6 WARRANTIES

A. INSTALLATION WARRANTY. The Contractor shall warrant cable trays unconditionally against defects in workmanship for a period of one (1) year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. Replacement of faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

B. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and covering follow-on support after project completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Drawings for specific requirements for sizes, and configurations. Minimum dimensions shall be 12 inches wide and 4 inches deep.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAYS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mono Systems, Inc. or comparable product by one of the following:

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. Chalfant Manufacturing Company.
3. Cooper B-Line, Inc.
4. MP Husky.
5. Niedax-Kleinhuis USA, Inc.
6. US Tray; a United Structural Products Co.

B. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 6 inches on center over the entire length of the cable tray.
3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 4 inches.
8. Width: 24 inches or as indicated on Drawings.
9. Fitting Minimum Radius: 12 inches.
10. The maximum uniform load and the support span are indicated by the cable tray class.
11. Class Designation: Comply with NEMA VE 1, Class 12C.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.3 MATERIALS AND FINISHES

A. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H 35.1/H 35.1M for extruded components and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H 35.1/H 35.1M for fabricated parts.
2. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, radius drops, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel." Provide warning sign on 8’ centers on both sides of cable tray.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

H. Place supports to provide clearances shown on Drawings.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze form as required by application.

J. Locate and install supports at each end connection and at mid-span. Support interval shall not exceed 6 feet.

K. Support trapeze hangers trays with 3/8-inch diameter rods.

L. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

N. Make changes in direction and elevation using manufacturer's recommended fittings.

O. Make cable tray connections using manufacturer's recommended fittings.

P. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

R. Cable tray shall have 12” clearance above, 26” to one side, and 6” below. Cable trays shall be the first utility install above the ceiling.

S. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to TIA/EIA 607 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications." Bonding conductor shall be a minimum of continuous #2 AWG copper.

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm). Factory radius drops shall be used for all transitions in elevation.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Physically and electrically connect pathways to cable trays per specifications and drawings.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 0.5 ohms.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

DIVISION 27 – COMMUNICATIONS

SECTION 270538 – NON-CONTINUOUS CABLE SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. All layout and installation of communications infrastructure shall be in accordance with ANSI / TIA 568 and the BICSI TDMM.

D. Each Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes: J-hook pathways.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of J-hook.

1. Include data indicating dimensions and finishes for each type of J-hook indicated.

B. Shop Drawings: For each type of J-hook.

1. Show fabrication and installation details of tiered J-hook assemblies, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, and fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled J-hook layouts and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of J-hook cabling pathways.
4. Vertical elevation of J-hook pathways above the floor or below bottom of ceiling structure.

B. Field quality-control reports.

1.5 WARRANTIES

A. INSTALLATION WARRANTY. The Contractor shall warrant J-hooks unconditionally against defects in workmanship for a period of one (1) year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. Replacement of faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

B. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

C. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

D. The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and covering follow-on support after project completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR J-HOOKS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Panduit “J-Pro”

B. Patented design provides complete horizontal and vertical 1" bend radius control that helps prevent degradation of cable performance.

C. UL 2043 and CAN/ULC S102.2 listed and suitable for use in air handling spaces.

D. Pre-riveted assemblies allow for attachment to walls, ceilings, beams, threaded rods, drop wires and underfloor supports to meet requirements of a variety of applications.

E. Wide cable support base prevents pinch points that could cause damage to cables.

F. Cable tie channel allows user to easily install 3/4" (19.1mm) Tak-Ty ® Cable Ties to retain cable bundle.

G. Durable non-metallic J-Hook materials provide the ability to manage and support a large number of cables.

H. Material: Black Nylon 6.6 J-Hook with metal attachments.

PART 3 - EXECUTION

3.1 J-HOOK INSTALLATION

A. Cable J-hook spacing maximum 4 feet on center. Maximum 2 feet on center for Data cabling.

B. Data cabling cannot be shared with any other type of cable or wires. Provide tiered J-hooks paths as required.

C. Cables cannot lay on ceiling tiles or other systems.

D. Do not exceed load ratings specified by manufacturer.

E. Do not fill cable hook greater than manufactures recommended guidelines. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.

F. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer or by TIA 568.

G. Do not install J-hooks that cannot be maintained without removal of another system.

3.2 CABLE INSTALLATION

A. Refer to specification 270610 for additional requirements.

B. Install cables only when each J-hook run has been completed and inspected.

C. Install cables without damaging conductors, shield, or jacket.

D. Install cables using techniques, practices, and methods that are consistent with Category 5e or higher requirements and that supports Category 5e or higher performance of completed and linked signal paths, end to end.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions or outlined in TIA 569. Use pulling means that will not damage media.

3.3 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Physically and electrically connect pathways to cable trays per specifications and drawings.

3.4 PROTECTION

A. Protect installed J-hooks and cables.

1. Install temporary protection for cables in open J-hooks to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and J-hooks can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

END OF SECTION 270538

DIVISION 27 - COMMUNICATION

SECTION 270600 - INTERCOMMUNICATION & CLASS CHANGE SIGNALING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Contractor's attention is directed to Section 260501 - General Provisions, Communications, and all other Contract Documents as they apply to his work.

1.2 GENERAL

A. Where applicable visit the site, verify all existing items shown on plans or specified, and be familiar with the working conditions, hazards, and local requirements involved. Submission of bids shall be deemed evidence of such visit. All proposals shall take these existing conditions into consideration before bidding.

B. All materials, unless otherwise specified, shall be new, free from any defects, and of the best quality of their respective kinds. All like materials used shall be of the same manufacture, model, and quality, unless otherwise specified.

C. Manufacturer's names are listed herein to establish a standard. The products of other manufacturers will only be acceptable if approved by the specifying architect 10 days prior to bid. These products must: be of equal or better quality than the features specified herein, will serve with equal efficiency and dependability, and satisfy the purpose for which the items specified were intended.

D. Contractor shall do all necessary cutting and drilling of present walls, floors, ceilings, etc., for the installation of new work; but no structural work shall be cut, unless specifically shown on drawings and/or approved by the Owner. All exposed building surfaces damaged by installation or removal of electrical work shall be patched and finished in the same materials and manner as adjacent areas by this Contractor.

E. Contractor shall co-ordinate their work with the Owner for times which changeover, removal of existing equipment, and new connections of existing systems can be completed.

1.3 RACEWAYS AND CABLES

A. Electrical work will conform to the National Electric Code and applicable local ordinances.

B. All 125-volt electrical conductors shall be installed in galvanized electrical metallic tubing with compression type fittings and couplings, minimum 1/2" size conduit.

C. All low-voltage wires and cables concealed in walls shall be run in EMT conduits from flush outlet boxes to above accessible ceilings. Provide conduits where cables penetrate firewalls above ceilings.

D. All EMT entering boxes shall be served with insulating throat connectors and locknuts.

E. No raceway shall be located in proximity of hot water lines or excessive heat.

F. Where raceways cannot be run concealed in walls, use Wiremold Series surface raceway complete with all fittings, box extension rings, and required accessories. Co-ordinate routing of surface raceways with the Owner.

G. Use Cast "C" clamps, "U" straps, or ring hangers attached to rods, and/or brackets fastened to structure.

H. No perforated straps or tie wires permitted for supporting raceways.

I. Use wire ties for supporting low voltage cables run concealed above ceilings. Do not run cables loose on ceiling tiles. Support from structure above. Group cables in bundles.

J. Tie mounts, plates, and anchors shall be used.

K. Ground all electrical apparatus in accordance with the National Electric Code.

1.4 QUALITY ASSURANCE

A. Manufactures: Firms regularly engaged in manufacture of integrated communication systems, time keeping systems, and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for no less than five years.

B. Installer's Qualifications: Firms with at least five years of successful installation experience with projects utilizing integrated communications systems and equipment similar to that required for this project.

C. All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

D. The Contractor shall be an established communications and electronics Contractor that has had and currently maintains a locally run and operated business for at least five years. The Contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.

E. The Contractor shall show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor shall maintain at their facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

F. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and experience in the industry. The Contractor shall have attended the manufacturer’s installation and service school and upon request must show proof of attending such a school.

1.5 SCOPE OF WORK

A. Furnish and install all materials, labor, equipment, permits, etc., to provide communications system as described herein and illustrated on the drawings for a complete operating system.

B. All manufactured articles, material, and equipment shall be applied, installed connected, erected, used, cleaned, adjusted, and conditioned as recommended by the manufacturers, or as indicated in their published literature, unless specifically herein specified to the contrary.

C. All work shall be performed by competent professionals and executed in a neat and professional manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials. At completion, the installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of this portion of work shall be removed from the premises.

D. Program the operational characteristics matching the operation described herein, adjusting for call routing, transfers, priorities, and volume levels.

E. Remove all existing conduit, wire device, etc., being abandoned due to relocation.

F. The Contractor shall provide a minimum of eight hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. Operator Manuals and User Guides shall be provided at the time of this training.

1.6 SUMMARY

A. Work Included. The scope of work of this section consists of the design, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances, and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:

1. Supervised Network Intercom and Paging System, including but not limited to:

   a. Supervised network amplifiers, back boxes, and all equipment, cabling and support required to interface the public address system to the Owner's telephone system via SIP Trunk Interface.
   b. Supervised network system speakers, and ceiling mounted speakers, wall mounted horn, both interior and exterior.
   c. Cabling to support the Public Address System (NOTE: category 5/6 cable must conform to Owner guidelines. Coordinate with Owner prior to submission for approval).
   d. Master and secondary clock system, clocks and cabling. Elapsed time indicator control panels where shown on the drawings.
   e. Supervised network PA override signal to local sound systems. Coordinate with 27 40 00 contractor.
   f. Supervised network emergency messaging display/clock capable of receiving and scrolling up to 64 character long custom messages without affecting or replacing display of time segments, and coded messages simultaneous with plain text message (displacement to time segments permissible for coded messages).
   g. Interactive Graphical User Interface (IGUI) supporting a pictorial view of architectural room locations on a map, and controlling intercom functions including zone or all page, dynamic zone assignments, answering intercom call-ins, selecting and distributing program sources to any and all zones. IGUI will also annunciate, locate and indicate loss of communication to all supervised network devices including speakers, amplifiers, emergency messaging display/clocks, and notification switches.
   h. Emergency communication shall be initiated by the local console or from a centrally located district office via a District Wide Emergency Communication platform not included in this contract. Emergency communication shall include but not be limited to, pre-recorded audio, live audio, emergency textual message display activation, computer pop-up notification, SMS Text message, and email.

1.7 SUBMITTALS

A. Equipment Data Sheets (EDS) shall be submitted on all components and materials provided by the contractor including cable types if applicable.

B. Shop drawings including locations of field devices, cabling and cable routes through the building, intercom console layout and location and typical wiring diagrams shall be submitted and approved by the project manager, prior to beginning work.

C. The UL listing card and other documents verifying compliance with to UL/CSA 60065 and FCC Standard C108.8 shall be submitted for equipment supplied by the contractor where applicable.

D. Submit the shop drawings, product data, and quality control submittals specified below at the same time as a package.

E. Shop Drawings: Composite wiring and/or schematic diagrams of the complete system as proposed to be installed. Drawing shall include relative position of all major components, typical connections, field components, accessories, and cable types.

F. Product Data: Include catalogue data sheets, manufacturer's default specifications, user operation guides, and bill of materials.

G. Quality control shall include the following:

1. Name, address, and telephone number of the nearest fully equipped service organization.

2. Submit a certificate of completion of installation and service training from the system manufacturer.

3. Submit a list of comparable completed projects. Furnish the name, address, telephone number, and contact name of end user.

1.8 SINGLE SOURCE RESPONSIBILITY AND OBSOLETE EQUIPMENT

A. Except where specifically noted otherwise, all equipment supplied by the contractor shall be the standard product of a single manufacturer of known reputation and experience in the industry. Only equipment, components and accessories in current production for at least five years beyond the completion date of this system shall be used and installed. Any equipment found to be obsolete or not in future production will be removed and replaced at contractor's expense.

1.9 CONTRACTOR QUALIFICATIONS AND QUALITY ASSURANCE

A. The installation contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least five years. Further this contractor must have a minimum of 3 years' experience in the specific installation, programming and application of intercommunications and class change signaling systems. I.E. school intercom systems.

B. The installation contractor shall show satisfactory evidence, upon request, that it maintains a fully equipped service organization capable of furnishing adequate inspection and service to the equipment and materials installed.

1.10 APPROVED EQUIPMENT

A. Bids must be submitted on the basis of the specified materials and manufactures or equal. Alternative materials and manufacturers must be approved as an equal by the engineer and the MCPS Electronic Maintenance Department and listed in an addendum to these specifications.

B. MCPS reserves the right to determine or equal.

C. Reference the paragraphs under "SUBSTITUTE EQUIPMENT PREQUALIFICATION" for the requirements to approve alternative systems.

1.11 IN-SERVICE TRAINING:

A. The contractor shall provide a minimum of four hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of school personnel in the operation of this system. A typewritten list of room speaker locations and their associated dial numbers shall be provided to the school and the Manager of the MCPS Electronic Maintenance Department at the time of this training.

1.12 WARRANTY AND SERVICE:

A. The contractor shall provide a one-year warranty covering the installation and programming of the installed system against defects in material and workmanship and provide warranty repairs on the Telecor intercom systems' equipment for the same time period. All labor, trip charges and materials shall be provided at no expense to the owner during this one-year period. The warranty period shall begin on the date of project substantial completion unless system is not operational or it is determined the system was not acceptable by the Owner/Engineer on that date.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION OF NETWORK INTERNAL COMMUNICATION SYSTEM

A. Supply and install a complete supervised network based intercom system. Field wiring shall be CAT 5E or CAT 6 cable, control wiring for power distributions and very long runs, and utilize an optional fiber backbone (when distances exceed normal Ethernet limitations). All station equipment shall utilize standard RJ-45 modular connections. All remote devices utilizing standard structured cabling shall be capable of PoE (Power over Ethernet) or power supplied within the CAT 5E or CAT 6 cable jacket. Wiring shall be capable of either being installed in conduit or cable trays, where shown on the plans

B. The system shall be capable of interconnecting with the building LAN (Local Area Network). This connection shall be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection per station to accomplish all intercom operations. Ethernet ports and associated network switches that are required to connect any intercom devices will be provided by the OWNER.

C. Provide a separate circuit for each room and administrative office so each room, speaker, amplifier, and emergency messaging display/clock can be individually addressed.

D. Overall intercom communications network shall utilize Ethernet or VoIP communications between all major components: administrative consoles, intercom stations, amplifiers and individual paging speakers, and network switches. Systems not utilizing Ethernet or VoIP communications protocol to each end-point device will not be acceptable. Systems not capable of supervising all networked devices including network amplifiers, network speakers, notification switches, and emergency messaging display/clocks will not be acceptable.

E. The network shall support a VLAN configuration to separate activity in the intercom system from other in building LAN traffic. In locations where the supervised network communications system will be considered as part of the facilities life safety systems, a dedicated and isolated network shall be required.

2.2 DESCRIPTION OF NETWORK INTERCOM / PA FEATURES

A. The system specified is based on the Telecor eSeries Supervised Network based Communications System providing at least the features and functions outlined below. It shall be installed and programmed by a local authorized and certified Telecor dealer. Equivalent systems Bogen Quantum and Valcom Class Connection IP will be considered provided they meet the criteria defined below.

B. The system shall utilize a decentralized network structure not requiring any head-end equipment, central server, or any other control hardware to maintain system operation. Systems utilizing centralized electronics and subject to a single-point-of-failure (power supply, CPU, server, power, etc.) shall not be accepted unless the system has 100% duplication of all centralized operating equipment running concurrently and can automatically take over, including up to the minute programming configuration in the event of a failure of the main system head-end electronics or any required, centralized electronics required to make the system fully operational. Systems that are not based on decentralized structure or systems that do not provide 100% duplication of head-end or systems that operate in a "down-graded" operational mode as the result of a centralized failure are not acceptable.

C. All station devices shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power-over-Ethernet network switch, all networked devices shall be immediately operational and as applicable shall be able to place or receive calls and pages fromm Stations as well as page all devices in the network. Consoles, intercom stations, clocks, emergency displays, or speakers connected to the network shall not require any network configuration or administration to function.

D. Speech shall be transmitted in the frequency range from 50 Hz to 7 kHz and shall use a maximum of 128 kbps of bandwidth during a call. In order to assure maximum intelligibility, all system audio shall be HD Audio as defined in Intel(TM) High Definition Audio Specifications, June 17, 2010.

E. Intercom communications between consoles and system devices shall be non-blocking with no channel restrictions or limitations (other than network capacity) to the number of simultaneous conversations at any time between pairs of intercom stations, intercom station to console, console to console, console to speaker or zone of speakers, program source to a speaker or zone of speakers, or bell tones to a speaker or zone of speakers regardless of number of stations or consoles. Any and all device shall have the ability to have its programming downloaded, individually or simultaneously via the network. Programming shall be downloadable in a series of human readable, industry standard comma-separated values (CSV) files that can be saved and edited using common spreadsheet applications. Consoles, intercom stations, clocks, displays, and speakers residing on a network shall have the ability to update their programming, simultaneously from a CSV file. Furthermore, all devices shall also have the capability to be configured directly, such that device numbers, names, zones, and call-in destinations can be altered in real time without the uploading or downloading of their programming. System shall be capable of uploading firmware updates to all device classes simultaneously, via the network, without the requirement of tools, by authorized technician or qualified facility technician or representatives.Audio communications between all devices shall be accomplished with latency values of a maximum of 0.1 seconds and connection times of 0.01s for 1 to 500 speakers.

F. The system shall support a minimum of 50 channels of simultaneous duplex communication paths on the intercom system LAN, plus a minimum of 10 simultaneous duplex channels for PBX integration.

2.3 SUPERVISED NETWORK ADMINISTRATIVE CONTROL CONSOLE

A. The Supervised Network Administrative Control Console (subsequently referred to as Console) shall be a Telecor model e300 or approved equal. The Console shall be supervised and allow the operator to establish two-way communications with an intercom station, talkback speaker, or another Console using the handset or speakerphone. VOX functioning shall be automatically enabled when the handset is used. The Push-to-Talk button shall toggle the Console between talk and listen mode when the speakerphone is used.

B. The Console shall provide a 2-line by 20-character LCD display. The display shall be able to be tilted at different angles for optimum viewing. When there are no active calls, the display shall show the Console name and dial number. If a time server is connected to the network, the display shall also show the time and date.

C. Incoming calls to a Console shall show the originating station dial number and name on the Console display. Calls shall be displayed in the order they are received. The operator shall be able to scroll through the list of calls and answer them out of sequence. Emergency call-ins shall be distinctly annunciated both visually and audibly.

D. The Console shall allow call-ins to be forwarded to another Console, or for calls to be put on hold or transferred to another Console location. Additionally, call-ins or calls shall be forward/transfer-able to PBX telephone extensions via a SIP trunk interface.

E. The Console shall be able to select remote audio sources connected at any location on the local area network, and distribute the audio broadcast from the source to all speakers in a facility or to selected areas such as a speaker zone or a selection of speakers. The Console shall be capable of audio source verification by attendant prior to page zone activation. In this manner attendants shall

be able to listen to the audio source locally, including listening to pre-recorded announcements, prior to system broadcast.

F. The Console shall be able select a tone or a pre-recorded announcement and broadcast the tone or announcement to all facility speakers or to select areas, such as a speaker zone or a selection of speakers.

G. The Console shall be equipped with digital volume control that shall allow for the separate adjustment of the speaker listen and handset listen volumes. The levels for intercom listen, tones, and program distributions shall be independently adjusted and stored in memory.

H. The system shall allow user programming of alphanumeric architectural room names and numbers. The Console shall be capable of using 1 to 7 digit sequences for dial out and call-in identification, and shall display station numbering, station name, and call-in priority.

I. The end-user shall be allowed to choose and determine the number and location of Consoles. The end-user shall not be limited by pre-set manufacturer limitations of the number of Consoles required by this project; allowing for unrestricted future expansion. Consoles may be added at any time. Consoles added by the end-user that exceed the engineered design for this project shall be at owner's expense. Communication between consoles or consoles and intercom stations or rooms shall not be inhibited by channel number restrictions.

J. The Console shall be capable of displaying room statuses such as Privacy and Do Not Disturb and shall have the ability to override any status limiting communication between the Console and a station with Privacy or Do Not Disturb status activated. Temporary override shall not interfere with continued activation of Privacy and Do Not Disturb after communication has been established and electively terminated.

2.4 SUPERVISED NETWORK INTERCOM TALK-BACK SPEAKER

A. The Supervised Network Intercom Talk-Back Speaker (subsequently referred to as Network Speaker) shall be a Telecor model eS8-TB. The Network Speaker shall be supervised and capable of up to 10 watts of audio signal and provide a minimum of 92db @ 1 meter SPL for maximum intelligibility. Speaker spacing shall be as defined by manufacturer to provide maximum intelligibility.

B. The Network Speaker shall provide transmission of HD audio as generated from intercom console and/or associated push-to-talk, intelligent microphone, supervised network amplifier, or program sources connected to the network.

C. The Network Speaker shall provide a dry contact output that can be activated remotely from a station or from a console, such as may be required in a door release application.

D. The Network Speaker shall receive power and data over a RJ45 connect CAT5E/6 cable via a Power-Over-Ethernet switch port. Once plugged into the LAN through a Power over Ethernet network switch, the Network Speaker shall be immediately functional and be able to receive calls and pages from consoles on the network. The Network Speaker shall not require any network configuration or administration to function.

E. The Network Speakers shall support talkback; to optimize intelligibility talkback capabilities shall be supported via a microphone conditioned for low noise, HD audio, and with compression and noise gate capability. Stations that use the speaker instead of a separate microphone for talkback capability shall not be accepted.

F. The Network Speaker shall have a call-in roll-over feature where if it places a call-in to a primary call destination which is not answered after a preset amount of time, the call-in shall be automatically escalated to a secondary call-in destination. If both the primary and secondary call-in destinations are unavailable, the call-in shall be redirected to a back-up Station, Console, or telephone device.

G. The Network Speaker shall have the capability to be configured as a member of 1 or more paging zones.

H. The Network Speaker shall support the direct connection with RJ45 connectors of two, supervised room notification stations. The stations shall provide the means for: normal calls, emergency calls,

privacy mode, and do not disturb mode. Notification stations shall include a call placed assurance status LED to indicate a call has been placed. Notification stations shall be supervised and immediately indicate disconnection or a wiring fault.

I. In addition to the visual call-in assurance status indicators on the notification stations, call-in assurance status indication must also be provided on the associated speaker. Also, in addition to visual call-in assurance, audible call-in assurance shall also be provided in support of persons with visual disabilities.

J. Under blackout conditions the notification station shall be illuminated such that it can be located in the dark.

K. Normal call stations must support the ability to activate emergency call-in signals via multiple button presses and press and hold operations. Emergency call stations shall be separate and clearly labeled with a red button so as to impart obvious operation in the event of an emergency. Systems that only provide a single call station with dual emergency and normal operation shall not be acceptable.

L. The Network Speaker shall provide local, visual indication of operation or failed-communication and shall immediately annunciate a loss of communication at the main console location.

M. Network Speaker volume must be capable of individual level settings through the network. Settings must not be adjustable without authorization. Volume controls located in rooms must be centrally lockable via the network. Systems that allow a volume adjustment without authorization shall not be acceptable. Systems that utilize a manually operated transformer or resistive volume control design shall not be acceptable. Volume controls shall be capable of establishing and maintaining levels for intercom, paging, program distribution, and tones, independently for each of the above functions. Emergency announcements shall be sent at a volume/level as required by the AHJ and shall not be affected by the adjustment of other speaker volume/levels for the purposes of paging, intercom, or other lower priority audio events.

2.5 SUPERVISED NETWORK MASTER/SATELLITE TALKBACK SPEAKER

A. The Supervised Network Master/Satellite Talkback Speaker (subsequently referred to as the Master Talkback Speaker) shall be a Telecor model eS8-TB4 or approved equal. The Master Talkback Speaker shall support all functionality of the Telecor model eS8-TB (specified above).

B. The Master Talkback Speaker shall be supervised and shall support the connection of Satellite Speakers, and support up to four watts of additional 25V Satellite Speaker load. Satellite Speakers shall be Telecor model S8T2570 or approved equal.

C. The Satellite speakers shall not support talkback; to optimize intelligibility talkback capabilities shall be supported from a single point via a microphone conditioned for low noise, HD audio, and with compression and noise gate capability. Stations that use the speaker instead of a separate microphone for talkback capability shall not be accepted.

D. The Satellite Speaker shall receive power over a RJ45 connect CAT5E/6 cable via the Supervised Network Master/Satellite Talkback Speaker. Both the Supervised Network Master/Satellite Talkback Speaker and the Satellite Speaker shall receive all power through a single Power-Over-Ethernet switch port. Systems that require auxiliary power or additional external or supplementary audio power amplification are not acceptable.

2.6 SUPERVISED NETWORK EMERGENCY DISPLAY/CLOCK

A. The Supervised Emergency Display/Clock (subsequently referred to as Message Display) shall be a Telecor model e365-TB or approved equal. The Message Display shall be supervised and shall simultaneously display the time and date. The time shall be displayed in hours, minutes, and seconds. Hours and minutes shall be displayed in large 2.25” digits. The seconds shall be slightly smaller for easy distinction. The date shall be displayed in plain text by a 10-character, dot matrix display showing the day of the week, followed by the month and date. Loss of communication to the Message Display shall result in an immediate indication of communication loss with the device and annunciated at the designated locations.

B. The Message Display shall receive power and data over a RJ45 connect CAT5E/6 cable from a single Power-Over-Ethernet switch. Once plugged into the LAN through a Power over Ethernet network switch, the digital calendar Message Display shall be immediately functional. The Message Display shall not require any network configuration or administration.

C. The Message Display shall by default show the time and date which shall be synchronized to all other Message Display. If time signal communication to the Message Display is lost, it shall maintain the time independently, and remain synchronized to other Message Displays connected on the local area network. Once communication is restored, the Message Display shall resynchronize with the time server and shall be automatically updated to current data communication provided at time of restoral.

D. The Message Display shall provide a dry contact output that can be activated remotely from a station or console, such as may be required in a door release application.

E. The Message Display shall be capable of supporting notification devices and shall have a call-in roll-over feature where if a call-in to the primary call destination is not answered after a pre-set amount of time, the call shall be automatically escalated to a secondary call destination. If both the primary and secondary call destinations are unavailable, the call shall be redirected to a back-up station or console.

F. The Message Display shall have the capability to be configured as a member of 1 or more paging zones.

G. The Message Display shall optionally activate strobe and siren signals in conjunction with emergency call-ins. Siren shall be automatically suspended upon an audio connection. Strobe shall be maintained until call completion.

H. The Message Display shall automatically activate and maintain strobe signals in conjunction with emergency pages, programs, tones, announcements, and/or textual messages.

I. In addition to displaying the time, the Message Display shall also feature elapsed timer and count-down functions. Timer functions shall include the ability to count upwards from zero to 24 hours, as well as counting down to zero from a specified value. The timer shall be controlled using the Telecor 2481-TBP Timer Button Panel, providing start, stop, and reset functionality. When not operating as a timer, the Message Display shall default back to displaying the current time. Elapsed time and countdown functions shall also be controlled via contact closure and connected directly to the Message Display

J. Mounting options for the Message Display shall include: surface mount and dual mount with the 2423 dual mounting kit, creating a double-faced version. The Dual Mounting Kit shall be supplied with a bracket that shall allow the Emergency Display/Clock to be mounted 4" away from a wall or ceiling surface. An optional 2433 clock guard shall also be available for the surface mount models. The guards shall be constructed from sturdy, heavy gauge steel and include a Plexiglas window that shall provide both protection and optimum visibility of the display.

2.7 WIRELESS ANALOG CLASSROOM CLOCKS

A. The Secondary Clock shall be a Wireless unit Telecor model as indicated on the drawings. It shall be able to both receive and re-transmit a correction signal. The time base shall be provided by a master clock or microprocessor-based administrative communication system and shall be transmitted by a wireless transceiver (model 2490). The clock shall be capable of receiving a wireless signal from other wireless clocks on the system. Each clock shall receive and transmit with 915-928 MHz frequency-hopping technology. The clock shall be capable of transmitting the signal simultaneously with other wireless clocks without interference. The clock shall immediately self-correct upon receipt of the wireless signal. The clock shall have a maximum correction time of five minutes. The clock shall include automatic calibration as well as diagnostic functionality allowing the user to check the quality of the signal, when the clock last received a signal, and to perform a comprehensive analysis of the clock itself. The clock case shall be constructed of black ABS plastic and shall have a smooth surface. The clock shall have black hour and minute hands as well as a red second hand. The dials shall have 12-hour Arabic numerals in Helvetica.

B. The Wireless Analog Clock shall be round and have a 12" diameter display, employing a low-profile, semi-flush metal case suitable for wall mounting. It shall require a standard 1-gang electrical box for installation. Model shall be 2491.

2.8 Supervised Call-In Switches

The Call-In Switches are used to initiate calls from **remote locations to eSeries eConsoles. These stations are specifically designed to operate with eSeries eS8-TB or eS*-TB4 talkback speakers. Switches for this project shall have the following features. Call Switch shall eCS-6**

A. Call Switch shall have call assurance LED.

B. Stations can provide "message waiting" indications to staff members. If no one is present in a room to respond to a call, or the room is in Privacy or Do Not Disturb mode, the console operator will have the option to leave a Message Waiting (MW) indication. If the MW option is chosen, the LED indicator on the room call stations will begin to pulse. When a call-in is initiated from the room, the MW indication will be automatically deactivated, and the call-in will be automatically routed to the console that left the MW indication.

C. A singular push will initiate a normal call-in function while providing an Emergency priority level call by pressing the button three times or press and hold for 3 seconds.

2.9 SUPERVISED NETWORK INTERCOM STATIONS (as shown on plans)

The Supervised Network Security Intercom Station (subsequently referred to as Intercom Station) shall be a Telecor model eSTN-0, eSTN-1, eSTN-2, eSTN-3, or approved equal. The Station shall be supervised and used to establish communication between specific areas of a facility, providing for two-way communications as well as call-in capabilities.

A. The Station shall be equipped with zero to three tamperproof push-button switches as required for the application. The unit shall be inscribed with simple operating instructions on the stainless steel faceplate. Stations shall support placement of a call-in (normal or emergency), the annunciation of a call-in, answering of a call-in for intercom, and placement of an all call, emergency, or zone page as required.

B. The Station shall have a station status LED indicator with "Status" inscribed on the faceplate.

C. The Station shall provide a dry contact output that can be activated remotely from another station or from a console, such as may be required in a door release application.

D. The Station shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power over Ethernet network switch, the Station shall be immediately functional and be able to receive calls and pages from consoles on the network. The Station shall not require any network configuration or administration to function.

E. The Stations shall have a call-in roll-over feature where if it receives a call-in as a primary call destination which is not answered after a preset amount of time, the call shall be automatically escalated to a secondary call destination. If both the primary and secondary call destinations are unavailable, the call shall be redirected to a back-up station or console.

F. The Station shall have the capability to be configured as a member of 1 or more paging zones.

G. The Station shall be wall-mounted on a 3-gang surface mount backbox with a depth of no less than 2.75". Mounting hardware shall be tamper-proof. The face plate shall be fabricated from 11 gauge stainless steel with a brushed, mar-resistant finish. The Station shall be designed to withstand physical damage and everyday wear-and-tear. The buttons shall be tamper-proof and the overall assembly shall be designed to be vandal-proof. A G3 weather-seal gasket shall be available as an additional option to weatherproof the Stations.

2.10 SUPERVISED NETWORK AMPLIFIERS

A. The Supervised Network Amplifier (subsequently referred to as Network Amplifier) shall provide a minimum of 25 watts for paging and public address and shall be capable of utilizing analog amplifiers to increase the amount of amplified signal from the network amplifier. The Network Amplifier shall be connected directly to the network switch by an RJ45 connector and shall receive signals directly from the network.

B. The Network Amplifier shall be supervised. In the event network communication is lost, an audible alert shall sound on the Amplifier. The Network Amplifier shall provide a silence feature to mute the audible alert for 24 hours.

C. The Network Amplifier shall also be capable of receiving local input from local devices such as tape decks, iPod docks, CD players, etc. The network amplifier shall be capable of transmitting signals received from the local input to other network locations or locally to directly connected 25/70 volt or 8 ohm analog speakers.

D. Each Network Amplifier shall be capable of providing two audio inputs for local devices and shall be programmable as either a microphone or line-level input.

E. The Network Amplifier shall be controlled remotely such that audio programs, input, tones, textual messages, or announcements may be initiated by other devices connected at different locations on the local area network.

F. The Network Amplifier shall have a minimum of 4 local tone/pre-recorded announcement audio message control lines which when activated will distribute tones/pre-recorded audio messages to intended network amplifiers for re-distribution, network talk-back speakers (or a zone), and/or local 25/70 volt or 8 ohm analog speakers directly connected to amplifier. Each network amplifier shall be capable of storing four (4) pre-recorded announcements in addition to a minimum of 16 tones. Tones and announcements shall be activated locally or from other network devices.

G. The Network Amplifier shall store and transmit companion textual messages for each stored audio announcements. Textual messages shall be automatically broadcasted to the same zones along with the audio messages such that any device programmed for that zone automatically receives both the audio and textual announcement/message and automatically reproduced each or both messages to the extent of the devices' capabilities.

H. The Network Amplifier shall be capable of transmitting HD level audio as defined by Intel(TM) High Definition Audio specifications, June 17th, 2010 at a minimum.

I. The Network Amplifier shall shut down to protect itself should an output short circuit fault or overload occur that jeopardizes the integrity of the Network Amplifier.

2.11 SUPERVISED INTERACTIVE GRAPHICAL USER INTERFACE

A. The system must provide a Supervised Interactive Graphical User Interface (subsequently referred to as IGUI). Provide networked PC (coordinate location with Owner), keyboard, mouse, and 21" LCD monitor. PC shall exceed manufacturer recommended specifications.

B. The IGUI shall be supervised and shall utilize an easy-to-use Graphical User Interface for quick and easy graphically aided navigation to access functionality for all intercom stations, paging zones, and program distribution sources. Emergency operations shall be simplified through the IGUI allowing stored audio files and alphanumeric messages for message displays to be activated from the IGUI. The IGUI shall allow common operations such as daily announcements to become simplified into single touch activated icons; removing multi-step console set ups and dial strings.

C. The voice device used to originate voice communication for the IGUI to selected locations shall be a system console, telephone handset, or microphone independent from the computer hosting the IGUI. The voice device shall remain functional and accessible regardless of the operational state of a computer supporting the IGUI.

D. The IGUI shall allow the creation of a custom operating screen(s) based on the floor plans of the facilities. Icons representing intercom stations, zones used for paging, tone distribution, textual

Message distribution, and audio program distribution shall be incorporated onto the floor plans. The IGUI software shall provide:

1. Simple routine call processing, including: hold, transfer, and forward
2. Activation of remote station auxiliary relays for applications such as door lock or release
3. Emergency functions
4. Paging
5. Audio program distribution
6. Customizable page elements
7. Customizable operating screen
8. Element library for emergency event icons
9. Initiation of emergency and non-emergency messaging, textual and audible
10. Remote station volume adjustment
11. Remote activation of do not disturb status and/or message waiting status
12. Remote station trouble indication
13. Remote station background music channel selection
14. Dynamic zone management for interactive on-the-fly console specific zones
15. Single touch emergency response (supporting both actual emergencies and drills) including but not limited to all or any combination of the following:

    - Live voice notification
    - Pre-recorded audio message
    - Digital plain text messaging with simultaneous numerically coded message capability
    - Remote system activation, i.e., access control systems, CCTV systems, door release systems, etc.

E. The IGUI must provide an efficient and reliable method of notifying the occupants within the facility of critical situations. A variety of emergency tone signals that reside within the intercom/paging system shall be activated by clicking on pre-programmed buttons on the IGUI screen, initiating the transmission of tone signals to speakers, and alphanumeric messages to message displays/digital clocks. A “lockdown” icon shall be designed as per Owner direction, with Owner selecting the appropriate tone. Whole building macros for emergency or off-normal response shall be built into the internal communication system as directed by the Owner. Each macro shall be capable of being activated by the console, the IGUI as indicated on plans or as directed by the Owner or AHJ. It shall be possible to activate a WAV file message or Owner selected tone coinciding with multi-language textual messages for distributions to zones as directed by the Owner, all from a single activation icon located on the IGUI. Other single action macros shall be activated in similar fashion via the IGUI and a custom labeled icon. Plain language labeling of all icons on the IGUI shall be user changeable.

F. Activation of Lock Down Message shall be integrated to Duress System initiating complete Lock Down protocol.

G. Activation of Door Intercom Station shall provide associated camera view within IGUI.

2.12 SUPERVISED SIP TRUNK IP/PBX INTERFACE

A. The system Session Internet Protocol (SIP) Interface shall be a VoIP PBX phone interface of the same manufacturer as the supervised network intercom and paging system. Third party gateway devices shall not be accepted.

B. The SIP Interface shall be supervised and shall connected directly to the facilities network and the PBX’s network and shall provide the following:

   i. Establish a barrier gateway between the intercom and paging network and the PBX and/or common computer network.

ii. Transparent audio operation between VoIP PBX phones and any device on the supervised network intercom and paging system. Paging access from any telephone on the facility system VoIP PBX to any intercom speaker, speaker zone, intercom station, console, all speakers, or paging horns and zones throughout the facility.

iii. Any call-in from the supervised network intercom and paging system shall be capable of being routed directly to a VoIP PBX phone. Call-in stations can be configured and programmed to automatically dial any number on the publicly switched telephone network, landline, or cellular number through the SIP interface and via the PBX.

iv. Ability to escalate a call-in directed to a console to be redirected to a VoIP PBX connected phone via the SIP Interface. Escalation can also include the ability to dial any number on the publicly switched telephone network, landline, or cellular number through the SIP interface via the PBX.

v. Ability to initiate alarm and crisis response protocols from any VoIP PBX connected phone.

vi. Ability to require security access code to utilize the intercom or paging system emergency communication features.

vii. Minimum of 10 simultaneous telephone channels of access to/from VoIP PBX phone system.

viii. Full caller ID support from any supervised network intercom call-in device to a VoIP PBX connected phone identifying the calling station ID/Location.

ix. Emergency level call-in to be uniquely identified as emergency on the VoIP PBX phones.

x. Activation of all supervised networked intercom and paging system emergency tones and pre-recorded announcements from any phone connected to the building VoIP PBX phone system.

xi. The SIP Interface shall additionally allow for calls to be placed from a console to any phone number on the publicly switched telephone network (landline or cellular). Additionally, intercom calls at a console may be transferred to any number on the publicly switched telephone network to any landline or cellular number through the SIP interface via the PBX.

C. Systems that connect to a building or district phone system and are limited to a SLT or CO connection will not be accepted as a substitute for a fully operational SIP Interface.

2.13 MASTER CLOCK

A. The 2400-IP-TCR Master Clock is designed to function as a central timekeeping, event scheduling, and relay control device. When used with the eSeries system, the Master Clock can be programmed to activate bells, sound tones, or activate other devices according to the Master Clock schedules. It can also be used to synchronize and correct synchronous movement analog clocks. Features of the Master Clock include:

- LED display of current time in HH:MM
- Any call-in.
- Two line, 20 character, backlit LCD display
- Programmable from the front panel pushbutton keyboard
- (S)NTP input capability

- Up to 10 pre-programmed server addresses for continuous synchronization
- DHCP capable
- 12 or 24 hour format
- Automatic bi-annual day lights saving time adjustment
- Web interface
- SMA settings IGUI configurable via web browser
- Minimum 4 aux relays for activation of timed events
- Control of all IP settings
- View complete list of events and schedules over web browser
- Minimum 800 event capability
- Compatible with synchronous wired secondary clocks
- Supports Telecor wireless clocks operating on 915-928 MHz
- Battery back-up for non-volatile memory and timekeeping

B. The Master Clock comes standard with (S)NTP capability for synchronization to any (S)NTP web site or Network Time Protocol (NTP) time server. Up to 10 server addresses can be pre-programmed into the Master Clock for this purpose. It also encompasses a fully functional web interface for controlling the Master Clock from any computer on a network or via a crossover cable. The Master Clock can also distribute time via (S)NTP protocol over the facilities network. IP devices on the network will be able to acquire (S)NTP data from the Master Clock for synchronization.

C. The 2400-IP is fully equipped with an LED readout displaying the current time. Event programming is easy with the 2X8 rubber tactile keypad and the backlit two line LCD display. A minimum of 800 events and 250 schedules can be programmed into the master clock. Events can be assigned to any of 4 relay zones (expandable to 8) for activation of time tones, bells, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the system in accordance with the manufactures printed instructions and recommended cable types.

B. Provide point to point wiring diagrams showing location of all wire pulls. Mark all cables corresponding to point to point wiring diagrams.

C. System Acceptance Test

a. Have the company field adviser adjust the completed system to desired volume levels of customer.

b. The system shall operate for at least two weeks with no failures or changes required.

c. Test every circuit in the system to ensure proper operation.

d. Test each daily function school will be using making sure staff is knowledgeable in the operation of the system.

D. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal hours. The warranty period shall begin on the date of acceptance by the Owner.

E. The Contractor shall, at the Owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

F. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

G. A licensed electrical contractor may install bridal rings, “J” Hooks, raceways and pull cables, but in no case connect and/or install any devices. This must be done by the personnel indicated under the CONTRACTOR QUALIFICATIONS AND QUALITY ASSURANCE Section.

H. All cables shall be concealed by all means possible unless shown otherwise on the drawings. Cables concealed within walls shall be installed in electrical metallic tubing (EMT). Cables concealed above suspended ceilings shall be installed in “J” hooks.

I. Any cable installed above ceilings shall be plenum rated cable.

J. ”J” hooks shall be spaced no more than four (4) feet apart in straight routes through the building that are perpendicular to and parallel with building walls and ceilings. Additional hooks shall be installed at device locations and termination points within twelve (12) inches of the device or where the cable transitions from hooks to enclosures, EMT or raceways

K. ”J” hooks shall be securely mounted directly to building walls, ceilings or structure. Mounting hooks to duct work, raceways, pipes, roof decks, structural bracing or supports for these materials is strictly prohibited. In no case shall load bearing structural elements such as bar joists be drilled or otherwise compromised to install “J” hooks or pathways for cables or wires. The engineer must approve changes to the building structure that may compromise the integrity of the structure in writing.

L. Cables shown on the drawings to be exposed shall be installed in EMT with compression fittings and approved metal outlet boxes.

M. The minimum size of EMT and flexible steel conduit shall not be less than ¾ inch. In no case shall the cable fill in EMT exceed 40% of the cross sectional area of the EMT. Contractor shall install whatever EMT size is necessary to meet this requirement.

N. In no case shall flexible steel conduit be used except to make connection to devices. Flexible steel conduit shall not exceed 18 inches in length.

O. Cable runs shall not run through or be separated by ducts, pipes or other materials or equipment above ceilings. Cables shall not touch or lay on ceilings, pipes, electrical conduits, ducts, raceways or any building structure. Cables shall be routed and spaced to maintain at least six (6) inches from any steam, hot water or other hot pipes and ducts.

P. Wall openings for cables to pass through shall be sleeved with EMT provided with plastic bushings on each end. After cables are installed both ends of the sleeve as well as the opening between the sleeve and wall shall be filled with a UL fireproof material regardless of the wall, floor and ceiling construction.

Q. Splices in Cat6 or Cat6a cables are not allowed.

R. Each cable shall be permanently labeled at the Audio Switching Module and/or intercom locations with Brady Tags or equal, with the room number it terminates in. Where no number exists the room name must be used. For example, the cable for gym speakers shall be labeled “GYM”.

S. Speaker Wattage Taps:

- All speakers shall be tapped at 1/2 or 5/8 watts, 25volt except as follows:
- Hallway and Cafeteria speakers shall be tapped at 1 or 1.25 watts, 25volt.
- Interior Horn speakers shall be tapped at 1.25 or 1.8 watts, 25volt.
- Exterior speakers shall be tapped at 8 watts, 25volt.
- Exterior Horn speakers shall be tapped at 7.5 watts, 25volt.
- Speakers that are located in restrooms are to be tied to the hallway speakers.
- Speakers located in small rooms or offices shall be equipped with a volume control recessed in the speaker.

- Storage rooms and offices located inside classrooms shall have their speakers tied to the speaker with in the room they are located.

Example

School Name Intercom

ated In IDF Room 226A	Location	Speakers	Total Circuit Wattage
Port-1	Ext Spk's Wing "A" East by CR-136	2	16
Port-2	Ext Spk's Wing "A" West by CR-133	2	16
Port-3	Office 131D	1	0.625
Port-4	Room A134	1	0.625
Port-5	Assistant Principal A136	1	0.625
Port-6	Office A130	1	0.625
Port-7	Assistant Principal A131	1	0.625
Port-8	Assistant Principal A132	1	0.625
Port-9	Office A120	1	0.625
Port-10	Principal Secretary A121	1	0.625
Port-11	Exterior Speaker West by A121	1	8
Port-12	Conference Room A123	1	0.625
Port-13	Office A126	1	0.625
Port-14	Exterior Speaker West by B116	1	8
Port-15	Open Office B110	1	0.625
Port-16	Office B108	1	0.625
Port-17	Coun Office B107	1	0.625
Port-18	Coun B101	1	0.625
Port-19	Coun B102	1	0.625
Port-20	Office B115	1	0.625
Port-21	Classroom 235	1	0.625
Port-22	Classroom 236	1	0.625
Port-23	Girls Rest Room 239	1	0.625
Port-24	Classroom 234	1	0.625
Port-25	Boys Rest Room 237	1	0.625
Port-26	Classroom 230	1	0.625
Port-27	Classroom 233	1	0.625
Port-28	Classroom 226	1	0.625
Port-29	Classroom 229	1	0.625
Port-30	Spare		
Port-31	Spare		
Port-32	Spare		
		Total Wattage	63.625

School Name Intercom

SS32-3 located in IDF Room 226A	Location
Port-1	Classroom 227
Port-2	Corridor 224
Port-3	Conference Room B2
Port-4	Office B215
Port-5	Office B213
Port-6	Office B212
Port-7	Office B211
Port-8	Mail B220
Port-9	Office B221
Port-10	Office B211 Corridc
Port-11	Girls Health B204
Port-12	Boys Health B207
Port-13	Men B209
Port-14	Women B208
Port-15	Lounge B203
Port-16	Penthouse 240
Port-17	Classroom 208
Port-18	Classroom 209
Port-19	Classroom 205
Port-20	Classroom 204
Port-21	Classroom 203
Port-22	Classroom 202
Port-23	Classroom 201
Port-24	Classroom 200
Port-25	Girls C201
Port-26	Room 210A
Port-27	Library Annex
Port-28	Room 210B
Port-29	ST 213A
Port-30	Spare
Port-31	Spare
Port-32	Spare

School Name Intercom

Located in MDF-C203	Location	Speakers	Total Circuit Wattage
Port-1	Boys C43 Third Floor	1	0.625
Port-2	Classroom 312	1	0.625
Port-3	Classroom 313	1	0.625
Port-4	Classroom 308	1	0.625
Port-5	Classroom 324	1	0.625
Port-6	Boiler Room C102	4	5
Port-7	Electric Room 117A	2	2.5
Port-8	Exterior Speakers C Wing by CR123	2	16
Port-9	Exterior Speakers C Wing by CR118	2	16
Port-10	Corridor C100 Wing "C"	5	6.25
Port-11	Corridor B122 Wing "B"	7	8.75
Port-12	Classroom 122	1	0.625
Port-13	Classroom 123	1	0.625
Port-14	Classroom 120	1	0.625
Port-15	Classroom 121	1	0.625
Port-16	Classroom 118	1	0.625
Port-17	Classroom 119	1	0.625
Port-18	Classroom 114	2	1.25
Port-19	Boys Restroom 116	1	0.625
Port-20	Exterior Speaker West Café 115 Wall	1	8
Port-21	Senior Citizens Room 112A	1	0.625
Port-22	Copy Room 112	1	0.625
Port-23	Classroom 110	2	1.25
Port-24	Girls Restroom 111	1	0.625
Port-25	Classroom 109	1	0.625
Port-26	Tardy Room 108	1	0.625
Port-27	Office 108A	1	0.625
Port-28	Corridor B129	1	0.625
Port-29	New Kitchen Office B132	1	0.625
Port-30	Spare		
Port-31	Spare		
Port-32	Spare		
		Total Wattage	77.5

School Name Intercom

SS32-7 Located in IDF-226A	Location
Port-1	Corridor A300
Port-2	Classroom 326
Port-3	Classroom 327
Port-4	Classroom 328
Port-5	Classroom 329
Port-6	Classroom 330
Port-7	Classroom 331
Port-8	Classroom 332
Port-9	Classroom 333
Port-10	Classroom 334
Port-11	Boys Restroom 339
Port-12	Classroom 336
Port-13	Girls Restroom 340
Port-14	Classroom 335
Port-15	
Port-16	
Port-17	
Port-18	
Port-19	
Port-20	
Port-21	
Port-22	
Port-23	
Port-24	
Port-25	
Port-26	
Port-27	
Port-28	
Port-29	
Port-30	
Port-31	
Port-32	

END OF SECTION

DIVISION 27 – COMMUNICATION

SECTION 270610 – VOICE AND DATA SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. All layout and installation of communications infrastructure shall be in accordance with ANSI / TIA 568 and the BICSI TDMM.

D. Each Contractor's attention is directed to Section 16000 - General Provisions, Communications, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. Optical Fiber cabling.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Patch cables and fiber jumpers
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management system.

B. The Contractor shall furnish all materials, labor, services, purchasing, testing of completely installed systems, etc., that are indicated or required to provide a complete telecommunications distribution network for the project.

C. The telecommunications distribution network shall be designed and installed in a format and construction as required for an IEEE 802.3Z compliant 1Gb Ethernet system. It shall be physically wired in a star configuration.

D. The telecommunications distribution system shall be installed complete, except as hereinafter described. The system shall be provided with all wall plates, inserts, wiring, equipment racks and supports, copper and fiber termination equipment, connections, wire terminations and identifications, 120 VAC power outlets, grounding etc., for a completely functioning premises wiring network. Components of each subsystem shall be of one manufacture, and be tested and certified as compatible to provide the specified performance.

E. Horizontal copper systems shall be Tyco/Amp or pre-approved equal. Fiber systems shall be Corning or Pre-approved equal.

F. The system active electronic hardware and software shall be installed by the Owner or his vendor, unless otherwise noted or specified.

G. The patch panels and racks shall be Owner furnished and Contractor installed.

H. All work shall comply with the National Electrical Code, Kentucky Building Codes. The guidelines developed by ANSI/TIA/EIA and BICSI (Building Industry Service Consultants International) shall be followed in construction of Telecommunications rooms.

I. The total horizontal distance of the cable path from the outlet to the Telecommunications room shall not exceed 275 feet, including termination loss and slack.

J. Per the drawings, a ladder tray will loop the entire perimeter inside all Telecommunications (MDF/IDF) rooms at no less than 8’ AFF. Maintain a 4” clearance from each wall. Ladder tray will be installed at the top of the communications racks spanning the width of the room. Radius drop outs will be installed on all cable trays where cables exit the tray to a lower elevation.

K. Fire treated plywood, 3/4-inch thick, shall be mechanically fastened to all walls of each Telecommunications (MDF/IDF) room. The plywood shall be painted with two (2) coats of neutral color fire resistant paint. The fire treated plywood will begin at 4” AFF and end at 8’-4” AFF. The room walls shall be finished with drywall (completely taped, sanded, and painted) or concrete block (painted) prior to mounting the plywood.

L. The vendor shall call the attention of the Owner to any materials or apparatus that the telecommunications vendor believes to be inadequate and any necessary items of work omitted.

1.3 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. Backbone cabling system shall comply with transmission standards in ANSI/TIA-568-C.1, when tested according to test procedures of this standard.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols. Splices shall not be installed in the horizontal cabling.

B. The maximum allowable horizontal cable length is 275 feet.

C. Horizontal cabling system shall comply with transmission standards in ANSI/TIA-568-C.1, when tested according to test procedures of this standard.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Submittals shall also be accompanied by a detailed bill of material, including part numbers and quantities.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For connectors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD on the permanent staff of installing Contractor.
2. Installation: Installation shall be under the direct supervision of a Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site. At least 50% of the Contractor’s technicians on site shall be BICSI Certified Installers.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
4. Installer shall be certified by the systems manufacturer as necessary to obtain the cabling system warranty as required by this specification.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with NFPA 70, and TIA/EIA-569-C.

1.7 GROUNDING:

A. Comply with NFPA 70, and ANSI/TIA-607-B.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test each pair of UTP cable for open and short circuits.

1.9 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers.

1. Meet jointly with telecommunications and LAN equipment suppliers, Engineer, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of racks, sleeves, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone and LAN equipment.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.10 WARRANTIES

A. INSTALLATION WARRANTY. The Contractor shall warrant the cabling system unconditionally against defects in workmanship for a period of two (2) years from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. Replacement of faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

B. Copper drops shall be warranted to results defined in the channel specifications of ANSI/TIA-568-C.2 Category 6A.

C. Fiber optic links shall be warranted to the link and segment performance minimum expected results defined in ANSI/TIA-568-C.1.

D. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

E. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

F. The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and covering follow-on support after project completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Horizontal Cabling

    a. Amp
    b. General Cable Corp.
    c. Belden
    d. Ortronics

2. Horizontal Termination Hardware

    a. Amp
    b. General Cable Corp.
    c. Belden
    d. Ortronics

3. Copper Backbone Cabling

    a. General Cable Corp.
    b. Superior Essex
    c. Belden
    d. Ortronics

4. Optical Fiber Cabling and Termination Hardware

    a. Corning Cable Systems

5. Protection

a. AT&T
b. Marconi

2.2 PATHWAYS

A. General Requirements: Comply with ANSI/TIA-569-C.

B. Cable Trays:

1. Comply with requirements in Division 16 Section "Cable Trays for Communication Systems".

C. Conduit and Boxes: Comply with requirements in Division 16 Sections "Raceways and Fittings for Electrical Systems" and "Cabinets, Outlet Boxes, and Pull Boxes for Electrical Systems" except as noted below.

1. All outlet boxes for communications shall be no smaller than 5" x 5" x 2-7/8" deep with a single or double gang plaster ring and integral wire management. Outlet plaster rings shall be as required for faceplates.
2. Minimum conduit size for communications is 1-1/4". Interior conduit shall be EMT or RGS. Exterior conduits shall be Schedule 40 PVC encased in 3" of concrete per detail.
3. A bonding jumper shall be used to ensure continuity to cable tray.
4. Provide all conduits with connector and insulated bushing at their termination point.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4" x 96" inches tall. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry".

2.4 EQUIPMENT FRAMES

A. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

B. Floor-Mounted Racks: Modular-type, steel construction.

1. Heavy duty aluminum 7' tall, floor mount racks with cable management channels on both sides and mounting rails for 19" equipment.
2. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
3. Baked-polyester powder coat finish.

C. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers. Provide vertical management on both sides of all racks.
4. Provide horizontal crossover cable manager at the top of each relay rack and between/below all patch panels, with a minimum height of two rack units each.

D. Rack Mounted Hardware

1. Rack elevation drawings showing termination hardware placement are required for approval prior to installation. Optical fiber distribution shelves shall be installed in the top positions of the rack. For MDF/IDF rooms with multiple racks, blank panels will be installed in the top positions to reserve the equivalent of seven (7) rack mount spaces in

all racks that do not require fiber closures. Patch panels will be installed with horizontal wire management panels above, below and in between each panel.

E. Wall Mounted Hardware

1. Wall mounted voice blocks shall be properly secured to the plywood backboard. Location of the blocks within the MDF/IDF rooms shall be approved by CNS Design and Engineering. D rings shall be installed for wire management on the backboard. Standard 50 pair 66 blocks or 110 blocks shall be used for voice backbone cable terminations not requiring protection. Provide wall mounted protection blocks.

2.5 UTP BACKBONE CABLE

A. Description: 100-ohm, UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket.

1. Comply with ANSI/ICEA S-90-661 for mechanical properties.
2. Comply with TIA/-568-C.1 for performance specifications.
3. Comply with TIA/-568-C.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Riser Rated: Type CMR or CMP complying with UL 1666.

B. All cable that enters or exits any building shall be provided with MOV protectors on each end. Entrance protectors shall be Avaya 489BCB1 with 4C1S capital modules or equal.

2.6 UTP BACKBONE CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: 110-style IDC for Category 6A. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated plus spares and blank positions adequate to suit specified expansion criteria.
2. Style: Panels shall be 48 port or 24 port angled style.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.7 UTP HORIZONTAL CABLE

A. Description: 100-ohm, 4-pair Unshielded UTP, covered with a thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA-568-C.1 for performance specifications.
3. Comply with ANSI/TIA-568-C.2 Category 6A.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG.
b. Communications, Riser Rated: Type CMR or CMP.

2.8 UTP HORIZONTAL CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with ANSI/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: Shielded modular jack to be compatible with cabling system. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

C. Patch Panel: Modular panels housing 24 modular snap-in jack units.

1. Patch panels shall be angled style.
2. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Provide factory-made, four-pair Category 6A cables in 48-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant. Patch cords shall have latch guards to protect against snagging.
2. Provide quantity to match quantity of horizontal cables.

2.9 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: Category 6A 100-ohm, unshielded balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568-C.2.

B. Workstation Outlets: Connector assemblies mounted in two gang faceplate. Provide number of ports as shown on the Drawings.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 16 Section "Wiring Devices and Plates."
2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.10 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Corning Cable Systems

B. Description: Multimode, 50/125 micrometer, laser optimized, non-conductive, tight buffer inside plant optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C.3 for performance specifications.
3. Comply with ANSI/TIA-492AAAA-B for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70.
5. Provide with central non-conductive strength member.
6. Minimum Effective Modal Bandwidth: 2000 MHz-km at 850 nm.
7. Individual fiber strands shall be color coded per telecommunications industry practice.
8. Number of strands shall be as noted on Drawings
9. Fiber strands shall meet the following specifications:

a. Fiber Type - Multi-mode, glass core, glass cladding.
b. Core Diameter - 50 microns +/- 3 microns.
c. Core/Clad Concentricity Error- < or = 3.0 microns.
d. Cladding diameter - 125 microns +/- 1 micron.
e. Cladding Noncircularity- < or = 1%.
f. Maximum attenuation at 850 nanometers (nominal) 3.0 dB/km.
g. Maximum attenuation at 1300 nanometers (nominal) 1.0 dB/km.
h. ISO/IEC 11801 Type: OM3.

C. Description: Multimode, 62.5/125 micrometer, non-conductive, loose tube, gel filled, outside plant optical fiber cable.

1. Comply with ICEA 87-640 for mechanical properties.
2. Comply with TIA/EIA-568-C.3 for performance specifications.
3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
5. Provide with central non-conductive strength member.
6. Minimum Effective Modal Bandwidth: 2000 MHz-km at 850 nm.
7. Individual fiber strands shall be color coded per telecommunications industry practice.
8. Number of strands shall be as noted on Drawings
9. Fiber strands shall meet the following specifications:

a. Fiber Type - Multi-mode, glass core, glass cladding.
b. Core Diameter - 62.5 microns +/- 3 microns.
c. Core/Clad Concentricity Error- < or = 3.0 microns.
d. Cladding diameter - 125 microns +/- 1 micron.
e. Cladding Noncircularity- < or = 1%.
f. Maximum attenuation at 850 nanometers (nominal) 3.5 dB/km.
g. Maximum attenuation at 1300 nanometers (nominal) 1.0 dB/km.
h. ISO/IEC 11801 Type: OM1.

D. Description: Single Mode, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C.3 for performance specifications.
3. Comply with ANSI/TIA/EIA-492-CAAA for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.

5. Provide with central non-conductive strength member.
6. Individual fiber strands shall be color coded per telecommunications industry practice.
7. Number of strands in cable shall be as noted on Drawings
8. Fiber strands shall meet the following specifications:

a. Fiber Type - Single-mode, glass core, glass cladding
b. Core Diameter - 8.0 to 9.0 microns
c. Core/Clad Concentricity Error- < or = 0.8 micron
d. Cladding diameter - 125 microns +/- 1 micron.
e. Cladding Noncircularity- < or = 1%
f. Maximum attenuation at 1310 nanometers (nominal) 0.65 dB/km.
g. Maximum attenuation at 1550 nanometers (nominal) 0.5 dB/km.
h. ISO/IEC 11801 Type: OS2

E. Jacket:

1. Jacket Color:

a. single mode-yellow

b. OM1-orange
c. OM3-aqua
d. OSP-black

2. Cable cordage jacket, fiber, unit, and group color shall be according to ANSI/TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.11 OPTICAL FIBER CABLE HARDWARE

A. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

B. Patch Cords: Provide factory-made, dual-fiber cables in 36-inch (900-mm) lengths, quantity to match quantity of fibers.

C. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with ANSI/TIA-568-C.3.
2. Quick-connect, simplex and duplex, Type SC.

2.12 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to ANSI/TIA-568-C.1.

B. Factory test UTP cables according to ANSI/TIA-568-C.2.

C. Cable will be replaced by contractor if it does not pass tests listed above and inspections.

D. Prepare test and inspection reports.

2.13 GROUNDING

A. Comply with requirements in Division 16 Section "Grounding and Bonding for Electrical Systems” for grounding conductors and connectors.

B. Comply with ANSI -607-B.

C. Communications Ground bar.

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600V. Lexan or PVC, impulse tested at 5000 V.

2.14 LABELING

A. Comply with TIA/EIA-606-B and UL 969 requirements for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Install buried entrance pathway complying with Division 16 Section "Raceway and Fittings”.

B. Comply with NECA 1.

C. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 WIRING METHODS

A. Wiring Method: Install cables completely within raceways and cable trays. Conceal raceway except in unfinished spaces.

1. Complete with requirements for raceways and boxes specified in Division 16 Sections "Raceway and Fittings for Electrical Systems" and "Cabinets, Outlet Boxes, and Pull Boxes for Electrical Systems".
2. Complete with requirements for cable trays specified in Division 16 Section "Cable Trays for Communication Systems".

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA-569-C.

1. Complete with requirements for cable trays specified in Division 27 Section "Cable Trays for Communication Systems".

B. Comply with ANSI/TIA-569-C for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows whenever possible.

D. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays complete around room as shown on drawings. Install cable ladder directly on top of racks and connect to perimeter tray. Refer to drawings for elevation.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 4 inches above finished floor and/or 18" below ceiling structure.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding bar.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints. Provide on all walls.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware for backbone cable and modular jacks for horizontal cable.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 30-foot long service loop on each end of fiber optic cable. Copper cables shall take the longest path around the room prior to landing on racks.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with ANSI/TIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with ANSI/TIA-568-C.3.
2. Cable shall be terminated on connecting hardware that is rack mounted.
3. All optical fiber cable installed shall be provided with supplemental protection. (1" minimum innerduct.)

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and ANSI/TIA-598-C recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 12 inches.

G. A pull string shall be installed in all conduits, including those with cables installed. String shall be securely tied off at both ends.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with ANSI/TIA-569-C, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter and Division 16 section "Grounding and Bonding for Communication Systems". Refer to the drawings for interconnections and cable sizes.

B. Comply with ANSI-607-B.

C. Bond metallic equipment to the grounding bus bar, using not smaller than #6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-B. The identification scheme shall be coordinated with the owner prior to any labeling or testing.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-B. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
b. Label each unit and field within distribution racks and frames.

3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
4. Both ends of all backbone cable shall be labeled. Labels will be self-laminating and machine generated. The label shall contain the following information:

a. The Origination (TR it is feeding from).
b. The Destination (TR it is feeding).
c. Number of pairs or fibers

5. Both ends of all horizontal cables shall be labeled. Labels shall be self-laminating and machine generated. The cable, workstation faceplate, panel ports and block positions shall be labeled with the room number, location in room, outlet type & # (data D1, D2,

etc). In rooms with multiple outlets, label clockwise as you enter the room: 1, 2, 3 e.g. a data port at the first drop location to the left of Room 216 door would be (216-1 D1). When terminating workstation cables in the TR, organize and label the cables in numeric room number order at the patch panel.

6. Owner (MCPS) will approve all labeling schematics prior to installation. "As-Built" drawing with all outlets identified shall be provided.

3.8 Labels shall be self-laminating or computer-printed type with printing area and font color that contrasts with cable jacket color. Handwritten labels will not be acceptable.

A. Cables use flexible vinyl or polyester that flex as cables are bent.

3.9 MANHOLE CABLES AND LABELING

A. All cables entering a manhole or pull-box shall loop around the manhole to allow for expansion of the cable. Looped cable shall be kept a minimum of six (6) inches above the floor of the manhole. All cables will be labeled at both ends using aluminum or stainless steel tags with the following information:

1. The owner of the cable
2. Cable number
3. Cable type
4. Pairs utilized
5. Termination point.
   Example: WCPS, Cable 05, SS 100, 101-200, PKS #2

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568-C.1.
2. Visually confirm Category marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

   a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

      1) All multimode fiber cables shall be tested at both 850 nm and 1300 nm after installation. Printed test results for each fiber strand are required. All tests are to be performed in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper. Fibers will be considered acceptable if the OTDR

trace for that fiber shows an end to end loss of less than xxdB + yy(0.2)dB + zz(0.5)dB (where yy is the number of splices, zz is the number of connector pairs and xx is calculated using the following formula: xx = distance X fiber attenuation/unit distance @ lambda). In addition, no splice may show a loss of greater than 0.2 dB and no connector pairs may show a loss of greater than 0.5 dB. Any additional tests required by the ANSI/TIA/EIA standard shall also be performed and also included in the written test report.

2) The vendor shall perform tier 2 testing on each fiber strand utilizing a OTDR bi-directional tester at the wavelengths specified above. Overall, the OTDR test results shall be made up of the wavelength of the conducted test, the link length, attenuation, cable identification, the locations of the near end, the far end and each splice point or points of discontinuity. Hard-copy and electronic copy results for each fiber strand shall be submitted as part of "As- Built" documentation.

6. UTP Performance Tests:

a. Test for each outlet. Perform the following tests according to ANSI/TIA-568-C.1 and ANSI/TIA-568-C.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

b. Final Verification Tests: Perform verification tests for UTP, and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

1) Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. If the cable or termination fails to meet the above requirements, it shall be replaced by the contractor at the contractor’s expense.

E. Prepare test and inspection reports documenting compliance with all requirements of these specifications. Provide three (3) printed copies and two (2) compact disks of all data.

PART 4 - PARTS LISTINGS

4.1 Approved Manufacturers and Parts List

A. Horizontal Cabling

1.	F/UTP 4/24 Category 6A PVC Cable (Black)	Amp	4-1499389-2

B. Horizontal Termination Hardware

1.	6 Port Faceplate	Amp	557691-X
2.	4 Port Faceplate	Amp	558088-X

3.	2 Port Faceplate	Amp	557505-X
4.	Cat 6A XG Shielded Modular Jack	Amp	1711342-2
5.	Blank Inserts	Amp	406339-X
6.	Green Data Icons	Amp	558198-3
7.	Modular Furniture Faceplate (confirm opening size with furniture supplier)		
8.	Back Box for Data Outlet 5” x 5” x 2-7/8”	Randl	
9.	Back Box for Cat 6A Outlets 5” x 5” x 2-7/8”	Randl	
10.	24 Port Category 6A Patch Panel	Amp	
11.	Horizontal Cable Mngmnt Panels 1 RMS	Panduit	CMPH1
12.	7" Blank Panel Kit	Amp	556965-4
13.	300 pr 110 Block Kit w/ legs	Amp	569446-1
14.	100 pr 110 Block Kit w/legs	Amp	569440-1
15.	Rack Mount 100 Pr 110 Block	Amp	558635-1

X = coordinate color of faceplates, modular outlets, and blanks (all same color) with the end user and electrical faceplates (if not stainless steel).

C. Copper Backbone Cabling

1.	300 pr UTP Riser Cable	General Cable	2133373
2.	200 pr UTP Riser Cable	General Cable	2133323
3.	100 pr UTP Riser Cable	General Cable	2133144
4.	25 pr UTP Riser Cable	General Cable	2133033
5.	900 pr OSP Armored 24 AWG	General Cable	7525876
6.	600 pr OSP Armored 24 AWG	General Cable	7525868
7.	300 pr OSP Armored 24 AWG	General Cable	7525843
8.	25 pr OSP Armored 24 AWG	General Cable	7525785

D. Optical Fiber Cabling and Termination Hardware

1.	24 Strand OFNR Fiber Cable SM	Corning Cable Systems	024R81-33131-24
2.	24 Strand OFNR Fiber Cable 62.5 MM	Corning Cable Systems	024K81-33130-24
3.	24 Strand OFNR Fiber Cable OM3 MM	Corning Cable Systems	024S81-33180-24
4.	12 Strand OFNR Fiber Cable SM	Corning Cable Systems	012R81-33131-24
5.	12 Strand OFNR Fiber Cable 62.5 MM	Corning Cable Systems	012K81-33130-24
6.	12 Strand OFNR Fiber Cable OM3 MM	Corning Cable Systems	012S81-33180-24
7.	6 Strand OFNR Cable MM	Corning Cable Systems	006K81-31130-24
8.	Outdoor Hybrid Fiber 48MM/48SM	Corning Cable Systems	096XW4-141XXA20
9.	Outdoor Hybrid Fiber 24MM/24SM	Corning Cable Systems	048XW4-141XXA20
10.	Outdoor Hybrid Fiber 12MM/12SM	Corning Cable Systems	024XW4-141XXA20
11.	Outdoor Hybrid Fiber 6MM/6SM	Corning Cable Systems	012XWR-141XXA20
12.	1” Innerduct (orange)		
13.	Fiber Connector Housing Pretium®	Corning Cable Systems	PCH-04U
14.	Fiber Connector Housing Pretium®	Corning Cable Systems	PCH-02U
15.	Fiber Connector Housing Pretium®	Corning Cable Systems	CCH-01U
16.	Connector Housing Panels (12 SM fiber)	Corning Cable Systems	CCH-CP12-59
17.	Connector Housing Panels (12 MM fiber)	Corning Cable Systems	CCH-CP12-91
18.	Connector Housing Panel (12 LOMMF)	Corning Cable Systems	CCH-CP12-E6
19.	Connector Housing Panels (6 SM fiber)	Corning Cable Systems	CCH-CP06-59
20.	Connector Housing Panels (6 MM fiber)	Corning Cable Systems	CCH-CP06-91
21.	Fiber SC Unicam Connector MM	Corning Cable Systems	95-000-41
22.	Fiber SC Connector SM	Corning Cable Systems	95-200-41
23.	Fiber SC Connector LOMMF	Corning Cable Systems	95-050-41-X
24.	Buffer Tube Fan Out Kit	Corning Cable Systems	

E. Telecommunications Room Racks

1.	7' floor rack	Ortronics	Mighty Mo
2.	12” Universal Cable Tray	Zero PFT	LR1012J

F. Cable Tray

1.	Cable Tray (6” rung spacing)	Monosystems	
2.	Horizontal Elbows, Vertical Risers, Ts,		
3.	Radius Drop Out		
4.	Connection components		

G. Protection

1.	Terminal Protection Block 100 pr	Marconi	R-355
2.	Solid State Protector Modules	Corning Cable Systems	6SPE-BT
3.	Bldg Entrance Protector Panel (100 pr)	Avaya	489BCB1-100
4.	Solid State Protector Module	Avaya	4C1S

H. Infrastructure Splice Components

1.	Splice Closure	Preformed	8000635
2.	Splice Closure End Plate Kits	Preformed	800081098
3.	MS 2 Splicing Module (Dry)	3M	4000-D/TR
4.	MS 2 Splicing Module (Filled)	3m	4000-D

END OF SECTION

DIVISION 27 - COMMUNICATIONS

SECTION 270900 - AI-PHONE DOOR ENTRY SYSTEM

PART 1 – DISCRIPTION OF WORK:

1.1 The work to be provided under this section consists of furnishing and installing all equipment, cabling and labor required for a complete, operable Door Entry System.

1.2 D**oor release hardware is not noted on this spec.**

1.3 Equipment locations are indicated on the project drawings.

1.4 CABLE:

1.4.1 Cat 6A plenum cable. Cabling shall be yellow.

PART 2 - SCOPE OF WORK:

2.1 Contractor is to program each unit as per instructions from the principal of the school.

2.2 The contractor is to install the Ethernet switch in a rack in the MDF or IDF room.

2.3 The contractor will provide all labor, cabling, accessories and hardware needed to complete the installation.

2.4 To insure the integrity and serviceability of the AI-Phone Door Entry System, all equipment and cable shall be installed by an AI-Phone Door Entry System contractor.

2.5 The entire installation will comply with all applicable electrical and safety codes and **shall be installed per the manufactures specifications.**

2.6 The Contractor shall guarantee the equipment supplied to be free from defects and workmanship for a period of one year from the date of installation. All labor and materials shall be provided by the Contractor during normal working hours to make repairs at no expense to the Owner.

2.7 Upon completion of the installation of the AI-Phone door entry system and after the system has been fully tested, the Contractor shall furnish the Architect with a written statement certifying that the system and materials are in compliance with contract documents, and that the complete system is in proper working order and also that the Owner's personnel have been fully instructed as to the correct operation and maintenance of system.

2.8 To ensure the integrity and serviceability of the AI-Phone door entry system, all equipment and cable shall be installed and programmed by a factory trained technician employed by an authorized AI-Phone authorized dealer.

PART 3 – EQUIPMENT:

3.1 Only the specified "Base Bid System" manufacturers specified will be considered.

3.2 **Note: The Data Switch must be labeled as follows: "For Use Of AI-Phone Only, Not A Network Switch"**

PART NUMBER	ITEM DESCRIPTION
ISIPDV	AI-Phone IP Video Door Station VNDL
ISIPMV	AI-Phone IP Video Master Station ***IS*** series
TQTPES80	Trendnet 8 Port Unmanaged Switch

END OF SECTION

DIVISION 27 - COMMUNICATIONS

SECTION 272800 – AUDIO/VIDEO SYSTEMS

PART 1 – GENERAL

1.1 The Audio/Video System Contractor is to furnish all materials, equipment, labor, professional services and instrumentation necessary to provide and install the system as herein described and indicated on the drawings in order to provide a complete and operating sound system.

1.2 This Contractor shall guarantee all equipment and wiring free from inherent mechanical or electrical defects one year warranty from date of installation.

1.3 This Contractor shall guarantee all equipment and wiring for two-years from the date of substantial completion, after acceptance testing of the system is performed and shall perform all repairs at no charge to MCPS during this time period.

1.4 The Equipment Supplier shall be a factory authorized franchised dealer for the products that they propose to furnish. The franchise agreement shall be available for inspection upon request.

1.5 The installation contractor shall show satisfactory evidence upon request that they maintain, within a fifty mile radius of the project, a fully equipped service shop with standard replacement parts. All installation and service performed shall be by factory trained personnel.

1.6 Provide all materials, equipment and services as specified herein.

1.7 Install speakers and equipment in locations as shown on drawings.

1.8 All installation of equipment is to be performed by Professional Sound Contractor including but not limited to speakers and final termination.

1.9 The sound system supplier shall be a “Sound System Contractor” who regularly engages in the provision and installation of professional sound reinforcement systems.

1.10 The Sound System Contractor shall be responsible for the installation of all cable, speakers, control and amplification equipment, final termination, and programming. The Contractor is responsible for leaving properly sized conduits with pull wires, standard electrical boxes, and 120V power for Sound System Contractor use.

1.11 The Sound System Contractor shall be Authorized Dealers of equipment as listed within this specification to provide full factory warranty for equipment provided.

1.12 The Scope of this project requires a Sound System Contractor maintaining a technical staff of no less than 15 full time technicians for support and service during the warranty period.

1.13 Proposed Contractor shall provide a list of technicians during the submittal phase of the project. Failure to comply will result in immediate rejection of submittal.

1.14 CONTRACTOR QUALIFICATIONS AND QUALITY ASSURANCE

1.14.1 The installation Contractor shall be an established audio/sound contractor that has currently maintained a locally run and operated business for at least five years. Further this contractor must have a minimum of 8 years' experience in the specific installation, programming and application of professional grade sound systems.

1.14.2 The installation Contractor shall factory trained personnel. The contractor shall submit written proof of their employee system training to the engineer and owner upon request.

1.14.3 The installation Contractor shall show satisfactory evidence, upon request, that it maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system with personnel trained by the system manufacturer. The installation contractor shall maintain at its facility an inventory of spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

1.14.4 All bids shall be based on equipment herein mentioned and specified. All substitute equipment shall be prequalified in writing (by addendum) by the Engineer, (CMTA) no later than ten (10) days prior to bid date. The substitute equipment supplier shall furnish, to the Engineer, system riser diagrams, engineering data and or samples of the alternate equipment, supporting compliance with the specifications, for prequalification.

1.14.5 All systems provided under this section shall be furnished with a one year warranty by the Contractor and longer factory warranties as available in standard products.

1.14.6 The intent of these Specifications is to describe and provide for complete Sound Systems of high professional quality and reliability. Professional performance standards by the Theatrical Sound Contractor (hereafter referred to as Installer) and the equipment will be required.

1.15 SINGLE SOURCE RESPONSIBILITY AND OBSOLETE EQUIPMENT

1.15.1 Except where specifically noted otherwise, all equipment supplied by the contractor shall be the standard product of a single manufacturer of known reputation and experience in the industry. Only equipment, components and accessories in current production for at least five years beyond the completion date of this system shall be used and installed. Any equipment found to be obsolete or not in future production will be removed and replaced at contractor's expense.

1.16 APPROVED EQUIPMENT

1.16.1 Bids must be submitted on the basis of the specified materials and manufactures or equal. Alternative materials and manufacturers must be approved as an equal by the engineer and the MCPS Electronic Maintenance Department and listed in an addendum to these specifications.

1.16.2 MCPS reserves the right to determine or equal.

1.16.3 Reference the paragraphs under "SUBSTITUTE EQUIPMENT PREQUALIFICATION" for the requirements to approve alternative systems.

1.17 SUBSTITUTE EQUIPMENT PREQUALIFICATION

1.17.1 Proposals for substitute or alternative manufactures, components, materials, and /or equipment must be received no later than fourteen (14) working days prior to bid opening date. These proposals shall include the following:

1.17.1.1 An index list showing the model and manufacturer of equipment installed in a facility, names of references at that facility, and approximate contract amount, where said equipment has been installed and business phone numbers of the contractor/suppliers principal owners.

1.17.1.2 A complete index of models and manufacturers for equipment and materials proposed for this project. Complete engineering data, catalog information, wiring, warranty information that states all components covered and length of warranty and connection diagrams and system layout drawings shall be included with this index.

1.17.2 NOTE: The Owner and Engineer shall be under no obligation to pre-qualify additional (substitute) equipment and / or manufacturers. However, if such pre-qualification is granted, it must be done in addendum form no later than four (4) days prior to bid opening date, thus informing all Contractors that the submitted substitute equipment is now ALTERNATE EQUIPMENT and will be considered for this project. Approval granted for such substitute manufactures, components, materials, and /or equipment is only an initial approval and does not relieve the contractor of furnishing components, materials, and /or equipment that complies with or exceeds the performance and quality as specified. Final approval of the alternate equipment shall be determined at the time of job completion. Failure to provide the “precise functional equivalent” shall result in the removal of the alternate equipment and replacement with the specified equipment at the contractor’s expense.

1.18 SHOP DRAWINGS AND SUBMITTALS

1.18.1 Equipment Data Sheets (EDS) shall be submitted on all components and materials provided by the contractor including cable types if applicable.

1.18.2 Shop drawings including locations of field devices, cabling and cable routes through the building, rack layout and location and typical wiring diagrams shall be submitted and approved by the project manager, prior to beginning work.

1.18.3 The system program shall be submitted and approved by the YPAS instructor.

1.18.4 The UL listing card and other documents verifying compliance with to UL/CSA 60065 and FCC Standard C108.8 shall be submitted for equipment supplied by the contractor where applicable.

1.18.5 Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work.

1.18.6 Drawings shall be prepared and submitted on 30" x 42" paper. Equipment lists, data sheets, etc. shall be 8-½” x 11" size, properly bound into a single or multiple volumes as necessary. Submit quantity in accordance with Division 1, General Requirements.

1.18.7 Within 30 days after the notice to proceed, submit to the Architect identical copies of the following for approval:

1.18.7.1 A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.

1.18.7.2 Manufacturers' data sheets on all equipment items.

1.18.7.3 Equipment rack layouts showing locations of all rack mounted equipment items.

1.18.7.4 Floor plans and reflected ceiling plans, prepared at a scale of not less than 1/8”=1'-0", showing loudspeaker locations and orientation, wall plates, and all other related device locations.

1.18.7.5 Proposed construction details for any custom fabricated items, including interface panels, patch panels and patchbays, wall plates, speaker mounts and rigging details. These details shall show dimensions, materials, finishes and color selection.

1.18.7.6 Comprehensive system schematics, showing detailed connections to all equipment, with wire numbers, terminal block numbers, and color coding.

1.18.7.7 Riser diagrams showing conduit requirements with pull boxes, outlet boxes, physical cable layouts, part numbers of cable types used, and number of circuits in each conduit.

1.18.7.8 Electrical power requirements for head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with the electrical contractor, showing exact conduit requirements and locations for switched duplex receptacles.

1.18.8 Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

1.18.9 All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Submit the following in accordance with Division 1, General Requirements. The Installer shall provide final documentation in both hard copy and electronic formats. Suitable electronic formats include Microsoft Word and Excel, AutoDesk (.dwg, .dwf), and Adobe Acrobat (.pdf)

1.18.9.1 A complete as-installed equipment list, listed by room, with manufacturers' names, model numbers, serial numbers, and quantities of each item.

1.18.9.2 A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and codes. System performance measurements as noted elsewhere in this specification shall be documented. Include diagrams or charts showing final settings of all control knobs in the system (mixers, equalizers, power amplifiers, etc.). Submit copies of software settings of each piece of equipment that is software controlled.

1.18.9.3 Complete equipment rack layouts showing locations of all rack mounted equipment items.

1.18.9.4 Floor plans and reflected ceiling plans, prepared at a scale of not less than 1/8"=1'-0", showing loudspeaker locations and orientation, wall plates, rack locations, and other related device locations.

1.18.9.5 Riser diagrams showing as-installed conduit with pull boxes, outlet boxes, physical cable layouts, part numbers of cable types used, and number of circuits in each conduit.

1.18.9.6 Repair parts lists for each and every major equipment item furnished.

1.18.9.7 Manufacturer's warranties and operating instructions for each and every equipment item furnished. Include a copy of the certificate of warranty, signed by both parties.

1.18.9.8 Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.19 WARRANTY AND SERVICE

1.19.1 Theatrical Sound System: The Theatrical Sound System Contractor shall provide an unconditional two-year warranty covering the installation, equipment, parts, labor, and programming of the installed system against defects in material and workmanship and provide repairs on the systems' equipment for the same time period. All labor, trip charges and materials shall be provided at no expense to the owner during this two-year period. The warranty period shall begin on the date of project substantial completion unless system is not operational or it is determined the system was not acceptable by the Owner/Engineer on that date.

1.19.2 Guarantee all parts, labor, and workmanship furnished under this contract for a period of two-years from the date of substantial completion.

1.19.3 During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

1.19.4 Where warranties on individual pieces of equipment exceed two-years, the guarantee period shall be extended to the warranty period of the particular items.

1.19.5 The equipment items shall be supported by service organizations which are reasonably convenient (less than 50 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.19.6 The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

1.19.7 Included in the warranty, and additional to the maintenance service is one visit scheduled to

occur approximately thirty (30) days prior to expiration of this warranty. The contractor will contact the owner approximately sixty (60) days prior to the expiration of the warranty to arrange visits to be at a time mutually agreeable to the Owner and Contractor. During the visit the technician will thoroughly examine system components, including error logs and replace failing or failed components.

1.20 RELATED WORK IN OTHER SECTIONS

1.20.1 All conduit with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation.

1.20.2 All 120VAC power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Division 26. The 120VAC power to the equipment racks shall be terminated inside the racks to isolated ground outlets.

1.20.3 An insulated #3 AWG stranded copper ground wire, sized according to NEC, shall be installed under the electrical section of Division 26 from the equipment racks sheet metal to the primary ground point within the building, and terminated at each end to bare metal using approved connectors and clamps.

PART 2 - PRODUCTS

2.1 GENERAL

2.1.1 All items shall be new and unused.

2.1.2 The following sections specifically list the acceptable equipment types and items for this project. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.

2.1.3 Note: All existing sound system equipment removed and not to be reused, is to be turned over to the school.

2.1.4 Note: All wire used shall be plenum rated.

2.2 CLASSROOM SOUND REINFORCEMENT
2.2.1 955 Access system w/(2) Flexmike's and (1) Charger
2.2.2 (1) TCO Multimedia ceiling speaker

2.3 GYM PROJECTORS AND PROJECTION SCREENS
2.3.1 Projection screens, 106” (H) x 188” (W). The Advantage® Deluxe Screen shall have two motors, one to operate door and one to operate screen. Door motor electrically operated 120 volt (60 Hz) not more than 1.2 amp, mounted inside the roller, to be three wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have pre-set but adjustable limit switches to automatically stop fabric door in the open position. The roller to be of 1.6" diameter aluminum. Screen motor is electrically operated 120 volt (60 Hz) not more than 2.4 amp, mounted inside the roller, to be three wire with ground quick reversal type, oiled for life,

with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the “up” and “down” positions. Rigid metal roller, to be at least 5¾" in diameter (on screens 14' to 18' wide) or 7" in diameter (on screens where either height or width equal or exceed 20'). Screen fabric to be flame retardant and mildew resistant fiberglass with black masking borders standard. Bottom of fabric shall be formed into a pocket holding a metal rod with plastic caps. Case shall be a white powder coated aluminum extrusion. Bottom of case to be self-trimming with a built-in flange around the bottom of the case. A section of the bottom of the case shall be a retractable aluminum door that opens and closes automatically with the lowering and raising of the picture surface. The balance of the bottom of the case shall be a second aluminum door with manual opening to provide access. Junction box shall be internally integrated into the housing making it possible to install the housing and wire to the building’s electrical system during construction. The junction box shall contain a quick connect connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site. To be complete with integrated low voltage control unit and three position control switch with cover plate. Suitable for use in environmental air space in accordance with section 300-22 (c) of the National Electric Code, and sections 2-128, 12-010 (3) and 12-100 of the Canadian Electrical Code, part 1, CSA C22.1. Screen to be listed by Underwriters’ Laboratories.

2.3.2 Projection Technology Single chip DLP Resolution WUXGA 1920 x 1200 Brightness 10,000 ANSI lumens Colors 16.7 million colors Aspect Ratio Native 16:10 / 4:3, 14:9 and 16:9 compatible Contrast Ratio 2500 : 1 (using active IRIS) Throw Ratio (distance : width) Specification will vary depending on which lens is used with the projector. Focus Distance 69" - 1258" (with SD903 lens) Display Size 50" - 600" Lens & Operation Lens Specification will vary depending on which lens is used with the projector. Lamp Wattage 430W (Dual) Expected Lamp Life* Approximately 2,000 hours (Standard mode) 4,000 hours (Eco mode), 1,000 hours (Portrait mode) Expected Filter Life** Approximately 15,000 hours Speaker Output N/A Keystone H and V: +/- 30º Compatibility Computer VGA, SVGA, XGA, WXGA/WXGA+/SXGA/SXGA+/WSXGA+/ UXGA/WUXGA, MAC 16" H-Sync 31.5 kHz - 106 kHz V-Sync 56 Hz - 120 Hz Composite Video NTSC, NTSC4.43, PAL, PAL-M, -N, SECAM Component Video 480i, 480p, 576i, 720p, 1080i, 1080p HDMI 480i, 480p, 576i, 720p, 1080i, 1080p, Computer signal TMDS clock 27 MHz - 150 MHz Connectors Digital Input HDBaseT x 1, HDMI x 2, BNC x 1 (SDI/HDSDI/3G), DVI x 1 Computer Input 1 15-pin mini D-sub x 1 (shared with analog component video input) Computer Input 2 N/A Computer Monitor Output 15-pin mini D-sub x 1 Video Input S-Video N/A Composite Video BCN x 1 Component Video 15-pin D-sub shrink x 1 (shared with analog computer in Audio Input N/A Audio Output N/A Network LAN Wired RJ-45 port x 1 Network LAN Wireless USB-A, IEEE802.11 b/g/n - optional wireless adapter required HDBaseT RJ-45 port x 1 USB Type A x 1 (wireless network) Wired Remote Control 3.5 mm stereo mini jack (IN/OUT) Control Terminals 9-pin D-sub x 1 (RS-232 control) Ratings & Warranty Power Supply AC110-120V / AC220-240V, 50/60Hz Power Consumption 1090W / 1070W Operating Temperature 32ºF - 113ºF (0ºC - 45ºC) Normal mode Dimensions (W x D x H) 21.1" x 17.2" x 6.7" (without lens) Weight Approximately 37.7 lbs. (without lens) Provide S2-902 Lens.

2.4 Multi-Purpose Room

2.4.1 Projection screen, 87”(H) x 139”(W), electrically operated 120 volt (60Hz), not more than 2.4 amp with a quick connect male plug-in connector on the motor. Shall have specially designed motor mounted inside the roller, to be three wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric

brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the “up” and “down” positions. Junction box shall be externally integrated into the housing making it possible to install the housing and wire to the building’s electrical system during construction. The junction box shall contain a quick connect connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly. The roller to be of rigid metal. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site. Roller mounting brackets to be adjustable to allow centering or offsetting of the screen within the case. Screen to be designed for left or right-hand motor installation. Screen fabric to be flame retardant and mildew resistant fiberglass with black masking borders standard. Bottom of fabric shall be formed into a pocket holding a metal rod. Heavy duty plastic caps shall protect the ends of the rod. Top, front and back of case to be made of extruded aluminum powder coated white. End caps to be of heavy gauge steel, powder coated white. Bottom of case to have a removable access door. Door to be of extruded aluminum powder coated white. Bottom of case to be self-trimming, with a built-in flange around the bottom of the case. To be complete with integrated low voltage control unit and three position control switch and cover plate. Suitable for use in environmental air space in accordance with section 300-22 (c) of the National Electric Code, and sections 2-128, 12-010 (3) and 12-100 of the Canadian Electrical Code, part 1, CSA C22.1. Screen to be listed by Underwriters’ Laboratories

2.4.2 Projector Lift - Provide projector lift with the following: 23 ½” W x 23 ½” D, maximum projector size should be 20” x 20”, weight Capacity of 35 lbs, and a lowering distance of 48”. Lift specification based on Draper model 300198 Micro Lift.

2.5 Band Room

2.5.1 Projection screen, 87”(H) x 139”(W), electrically operated 120 volt (60Hz), not more than 2.4 amp with a quick connect male plug-in connector on the motor. Shall have specially designed motor mounted inside the roller, to be three wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the “up” and “down” positions. Junction box shall be externally integrated into the housing making it possible to install the housing and wire to the building’s electrical system during construction. The junction box shall contain a quick connect connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly. The roller to be of rigid metal. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site. Roller mounting brackets to be adjustable to allow centering or offsetting of the screen within the case. Screen to be designed for left or right-hand motor installation. Screen fabric to be flame retardant and mildew resistant fiberglass with black masking borders standard. Bottom of fabric shall be formed into a pocket holding a metal rod. Heavy duty plastic caps shall protect the ends of the rod. Top, front and back of case to be made of extruded aluminum powder coated white. End caps to be of heavy gauge steel, powder coated white. Bottom of case to have a removable access door. Door to be of extruded aluminum powder coated white. Bottom of case to be self-trimming, with a built-in flange around the bottom of the case. To be complete with integrated low voltage control unit and three position control switch and cover plate. Suitable for use in environmental air space in accordance with section 300-22 (c) of the National Electric Code, and sections 2-128, 12-010 (3) and 12-100 of the Canadian Electrical Code, part 1, CSA C22.1. Screen to be listed by Underwriters’ Laboratories

2.6 VOCAL AND BAND ROOM SOUND/ RECORDING SYSTEM/VIDEO PROJECTION

2.6.1 General Description

2.6.1.1 The system is to provide sound reinforcement within the room for playback or accompany functions.
2.6.1.2 The Main Head End is to be housed within a sectional wall cabinet as shown on drawings.
2.6.1.3 All microphones are to be terminated in the wall cabinet.
2.6.1.4 Hanging microphones are for recording purposes only
2.6.2 Acoustic Performance
2.6.2.1 The frequency response of the system shall be measured in the free field with a calibrated spectrum analyzer. The Frequency Response curve shall be flat from 100 Hz to 6 kHz with a 3 dB per octave roll off above 6 kHz.
2.6.2.2 System shall be capable of providing an average SPL of 92dB with a Standard Deviation of 1.6dB.
2.6.2.3 Check system for any RFI and remove unwanted signal as required.
2.6.2.4 The Sound Contractor shall provide factory trained technicians utilizing professional grade testing equipment and software to measure sound pressure, intelligibility, and frequency response.
2.6.2.5 Alternate manufacturers will be considered with the submission of the following criteria 10 days prior to bid.
2.6.2.5.1 Data sheets on proposed digital platform.
2.6.2.5.2 Full system point to point flowchart showing all processing, mixing, and system performance data.
2.6.3 Products
2.6.3.1 Main Equipment Cabinet

The E.I.A. Compliant, UL Listed (Standard 1678) welded rack shall be Lowell Model LWR-1623. The rack shall consist of two parts, a backbox and a mounting section with side vents. The mounting section shall be 14.18"D and formed of 16-gauge certified U.S. steel
with triple-formed side-to-bottom and side-to-top wrapped construction to achieve strength equivalent to 3/16" thick steel. It shall include one pair of front-to-rear adjustable mounting rails tapped 10-32 (mounting hardware included), integral rails on E.I.A. spacing (top and bottom), and knockouts for BNC style antennae (top and bottom). The mounting
section shall attach to the backbox from the inside using two heavyduty, spring-loaded L-pins that are self seating and positive locking. The L-pins shall be capable of being moved to the opposite side to change swing orientation if needed. The backbox shall be 4.69"D and
formed from 16-gauge certified U.S. steel with keyhole mounting slots on 16" centers. It shall include a 10" x 10" opening for mounting over electrical pull boxes, removable knockout panels (top and bottom), embossed dimples and lacing points on the back plane, and two locks on the 4.69"D side for security between the backbox and the mounting
section. Knockout panels shall be equipped with 0.5" knockouts for BNC and compound knockouts for conduit size .75"-.5" and 1.5"-1". The mounting section and backbox shall have a black wrinkle powder epoxy finish. Provide quantity of 1 with Fully Vented Front Locking Door.

2.6.3.2 Mixer

The mixer shall have four studio-grade mono mic/line inputs each with XLR input jack, 15 V phantom power, line pad, A / A+B / B mix assign switch, level control and signal/overload indicator. A single switch shall make phantom power available to all four microphone inputs. Phantom power shall be removed automatically from any mic/line input set for line input. For ease of use, mic/line preamplifiers shall use a single control for input gain trim and mix level. The mixer shall feature four stereo line inputs each with

¼" TRS input jack, level control and pre-level control mono switch. The inputs shall provide for dual mono operation with four mono signals available for the A mix and four mono inputs available for the B mix. A and B mix outputs shall feature overload indicators, independent A/B level controls, internally selected 40 dB pad for microphone level output and XLR output jacks. Security features shall include placement of the phantom power and line switches on the rear panel, recessed assign switches, internally located pad switch for selecting line or microphone output level and recessed stereo line input mono switches with position indicators. The unit shall be capable of operation by means of its own built-in universal power supply operating at 100-240 VAC and meet CE requirements. The unit shall be UL and cUL listed. The unit shall be constructed entirely from cold-rolled steel, and mount into a standard EIA relay rack occupying 1 rack-space. The unit shall be a Rane MLM82S Mic & Line Mixer.

2.6.3.3 Main Speakers-

The loudspeaker system shall be a two-way, full-range compact system with an 8-inch low frequency transducer with patented Carbon Ring Cone Technology™ and a coaxially mounted 1.25-inch exit high frequency compression driver. The drivers shall be connected to an integral crossover with a crossover frequency of 1.3 kHz, with a self-resetting solid state circuit breaker for driver protection. The paintable enclosure shall be constructed of high-impact ABS plastic. The system shall have an amplitude response of 70 Hz to 20

kHz (+/- 4.3dB) and a low impedance (8 ohm) input capability of 35V RMS. The sensitivity at 1W/1m shall be 95 dB (125 Hz to 12.5 kHz, 1/3 octave bands). The loudspeaker system shall have a conical coverage pattern of 115 degrees from 500 Hz to 6 kHz. The nominal system impedance shall be 8 ohms (in low impedance setting). The system shall be equipped with a 120W high performance autoformer for use in 70.7V or 100V distributed audio systems, with 120W, 60W, 30W and 15W taps available in 70.7V distributed systems (120W, 60W and 30W taps available in 100V distributed systems). An easily accessible front-face tap selector switch located behind a rotatable logo shall be available for selecting autoformer and low impedance settings. Dimensions shall be 18.5 inches (470mm) high, 9 inches (230 mm) wide and 10.1 inches (257 mm) deep, with a loudspeaker weight of 17.6 lbs (8 kg). Speaker shall be Community model D8. Acceptable equivalents by EV or RCF.

2.6.3.4 Amplifiers

Overview: Certification and Channel Modes

The power amplifier shall be Energy Star 2.1 certified. It shall provide two discrete channels of amplification, with each channel capable of independently driving either low-impedance or high-impedance (70 V) loads. The output circuit shall be an inherently bridged Class

D topology. Maximum total output with both channels driven shall be 400 W.

Power Output and Performance

The power amplifier shall offer two power output modes (Lo-Z and 70 V) selectable by a rear-panel switch. Power output per channel, both channels driven, shall be as follows in Lo-Z mode: 200 W into 2 ohms, 200 W into 4 ohms, 100 W into 8 ohms and 50 W into 16

ohms. Power output per channel, both channels driven, shall be as follows in 70 V mode: 200 W into 8 ohms, 200 W into 16 ohms, and 200 W into a 70 V system. The amplifier shall incorporate a rail voltage sensing circuit to ensure low distortion. Peak voltage output

per channel shall be 100 V (70 V rms); maximum output current per channel shall be 11 Arms. Power outputs higher than stated prior shall be possible in one channel with asymmetrical loading or with no load connected to the other channel. Gain shall be 35.2

dB in 70 V mode and 27.2 dB in Lo-Z mode. The amplifier shall exhibit the following performance parameters: Frequency response shall be 2 Hz to 40 kHz (+0/-3 dB at 1 watt into an 8 ohm load); channel separation shall be greater than 70 dB; and signal-to-noise ratio shall be greater than 112 dBA. THD at 1 watt (20 Hz - 7 kHz) shall be less than 0.1%; THD at 1 kHz shall be no more than 0.05% at 1 dB below clipping.

Connectors, Controls, and Indicators

The following connectors and controls shall be provided on the REAR PANEL of the amplifier. The input connectors shall be electronically balanced, 3-pin detachable screw terminals. The output connectors shall be 2-pin detachable screw connectors. GPIO (General Purpose Input/Output) functions shall be provided on two 2-pole detachable screw terminal connectors. Two detented potentiometers shall provide level adjustment from -infinity to 0 dB. A power switch shall toggle between On and Standby power states. The following LED indicators shall be provided on the FRONT PANEL of the amplifier: One bi-color power indicator (amber standby, green on); one temperature indicator (flashing amber warning and steady amber over-temperature/mute); two LED indicators per channel, one for signal present and one for limiter active.

Power Supply, Protection, and Cooling

The power supply shall be a universal type (AC line input between 100 and 240 VAC at 50 or 60 Hz). The power supply shall offer three modes for power on/standby/off. Default mode shall be auto-power down (APD): the amplifier shall go into standby mode when no signal is present at the inputs for 20 minutes; power on mode shall resume with restoration of input signal. Standby power consumption shall be less than 1 W. Alternative power modes shall be manually switched on/standby or external power sequencing via GPIO connections.

The amplifier shall be cooled by a temperature-controlled, variablespeed fans with air flow from front to rear.

Physical

The amplifier shall be 483 mm (19 in.) wide, 44 mm (1.75 in / 1 U) high, and 276 mm (10.9 in.) deep. The weight shall be no more than 4.0kg (8.8 lbs). The chassis shall be black painted steel with a grey painted aluminum front-panel. The amplifier shall be approved for use as specified by CE. The amplifier shall be the Lab.gruppen E 4:2. Equal by Crown or QSC but must meet power consumption, power output, and THD Specifications as listed above.

2.6.3.5 Recording and CD

Provide a Network capable SD/USB Audio Recorder. This unit shall record to SD/SDHC and USB Media in MP3 and WAV file formats up to 24-bit 96kHz. It shall offer Dual Record feature, relay record feature, file archiving via FTP, SDL marking and file edit features, and rack kit. Provide Denon Professional DN-700R and Denon DN-500C CD player with iPod dock. Equivalent by Tascam.

2.6.3.6 Sequential Power/Conditioner

Current Rating 15 amps (“E” version 10 amps)
Operating Voltage 90 to 140 VAC (“E” version 180 to 280 VAC)
Over Voltage Shutdown 140 VAC typically (“E” version 280 VAC typically)
Spike Protection Modes Line to neutral, zero ground leakage
Spike Clamping Voltage 188 Vpk @ 3,000 amps, 133 VAC RMS
(tested to UL-1449 6,000 Vpk @ 3,000 amps)
Response Time 1 nanosecond

Maximum Surge Current 6,500 amps
Noise Attenuation
10 dB @ 10 kHz
40 dB @ 100 kHz
100 dB @ 10 MHz
Linear attenuation curve from 0.05 - 100 ohms line impedance
Dimensions 19” W x 10.5” D x 1.75” H
Weight11 lbs (5 kg)
Power Consumption 6 watts
Safety Agency Listings CE, NRTL-C
Three Year Limited Warranty
Model shall be Furman PS-8R II mounted in main equipment cabinet.

2.6.3.7 Wired Microphone

Provide 4 Shure MX200 Series Microphone with Supercardioid Cartridges as shown on plans and terminate to mixer. Provide in black finish and position for optimum pickup of vocal or instrument recording.

2.6.3.8 Projection Screen

SUGGESTED SPECIFICATIONS: projection screen, 87”(H) x 139”(W), electrically operated 120 volt (60Hz), not more than 2.4 amp with a quick connect male plug-in connector on the motor. Shall have specially designed motor mounted inside the roller, to be three wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the “up” and “down” positions. Junction box shall be externally integrated into the housing making it possible to install the housing and wire to the building’s electrical system during construction. The junction box shall contain a quick connect connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly. The roller to be of rigid metal. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site. Roller mounting brackets to be adjustable to allow centering or offsetting of the screen within the case. Screen to be designed for left or right-hand motor installation. Screen fabric to be flame retardant and mildew resistant fiberglass with black masking borders standard. Bottom of fabric shall be formed into a pocket holding a metal rod. Heavy duty plastic caps shall protect the ends of the rod. Top, front and back of case to be made of extruded aluminum powder coated white. End caps to be of heavy gauge steel, powder coated white. Bottom of case to have a removable access door. Door to be of extruded aluminum powder coated white. Bottom of case to be self-trimming, with a built-in flange around the bottom of the case. To be complete with integrated low voltage control unit and three position control switch and cover plate. Suitable for use in environmental air space in accordance with section 300-22 (c) of the National Electric Code, and sections 2-128, 12-010 (3) and 12-100 of the Canadian Electrical Code, part 1, CSA C22.1. Screen to be listed by Underwriters’ Laboratories

2.6.3.9 Projector

Projection Technology 3LCD, 3 chip technology Resolution WUXGA - 1920 x 1200 White Light Output 7,000 ANSI lumens Color Light Output 7,000 ANSI lumens Colors 16.7 million colors Aspect Ratio Native 16:10 and 4:3 / 16:9 compatible Contrast Ratio 10,000 : 1 (using active IRIS) Throw Ratio (distance : width) Specifications will vary depending on which lens is used with the projector Focus Distance 43.3" - 1480.3" Display Size 30" - 600" Lens & Operation Lens Specifications will vary depending on which lens is used with the projector Lamp Wattage 430W Expected Lamp Life* Approximately 2,000 hours (standard mode), 4,000 hours (Eco mode), 1,000 hours

(portrait mode) Expected Filter Life** Approximately 20,000 hours Speaker Output 16W (8W x 2 stereo) Keystone H and V: +/- 5º (with standard lens) Compatibility Computer VGA, SVGA, XGA, WXGA, WXGA+/SXGA/SXGA+/WSXGA+/ UXGA/WUXGA, MAC 16" H-Sync 15 kHz - 106 kHz V-Sync 50 Hz - 120 Hz Composite Video NTSC, NTSC4.43, PAL, PAL-M, -N, SECAM Component Video 480i, 480p, 576i, 720p, 1080i, 1080p HDMI 480i, 480p, 576i, 720p, 1080i, 1080p, Computer signal TMDS clock 27 MHz - 150 MHz Connectors Digital Input HDMI x 2, HDBaseT x 1, Display Port x 1, SDI x 1 Computer Input 15-pin mini D-sub x 1 Computer Monitor Output 15-pin mini D-sub x 1 Video Input S-Video N/A Composite Video RCA jack x 1 Component Video 15-pin mini D-sub (shared with computer input) Audio Input 3.5 mm stereo mini jack x 1, RCA x 1 Audio Output 3.5 mm stereo mini jack x 1 Network LAN Wired RJ-45 jack x 1 Network LAN Wireless USB-A, IEEE802.11 b/g/n - optional wireless adapter required HDBaseT RJ-45 jack x 1 USB Type A x 1 (wireless network) Wired Remote Control 3.5 mm stereo mini jack (IN/OUT) Control Terminals 9-pin D-sub x 1 (RS-232 control) Ratings & Warranty Power Supply AC90-132V / AC198-264V, 50/60Hz Power Consumption 580W / 560W Operating Temperature 32ºF - 113ºF (0ºC - 45ºC) Dimensions (W x D x H) 19.6" x 16.8" x 6.1" (without lens) Weight Approximately 24.5 lbs. Specification based on Hitachi model CP-WU8700W. Mount using Chief RPAUW, CMA 440, and CMS003W.

2.6.3.10 Controller

Provide controller with the following:

Package Type: Single-Gang Decora™ Mounting Dimensions: 4.130" (h) x 1.745" (w) x .90" (d) Weight (PCB with bezel and 3 insert modules): 2.5 oz Power Supply: 6VDC, 300mA Output Type: IR Emitter & unidirectional RS232 Outboard Current-Limiting Resistor (IR Emitter): 150 ohm Recommended Wire: 18- to 22-Gauge 3-conductor wire. Model SP PXE-DCM+ with PXE-EMT-REL2

2.6.3.11 Cable

Speaker cable shall be equivalent to West Penn 224 18/2 Stranded. Signal cable shall be equivalent to West Penn 291

2.7 GYMNASIUM AUDIO VIDEO SYSTEM

2.7.1 General Description

2.7.1.1 The system is to provide sound reinforcement for several different types of events. This is to be accomplished by multiple clusters of speakers.

2.7.1.2 The Main Head End is to house within an equipment rack Digital Mixer, Digital Signal Processing, DSP Configuration Control, Amplifiers, Wireless Router, Wireless Microphone Receivers, Antenna Distribution, and Sequential Power Up/Down System.

2.7.1.3 A remote rolling rack is to house game mixer, Direct Box, and CD/ IPOD Player.

2.7.1.4 System to include a Wireless Router for transmission of signals controlling digital mixer.

2.7.1.5 Digital Control of Video Matrix, projectors, and electric screens.

2.7.1.6 Program DSP for the following modes of operation:

Game Mode- Four Speaker Clusters for bleacher coverage.

Stage Mode-All Speakers and stage monitors.

Video Presentation Mode- Bleacher Speakers

Room Split Presentation Mode-Bleacher Speakers in Left/Right configuration

2.7.2 Qualifications

2.7.2.1 The AV system supplier shall be a “AV System Contractor” who regularly engages in the provision and installation of professional sound reinforcement and video systems.

2.7.2.2 The AV System Contractor shall be responsible for the installation of all cable, speakers, control and amplification equipment, final termination, and programming. The Electrical

Contractor is responsible for leaving properly sized conduits with pull wires, standard electrical boxes, and 120V power for Sound System Contractor use.

2.7.2.3 The Sound System Contractor shall be Authorized Dealers of equipment as listed within this specification to provide full factory warranty for equipment provided.

2.7.2.4 AV Contractor will submit Factory Training Certification for Audio DSP and Video Control Programming Certification with submittal.

2.7.2.5 The AV System Contractor must maintain a fully functional business within Kentucky with no less than 20 full time staff technicians to support the installation and service of equipment.

2.7.3 Acoustic Performance

2.7.3.1 The frequency response of the system shall be measured in the free field with a calibrated spectrum analyzer. The Frequency Response curve shall be flat from 100 Hz to 6 kHz with a 3 dB per octave roll off above 6 kHz.

2.7.3.2 Sound Pressure is not to deviate more than 3 dB in the seated area of the spectators.

2.7.3.3 Check system for any RFI and remove unwanted signal as required.

2.7.3.4 The Sound Contractor shall provide factory trained technicians utilizing professional grade testing equipment and software to measure sound pressure, intelligibility, and frequency response. Equipment and software manufactured by Gold Line, Terra Sonde, and SIA shall be acceptable.

2.7.4 Materials

2.7.4.1 Alternate manufacturers will be considered with the submission of the following criteria 10 days prior to bid.

1. Data sheets on mixer, DSP, amplifiers, projectors, and speakers.
2. Acoustic 3D model analysis of the room utilizing proposed equipment. Data shall demonstrate direct and total sound pressure, and STI Mapping.

2.7.5 Equipment

2.7.5.1 Main Equipment Cabinet-

The stand alone floor rack shall be Lowell Model No. LFR-4027. Overall measurements shall be 76.125”H x 27”D x 23.06”W with panel space of 40 rack units. Load capacity shall be 2000 lbs. The rack shall include a recessed rear door with vents and key lock, welded side panels with vents, 7U top opening that can be closed with the included shipping stiffener panels, open base with grounding stud, one pair fixed-position front mounting rails with printed RU increments, combination knockouts above and below rear door, and provisions to mount optional rear rails or optional surface-mount front door. The rack shall be manufactured in the U.S.A. with certified U.S. steel and have a black wrinkle powder epoxy finish. Provide with UDP-414 Drawer, (2) ACS-1510-RPC Power Strips, and SCS-4RK Sequencer. Blank off all unused rack spaces.

2.7.5.2 Remote Equipment Cabinet

The E.I.A. compliant UL Listed (Standard 1678) rack shall be Lowell
Model LPR-2122, constructed of 16-gauge steel with 14-gauge steel bottom and reinforced at all junctures. The rack shall feature vents above and below the surface-mount (solid, smoked Plexiglas, or fully-vented) front door, which shall include a recessed handle and key-lock. Rack shall include one-pair swivel and one-pair swivel/locking 4" heavy-duty rubber casters with 225 lbs. load rating each (900 lbs. total), vented side panels with recessed handles, recessed rear door with vents and key-lock, and one-pair of adjustable mounting rails tapped 10-32 (field-adjustable to access square-punched holes for alternate hardware needs). The rear of the rack shall feature removable knockout panels above and below the door with .5" knockouts for BNC

wireless antenna, compound knockouts for conduit size .75"-.5" and 1.5"-1", and a blank project panel. Rack finish shall be black wrinkle powder epoxy. Provide with UDP-414 Drawer.
Equipment contained in Remote Rack shall be the following: Power Sequencer, Mixer, CD Player with IPod Dock.

2.7.5.3 Speakers

There shall be six dual vertical splayed speaker clusters. The loudspeaker system shall be a two-way, full-range bass reflex design incorporating one 12 in. (305mm) neodymium LF driver with integrated demodulation ring and double-treated cone and one 1.4 in. exit neodymium HF compression driver with integrated demodulation ring and a ketone polymer diaphragm mounted to a 60° x 60° rotatable fiberglass constant directivity horn. In Passive Mode, drivers shall be connected to an internal frequency dividing network with an acoustical crossover frequency of 950 Hz. There shall be two six-terminal barrier strips and external jumper assembly to allow the selection of Biamp or Passive operating modes on a recessed powder-coated 2mm thick steel input panel. The loudspeaker enclosure shall be 30° trapezoidal in shape. It shall be constructed of 11-layer cross-laminated exterior grade 15mm thick Baltic birch plywood and shall be fitted with 15 x M10 flying/rigging inserts and finished with low gloss, uniformly textured coating. The front of the enclosure shall be fitted with a wraparound powder-coated 1.5mm perforated steel grille backed with color-matched acoustically transparent woven fabric. The system shall have an operating range of 43 Hz to 19.5 kHz (-10dB SPL). In Passive Mode, the system shall have a nominal impedance of 8 Ohms, an input capability of 80V, shall produce a sound pressure level of 94 dB (averaged SPL between -10 dB points) on axis at one meter with a power input of 1 Watt, and shall be capable of producing a continuous output of 123 dB SPL (with peak output of 129 dB SPL) on axis at one meter. In Biamp Mode, the low frequency section shall have a nominal impedance of 8 Ohms, an input capability of 69V, shall produce a sound pressure level of 95 dB (averaged SPL between - 10 dB points) on axis at one meter with a power input of 1 Watt, and shall be capable of producing a continuous output of 123 dB SPL (with peak output of 129 dB SPL) on axis at one meter. The high frequency section shall have a nominal impedance of 8 Ohms, an input capability of 25V, shall produce a sound pressure level of 108 dB (averaged SPL between -10 dB points) on axis at one meter with a power input of 1 Watt, and shall be capable of producing a continuous output of 127 dB SPL (with peak output of 133 dB SPL) on axis at one meter. The nominal dispersion shall be 60° H x 60° V. The loudspeaker shall be 28.00 in. (711 mm) H x 14.50 in. (368 mm) W (front) x 5.83 in. (148 mm) W (rear) x 17.70 in. (449 mm) D, and weigh 54 lbs. (24.5 kg). Speaker shall reside on the top side of the cluster and shall be Community model number IP8-122/66. Provide one per cluster.

The bottom speaker in the cluster shall have the following specifications:
The loudspeaker system shall be a two-way, full-range bass reflex design incorporating one 12 in. (305mm) neodymium LF driver with integrated demodulation ring and double-treated cone and one 1.4 in. exit neodymium HF compression driver with integrated demodulation ring and a ketone polymer diaphragm mounted to a 90° x 60° rotatable fiberglass constant directivity horn. Rotate horn to produce 60 x 90 coverage over bottom bleacher. In Passive Mode, drivers shall be connected to an internal frequency dividing network with an acoustical crossover frequency of 900 Hz. There shall be two six-terminal barrier strips and external jumper assembly to allow the selection of Biamp or Passive operating modes on a recessed powder-coated 2mm thick steel input panel.

The loudspeaker enclosure shall be 30° trapezoidal in shape. It shall be constructed of 11-layer cross-laminated exterior grade 15mm thick Baltic birch plywood and shall be fitted with 15 x M10 flying/rigging inserts and finished with low gloss, uniformly textured coating. The front of the enclosure shall be fitted with a wraparound powder-coated 1.5mm perforated steel grille backed with color-matched acoustically transparent woven fabric. The system shall have an operating range of 44 Hz to 22.4 kHz (-10dB SPL). In Passive Mode, the system shall have a nominal impedance of 8 Ohms, an input capability of 80V, shall produce a sound pressure level of 94 dB (averaged SPL between -10 dB points) on axis at one meter with a power input of 1 Watt, and shall be capable of producing a continuous output of 123 dB SPL (with peak output of 129 dB SPL) on axis at one meter. In Biamp Mode, the low frequency section shall have a nominal impedance of 8 Ohms, an input capability of 69V, shall produce a sound pressure level of 95 dB (averaged SPL between -10 dB points) on axis at one meter with a power input of 1 Watt, and shall be capable of producing a continuous output of 123 dB SPL (with peak output of 129 dB SPL) on axis at one meter. The high frequency section shall have a nominal impedance of 8 Ohms, an input capability of 25V, shall produce a sound pressure level of 105 dB (averaged SPL between -10 dB points) on axis at one meter with a power input of 1 Watt, and shall be capable of producing a continuous output of 124 dB SPL (with peak output of 130 dB SPL) on axis at one meter. The nominal dispersion shall be 90° H x 60° V. The loudspeaker shall be 28.00 in. (711 mm) H x 14.50 in. (368 mm) W (front) x 5.83 in. (148 mm) W (rear) x 17.70 in. (449 mm) D, and weigh 54 lbs. (24.5 kg). The speaker shall be Community speaker model number IP8-1122/96. One per cluster with horn arranged such the distribution is 60°H x 90°V.

Use Community VSF-BFR22 Vertical Splay Kit.
Equivalent models as manufactured by Renkus-Heinz shall also be considered equal. Provide as shown.

2.7.5.4 Monitor Speakers

The loudspeaker system shall be a compact, two-way, full-range coaxial design. The loudspeaker system shall have one 10-inch woofer and one 1.25-inch exit high frequency driver with 100 degree conical coverage. Drivers shall be connected to an integral crossover with a crossover frequency of 1 kHz and integral DYNA-TECH™ driver protection circuitry. There shall be two NL4-compatible locking connectors and one 2-screw terminal strip. The loudspeaker enclosure shall be solid birch plywood with a 16-gauge perforated steel grille and finished with black or white paint. The system shall have an amplitude response of 90 Hz to 16 kHz (+/- 4 dB), input capability of 40V RMS, 99 dB sensitivity at one meter and 2.83V / 8 ohms nominal impedance. The nominal dispersion shall be 100°H x 100°V from 500 Hz to 6 kHz. The loudspeaker shall be 10.8 in. (275 mm) H x 12.6 in. (321 mm) W x 16.5 in. (419 mm) D and weigh 22 lbs (10 kg). Provide three Community MX10 monitor speakers in black with patch cables 20’ in length.

2.7.5.5 Amplifiers-Located in Main Rack

1. Stage Monitor Amplifier

Overview: Channel Modes and Network The power amplifier shall provide four discrete channels of amplification. Rear-panel switches shall enable bridging of adjacent channels to allow reconfiguration as a 2- or 3-channel amplifier, with increased power

output available through the bridged channels. Each channel (discrete or bridged) shall be capable of independently driving either low impedance or high impedance (70 Vrms /100 V peak) loads. The amplifier shall employ a proprietary tracking Class D output circuit topology. The amplifier shall be equipped with sensing and communication circuits to allow comprehensive remote control and monitoring functions via a separate network bridge. The proprietary control and monitoring network shall employ TCP/IP protocols, use Cat-5 cable for interconnection, and allow remote control from either the network bridge front-panel or from an external PC using proprietary software. Power Output and Performance Maximum total output of all four channels shall be 1600 watts. In discrete four-channel mode, each amplifier channel shall deliver maximum continuous output power as follows: 400 watts into 16 ohms, 400 watts into 8 ohms; 300 watts into 4 ohms; or 400 watts into a high impedance (70 Vrms /100 V peak) load. Maximum output voltage per channel shall be 100 Vrms; maximum output current per channel shall be 8.5 Arms. In bridged mode, each bridged channel shall deliver maximum continuous output power as follows: 800 watts into 16 ohms; 600 watts into 8 ohms; or 800 watts into a high impedance (140 Vrms / 200 V peak) load. Default amplifier gain shall be 35 dB, with rear-panel adjustment from 23 - 44 dB in 3 dB increments, selectable for each channel. For bridged channels, the amplifier shall automatically compensate –6 dB gain internally to maintain operation of all channels at selected gain. The amplifier shall exhibit the following performance parameters with gain set at 35 dB and VPL (Voltage Peak Limiter) at 141 V: Frequency response shall be 6.8 Hz to 34 kHz, +0/-3dB at 1 watt into an 8 ohm load; channel separation shall be greater than 70 dB; and signal-to-noise ratio shall be 112 dBA. THD at 1 watt, 20 Hz – 20 kHz, shall be less than 0.1%; THD at 1 kHz shall be no more than 0.05% at 1 dB below clipping. A voltage peak limiter shall limit peak output as determined by rearpanel switches. In discrete four channel mode, peak voltage shall be selectable in eights steps across a range of 141 V to 42 V. In bridged mode, peak voltage shall be selectable in eight steps from 282 V to 84 V. The voltage limiter mode shall be selectable for either hard or soft limiting characteristics. Connectors, Controls, and Indicators The following connectors and controls shall be provided on the REAR-PANEL of the amplifier. The four input connectors shall be electronically balanced, 3-pin Phoenix connectors. The four output connectors shall be 2-pole barrier strip screw connectors. A group of seven DIP-switches shall determine the following: Amplifier gain (23 dB to 44 dB in 3 dB increments); option active; fan masked; and bridged mode selection for channel pairs. A group of sixteen DIP-switches shall determine Voltage Peak Limiter values for each channel, selectable in eight steps, and Hard or Soft limiting characteristic. Two RJ45 connectors shall be provided for input and output of the control/monitoring network signals. An LED adjacent to the RJ45 connectors shall indicate active or inactive status of the network. The following indicators and controls shall be provided on the FRONT-PANEL of the amplifier. Four level control potentiometers, one for each channel, shall be provided beneath a front-panel security cover; potentiometers shall be detented and provide attenuation from 0 dB to minus infinity in 21 steps. Individual switches shall be provided for power on/off and remote power on/off enabling. Frontpanel LED indicators shall be provided to show status of power on/ off (green), network connection (blue), Power Average Limiter (red), and option card active (yellow). Additional LED indicators shall be provided to show the status of the following for each channel: signal present and high-impedance warning (green/red), signal present at –10 dB and –4 dB (2 x green), voltage peak limiter clipping (red), current peak limiter (CPL) active (orange), very high frequency (VHF) warning (yellow), high temperature warning (yellow flashing), and high temperature fault with output muted (yellow constant). Mute shall be indicated by illumination of both the temperature and VHF LEDs on a channel; fault shall be indicated by illumination of both

the CPL and VHF LEDs on a channel. Power Supply, Protection, and Cooling The power supply shall be a regulated switch mode type. The amplifier shall operate from AC line sources of either 230 V nominal or 115 V nominal, with operating ranges of 130 – 265 V and 65 – 135 V at line frequencies of 50 Hz or 60 Hz. Minimum power-up voltages are 171 V (230 V nominal) and 85 V (115 V nominal). A soft start circuit shall limit current inrush at power-up to 5 A. The amplifier shall be equipped with a PAL™ (Power Average Limiter) circuit to prevent excessive current draw. The amplifier shall be cooled by two temperature-controlled, variable-speed fans, with air flow from front- to-back. Adaptive fan on/off function shall be dependent on presence of an output signal. Physical The amplifier shall be 483 mm (19 in.) wide, 88 mm (3.5 in. / 2 U) high, and 343 mm (13.5 in.) deep. The weight shall be 12 kg (26.4 lbs). The cabinet shall be black painted steel with a grey painted steel front-panel. The amplifier shall be approved for use as specified by CE, ANSI/UL, ETL and the FCC. The amplifier shall be the Lab.gruppen C 16:4. Provide one unit.

2.7.5.6 Main Speaker Amplifier

Amplifiers shall be based on Class TD technology with a regulated switch mode power supply. Each amplifier shall provide four channels of output configured to drive a four ohm load at 1200 Watts each channel. The following specifications shall apply:
Number of channels 4
Peak total output all channels driven 4800 W
Peak output voltage per channel 141 V
Max. output current per channel 17.5 Arms
Max. Output Power 16 ohms 8 ohms 4 ohms 2 ohms Hi-Z
Per ch. (all ch.'s driven) 625 W 1000 W 1200 W 600 W 900 W (70 Vrms / 100 V peak)
Bridged per ch. 2000 W 2400 W 1200 W n.r. 1800 W (140 Vrms / 200 V peak)
Performance with Gain: 35 dB and VPL: 100 V
THD 20 Hz - 20 kHz for 1 W <0.1%
THD at 1 kHz and 1 dB below clipping <0.05%
Signal To Noise Ratio >112 dBA
Channel separation (Crosstalk) at 1 kHz >70 dB
Frequency response (1 W into 8 ohms) +0/-3 dB 6.8 Hz - 34.2 kHz
Input impedance 20 kOhm
Input Common Mode Rejection, CMR 50 dB
Output impedance @ 100 Hz 30 mOhm
Voltage Peak Limiter (VPL), max. peak output
VPL, selectable per ch. 3) 141, 118, 100, 85, 71, 59, 50, 42 V
VPL, when bridged 3)
1) 282, 236, 200, 170, 142, 118, 100, 84 V
Voltage Peak Limiter mode (per ch.) Hard / Soft
Gain and Level
Amplifier gain selectable (all channels) 1)
– rear-panel switches 23, 26, 29, 32, 35, 38, 41, 44 dB
Default gain 35 dB
Level adjustment (per ch.) Front-panel potentiometer, 21 position detented
Connectors and switches
Input connectors (per ch.) 3-pin Phoenix, electronically balanced
Output connectors (per ch.) Barrier strip 2-pole screw terminals
Output bridge mode A+B and/or C+D, inputs A and C are input source
NomadLink® network On board, 2 x RJ45 connectors
Intelligent fans (on/off) Yes, depending on presence of output signal

Power on/off and Remote enable on/off Individual switches on front-panel
Cooling Two fans, front-to-rear airflow, temperature controlled speed
Front-panel indicators
Common NomadLink® Network; Power Average Limiter (PAL) 2); Power on
Per channel Signal present / High-impedance; -10 dB and -4 dB output signal; Voltage Peak Limiter (VPL); Current Peak Limiter (CPL);
Very High Frequency (VHF); High Temperature; Fault; Mute
Power
Operating voltage, 230 V / 115 V nominal 130 -265 / 65-135 V
Minimum power-up voltage, 230 V / 115 V 171 V / 85 V
Power Average Limiter (PAL) 2) Yes
Soft start / Inrush Current Draw Yes / max. 5 A
Mains connector 230 V CE: 16 A, CEE7; 115 V ETL: 20 A / NEMA 5-20P
Dimensions (W/H/D) W: 483 mm (19”), H: 88 mm (2 U), D: 343 mm (13.5”)
Weight 12 kg (26.4 lbs.)
Finish Black painted steel chassis with gray painted steel front
Approvals CE, ANSI/UL 60065 (ETL), CSA C22.2 NO. 60065, FCC.
Unit shall be Lab Gruppen model C 48:4. Provide a total of 2 units with one channel per cluster at bleachers and one channel per each cabinet at stage.

2.7.5.7 Digital Mixer

The mixer shall be a compact, rack-mountable digital mixing solution without physical fader strips, but shall include 16 mono and 3 stereo line input channels mixing to 12 mix outputs and 4 stereo rack FX engines, 4 DCA groups and 4 Mute groups. All output mix channels
shall contain Insert, Parametric EQ, Graphic EQ, Compressor, and Delay. Signal delays in the system shall be adjustable in Milliseconds.
Pre/Post fader routing and assignments, processing of signals, level sends, FX sends, DCA and Mute Groups shall be accessed and adjusted via a 5-inch colour touchscreen provided on front panel of the mixer or from Apple iOS touchscreen devices.
There shall be a Channel page on the touch screen replacing physical fader strips with different tabs providing access to Input Channels, FX, Groups, Mixes, DCA and Mute Groups and control of level, mute, pan and PAFL for the selected channel and a fully customizable
page giving access to channels and settings tailored to the user and the specified application. Several ‘widgets’ shall be assigned to this page, these shall include channel levels, mutes and assignment on/off switches and shall be arranged to suit the user requirement.
The front panel of the mixer shall include 16 custom select keys and indicators, giving access to any combination of user defined input channels, output channel mixes, FX sends, FX returns or Main mix and also 15 assignable Soft Keys giving access to DCA mute masters and MIDI control as well as Tap Tempo, Instant Scene Recall/Navigation or PAFL Clear.
There shall also be dedicated keys for quick Copy/Paste/Reset of mixes and processing parameters. The name and number of the selected channel or mix shall always be identified on screen when in the processing or routing pages.

The mixing system shall include application software for Apple iOS touchscreen devices connecting via a wireless network router to an Ethernet LAN port. The application shall allow control of function including the preamp gain, phantom power, mix channel levels and shall have a graphical representation of physical controls and indicators including

signal processing parameters and shall provide control of channel processing including Parametric EQ, Graphic EQ, Compressor, and Delay.

The mixer shall have a built in power supply accepting AC mains voltages of 100-240V, 50/60 Hz, 55W max via an earthed 3 pin IEC male connector mounted on the rear chassis. A Two Pole Push-Button switch shall be provided near the mains input. Recommended operation temperature for the mixer shall be 5 to 35 degrees Celsius.

The mixer shall be the Allen & Heath Qu-Pac Digital Mixer. Provide with Apple iPad Air 2 and Linksys Wireless Router. Program mixer pre-set programs to provide functionality as described under General Descriptions to route signals to the DSP or recall. This includes the ability to split mixer inputs to process for room left and room right during room split configuration.

2.7.5.8 Digital Signal Platform

The device shall provide eight analog inputs that are selectable as line or mic level with fine trim and phantom power plus eight analog line outputs that are adjustable with fine trim. Levels, phantom powers, signal inversions and mutes shall be controllable via software. Audio connections shall be accessed via rear panel 3.81 mm terminal block connectors. A designer software application shall be provided that operates on a Windows computer, with network interface installed, running Windows® 7 or higher operating system. Computer connection for configuration shall be via the device's rear panel Ethernet connector. All internal processing shall be digital (DSP). Available DSP components shall include (but not be limited to) various forms of: mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, onboard logic, and diagnostics. The front panel shall include a LCD and momentary switch. The display shall indicate unit name, IP address, MAC address, Site File version, and fault messages and can be switched between system overview and meter displays. External control shall include dedicated software screens as well as preset selection, I/O level control and muting using the optional ARC wall panel remote controls via industry-standard CAT5 cable with RJ45 connectors. A built-in web server shall provide four instances of ARC-WEB, which allows for user control from nearly any web browser or mobile device. Logic I/O shall consist of four contact closures or two potentiometer inputs along with four logic outputs. The logic outputs may be used to drive LEDs directly or control external relays or switchers. All program memory shall be non-volatile and provide program security should power fail. The device shall provide an on-board real-time clock to facilitate automatic, timed changing of presets and may sync to NTP. Third-party control systems may interface over IP using a published ASCII control protocol. Audio conversion shall be 24-bit, 48 kHz and internal processing shall be 32-bit or 40-bit floating point, 48 kHz. The dynamic range shall not be lower than 110 dB, A-weighted with a maximum input level of +23 dBu and maximum output level of +24 dBu.. The device shall have a power plug that accepts power from Symetrix part number 12-0034, CUI power supply part number SDI65-24-U-P5. The device shall meet UL/CSA and CE safety requirements and comply with CE and FCC Part 15 emissions limits. The device shall be RoHS compliant. The chassis shall be constructed of cold rolled steel, and mount into a standard 19" 1U EIA rack. The device shall be a Symetrix Solus NX 8x8.

2.7.5.9 CD Player

The CD Player shall have the following features:

- Plays audio CDs, MP3 CDs and WAV file CDs
- Dock connector for Apple iPod charging and playback

• iPod video playback from S-video or composite output
• CD TEXT and ID3 tag support
• Continue, Random and Program play modes
• Repeat All and Repeat Single play modes
• Index Search
• Shock/skip prevention memory buffer
• ±12% pitch control (analog outputs only)
• RCA unbalanced line outputs (CD and iPod)
• Coaxial and Optical S/PDIF digital out (CD only)
• 1/4" stereo headphone output
• 2u rack mountable
• Wireless 55-key remote control
• 19"W x 3.72" H x 11.73"D
• 9.3 lbs

Provide (2) Tascam model CD-200i or equivalent, 1 unit in each rack.

2.7.5.10 Mixer-Remote Cart

The Shure Model SCM800 is a full-featured, eight-channel microphone mixer for sound reinforcement, general audio recording, and audio-visual systems. Any low-impedance, balanced dynamic or condenser microphone, including a wireless microphone system, can be used with the SCM800 mixer. Each SCM800 accepts up to eight microphone- or line-level inputs and one aux-level input (two input jacks feed the same channel). Up to four SCM800 mixers can be linked to provide up to 32 input channels. Each input channel has a two-band equalizer, switchable microphone- or line-level operation, switchable 48 V phantom power, and a 1/4-inch send/receive insert jack. The SCM800 operates on 120 Vac power; the SCM800E operates 230 Vac power. Both models are supplied with rack-mounting hardware, link cable and removable block terminal connectors. An accessory rack panel adapter (Model RKC800, available separately) converts the removable block input and output connectors to XLR connectors, and the Aux connectors to phono jacks.

2.7.5.11 Direct Box Remote Cart

The signal splitting/impedance matching unit shall be suitable for interfacing one (1) unbalanced high- or low-impedance source to one (1) balanced or floating low-impedance (1.0 kohm nominal) microphone preamplifier input. There shall be two (2) 1/4" (6.3mm) 2-conductor phone jacks wired in parallel to provide input and loop-through output for the source. There shall be a switchable 20 dB attenuator to accommodate line- or speaker-level sources*, with a switchable filter to further attenuate high frequencies by 6 dB per octave above 4.0 kHz. There shall be a transformer-isolated low-impedance output from a 3-pin male XLR-type connector. The transformer shall be a Pro Co DBT-1 Direct Box Transformer. The primary electrostatic shield shall be connected to the source input ground and the enclosure. There shall be a ground-lift switch to allow the shields to be connected together or isolated as required. The XLR output connector shall be wired with pin 2 "hot" or "in phase" and pin 3 "cold" or anti-phase" with respect to the input. The enclosure shall be constructed in the Pro Co "Uni-box" design with 16-gauge steel black zinc finish top and bottom plates, 16-gauge black texture powder coated steel end plates and black anodized aluminum side channels. Control functions shall be identified by a printed Lexan® top panel overlay. Switches shall be of the miniature "rocker" type and shall be flush-mounted. The enclosure shall be provided with two (2) miniature handles at each end (front and back) and four (4) non-conductive feet. The dimensions of the unit shall be 4.875" D x 4.375" W x 1.75" H

(123.8mm D x 111.1mm W x 44.4mm H). The signal splitting/impedance matching unit shall be a Pro Co TradeTools DB1 Direct Box. The DBT-1 is a carefully designed, custom-built impedance-matching transformer whose characteristics are optimized for use with high-impedance sources such as electric bass guitars and other unbalanced sources such as keyboard instruments. Special winding techniques and a high-permeability (80% nickel) core lamination preserve full frequency response while minimizing signal losses and other "loading" effects. Mu metal can and separate electrostatic shields for primary (input) and secondary (output) windings reduce capacitive coupling of ground-borne electrical noise between stage amps and PA or recording mixers, eliminating EM/RF and ground noise. The source impedance of the DBT-1 is very similar to that of a low-impedance microphone to ensure proper matching to the input circuitry of the mixer. The result is clean transient response (minimal overshoot or ringing) and low distortion even at low frequencies and high input levels.

2.7.5.12 Sequential Power/Conditioner Remote Cart

Current Rating 15 amps ("E" version 10 amps)
Operating Voltage 90 to 140 VAC ("E" version 180 to 280 VAC)
Over Voltage Shutdown 140 VAC typically ("E" version 280 VAC typically)
Spike Protection Modes Line to neutral, zero ground leakage
Spike Clamping Voltage 188 Vpk @ 3,000 amps, 133 VAC RMS
(tested to UL-1449 6,000 Vpk @ 3,000 amps)
Response Time 1 nanosecond
Maximum Surge Current 6,500 amps
Noise Attenuation
10 dB @ 10 kHz
40 dB @ 100 kHz
100 dB @ 10 MHz
Linear attenuation curve from 0.05 - 100 ohms line impedance
Dimensions 19" W x 10.5" D x 1.75" H
Weight11 lbs (5 kg)
Power Consumption 6 watts
Safety Agency Listings CE, NRTL-C
Three Year Limited Warranty
Model shall be Furman PS-8R II in remote cart.

2.7.5.13 Wired Microphones

Provide four handheld dynamic microphones with on/off switch, Supercardioid Polar Pattern, with a Frequency Response of 80Hz to 13kHz. Acceptable manufacturers of Audio Technica, Shure, or CAD Audio. Provide with four microphone stands equivalent to Atlas Soundolier MS-12C and four 25' microphone cables. Provide one CAD Audio 878HL tabletop paging microphone with 25' cord.

2.7.5.14 Wireless Microphones

The frequency-agile FM wireless receiver shall be part of a wireless microphone system operating in the bands of 482.000–507.000 MHz, 541.500–566.375 MHz , or 655.500–680.375 MHz. It shall be capable of operating on any of 996-1001 PLL-synthesized frequencies per band. The all-metal receiver shall provide an automatic scanning function to select appropriate local usable channels for proper wireless system operation.

All configuration functions of the receiver shall be controlled by soft-touch controls on the receiver front panel. It shall be a True Diversity receiver with two independent internal receiver sections, automatically selecting the highest quality signal for the receiver's output. The system will be equipped with an advanced Tone Lock™ digital identification system to
ensure that only the desired wireless microphone transmitter allows the receiver to be un-muted. The receiver shall have an alert LED on the front panel that indicates transmitter low battery warning, signal loss and input overload. The receiver shall continuously monitor and display the battery life indicator of the wireless transmitter, the RF signal strength and the
diversity selection of internal dual tuner sections (A&B). The receiver shall have a rear panel selector to lift the ground connection from pin 1 of the XLR-type output connector to prevent ground loops. The receiver shall be able to be powered by 120V AC 60 Hz or 12–18V DC at 500 mA. Antennas shall be located on the rear of the receiver and shall incorporate
standard BNC-type connectors to allow them to be detached from the receiver to facilitate the receiver being used with external antennas or antenna distribution devices. Switchable 12V DC power shall be provided on the BNC-type connectors. An accessory bracket should allow for the antennas to be located at the front of the receiver. The receiver can be rack-mounted singly or in pairs in a single rack space. The receiver's design shall provide totally silent audio output mute when the wireless transmitter is turned off or signal is lost. The wireless receiver and the supplied metal rack-mounting brackets shall be industrial black.
The FM wireless receiver shall be an Audio-Technica ATW-R3100b or equivalent. Provide 4 units, 2 with ATW-T341b handheld transmitters. Provide 2 with ATW-ATW-T3201 body-pack transmitter and BP892cH headworn microphone. ,Provide antenna combiner and remote antenna mounted on top of rack. Equivalent SLX Series by Shure or 3000 Cad Audio.

2.7.5.15 Assisted Listening

Furnish and install an RF wireless assistive listening system for use by the hearing-impaired. The assistive listening system (ALS) shall be capable of broadcasting on 3 wide band channels and be frequency agile. The ALS system shall have 62dB SNR or greater, end-to-end. Receivers shall be frequency agile to 3 wide band frequencies set with a "channel select" switch. The receivers will incorporate a stereo headset jack that allows the user to plug in either a mono or stereo headset and listen to audio normally. The receivers shall incorporate automatic battery charging circuitry for recharging of Ni-MH batteries. The receivers and transmitters shall offer a limited lifetime warranty. Listen Technologies Corporation LP-3CV-072-01 products are specified. Provide (10) additional LR-200-072 Receivers with LA-161 Single Ear Buds.

2.7.5.16 Stage Floor Boxes

Floor box assembly shall consist of a Door / Cover with hinged door opening, a Gasket, and a Basket. Door / Cover shall be of 12 gauge steel, shall measure 14"L x 8"W, shall be self-trimming, mount virtually flush with the floor or surrounding surface and shall be secured with security socket head screws. Door / Cover shall have hinged Cable Door 1.25" x 1.25",
shall have radiused corners and shall have a ceramic plastic satin black finish so as not to create specular light reflections. Basket shall be of 16 gauge steel and shall be 10.5"L x 4.625"W x 2.5" deep. Basket shall mount on manufacturer's backbox BB2000.
All components shall be UL Listed and conform to all applicable standards of the

National Electrical Code. Floor box assembly shall be Mystery Electronics FMCA2400. Provide three as shown with 2 MPK Moduline Insert Panels. Install (4) XLR input connectors and (2) speakon monitor connector in each box. Each floor box shall have a channel A and Channel B monitor mix. Provide two floor boxes as shown.

2.7.5.17 Cable

Main Speaker Cable shall be equivalent to West Penn 227 12/2 Stranded. Microphone and signal cable shall be equivalent to West Penn 291 22/2 Stranded.

2.7.5.18 Projection Screens

Screen shall be based on Da-Lite model Studio Electrol , 216"(H) x 384" (W), electrically operated 120 volt (60Hz), not more than 3.4 amp. Shall have specially designed motor mounted inside the roller, to be two wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the "up" and "down" positions. Junction box shall be internally integrated into the housing making it possible to install the housing and wire to the building's electrical system during construction. Rigid metal roller, to be at least 7 5/8" in diameter. The motorized fabric and roller assembly to be installed in the case at the factory. Screen to be designed for left hand motor installation. Screen fabric to be flame retardant and mildew resistant. Bottom of fabric shall be fitted with a metal slat covering. Heavy duty plastic caps shall protect the ends of the metal slat. Case housing to be made of structural steel tubing with aluminum metal coverings on top, aluminum profiles on rear and front and two extruded aluminum side coverings. The bottom of the casing is standard open. To be complete with a three-position radio remote control. Provide quantity as shown. Provide a minimum of 6 attachment points. All hardware to be forged and a 5:1 safety ratio to be maintained.

2.7.5.19 Projectors

Projector based on the following specifications:

Projection Technology Three chip DLP Resolution WUXGA 1920 x 1200 Brightness 13,000 ANSI lumens Colors 1.07 billion colors Aspect Ratio Native 16:10; 16:9, 4:3, 5:4, 1.88, 2.35, letter box, unscaled compatible Contrast Ratio 2000 : 1 Throw Ratio (distance : width) 1.87 - 2.56 :1 (with ML-K04 lens, sold separately) Focus Distance 159" - 868" (with ML-K04 lens, sold separately) Display Size 100" - 400" (with ML-K04 lens, sold separately) Lens & Operation Lens f = 39.0 - 53.4 mm (with ML-K04 lens, sold separately) Lamp Wattage 465W x 2 Expected Lamp Life* Approximately 2,000 hours (standard mode) 2,500 hours (Eco mode) Expected Filter Life** Approximately 10,000 hours Approximately 15,000 hours Speaker Output N/A Keystone H: +/- 35º and V: +/- 20º (Note: Input signal is WUXGA @ 50Hz, Zoom position is Wide max. Does not work with DVI-D input.) Compatibility Computer VGA, SVGA, XGA, WXGA/WXGA+/SXGA/SXGA+/WSXGA+/ UXGA/WUXGA (compressed), MAC 16" H-Sync 15.7 kHz ~ 91 kHz V-Sync 48 Hz ~ 85 Hz Component Video 480i, 480p, 576i, 720p, 1080i, 1080p 3D (DVI) 1920 x 1080@120Hz, 1920 x 1080@100Hz, 1920 x 1080@60Hz, 1920 x 1200@120Hz, 1920 x 1200@100Hz, 1920 x 1080@60Hz HDMI 480i, 480p, 576i, 720p, 1080i, 1080p, Computer signal TMDS Clock 27 MHz - 150 MHz 3G SDI NTSC, PAL, 1035i, 1080i, 1080p, 720p, 1080Sf Connectors Digital Input HDMI x 2 (HDCP compliant), Stereo DVI x 1, SDI/HDSDI/3G BNC x 1 Computer Input 1 15-pin mini D-sub x 1

Computer Input 2 BNC x 5 (shared with component 2) Digital Output SDI/HDSDI/3G BNC x 1 Video Input S-Video N/A Composite Video N/A Component Video 5BNC x 1 (shared with computer in 2), 3 RCA jack x 1, 15-pin mini D-sub x 1 (shared with computer in 1) Projector shall be Hitachi model number CP-WU13K. Provide with Hitachi SL-K03 Lens after confirming exact installation locations. Order lens after location has been field verified.

2.7.5.20 Projector Mount and Cage

Provide protective cage fully enclosing projector manufactured in steel. Cage shall accommodate equipment 11.36" H x 25" W x 24.9" D. Protective cage shall be Chief model number PG3A. Mount shall be Chief model VCMUW. Install on Chief CMS006009 Adjustable Column, structural adapter, and vibration isolator coupler.

2.7.5.21 Controller

i. Manufacturers

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

ii. Basis of Design Product:

1. Crestron CP3

iii. Minimum Characteristics:

1. Operating System:
   a. Modular architecture supports multiple simultaneous running programs.
      i. Number of simultaneously running user programs: 10
   b. Real-time, preemptive multithreaded/multitasking kernel.
   c. Vector floating point coprocessor.
   d. Utilize a real time, event driven, multi-tasking, multi-threaded operating system.
2. Communication:
   a. Control Processor shall support direct communication with the following devices:
      i. Connected Ethernet devices.
      ii. Devices connected to built-in control ports.
      iii. Proprietary control network devices.
      iv. BACnet IP devices.
      v. Control processors of same type.

3. Native BACnet/IP
    a. Number of BACnet objects supported: 1000
4. File Structure:
    a. Transaction-safe extended FAT32 file system
5. Memory:
    a. RAM:
        i. 512 MB
    b. Flash:
        i. Built-In: 4 GB
        ii. USB or MMC slot: up to 32 GB
    c. External Storage
        i. Supports up to 1 TB.
6. Network:
    a. Built-in 10/100BaseT Ethernet port.
    b. Built-In Web Server: IIS v.6.0
    c. SNMP remote management.
    d. Active Directory support.
    e. IPv6 ready.
    f. TCP/IP Communications
    g. DHCP and DNS Support
    h. Native Email Client
    i. Remote Diagnostics
    j. Remote Program Loading and Administration
    k. SSL security plug in
    l. Support user assigned or dynamic IP address.

iv. External Ports

The control system shall be equipped with the following external connection ports:

1. Infrared Output Port
    a. Number of built-in ports: 8
    b. Connector: 2 8-pin 3.5mm detachable terminal blocks.
    c. Signal:
        i. One-way infrared: up to 1.2 MHz
        ii. One-way serial output: TTL/RS-232 (0-5 Volts)
            1. Baud rate: 9600 to 115,200 baud

2. Serial Communication Port - Type 1
    a. Number of built-in ports: 1
    b. Connector: 5-pin 3.5mm detachable terminal blocks.
    c. Signal:
        i. Bidirectional RS-232
            1. Baud rate: 1200 to 115,000 baud
            2. Software handshaking: off or XON
        ii. Bidirectional RS-422 or RS-485
            1. Baud rate: 1200 to 115,000 baud
            2. Hardware handshaking: CTS, RTS, or RTS/CTS
            3. Software handshaking: off or XON
3. Serial Communication Port - Type 2
    a. Number of built-in ports: 2
    b. Connector: 3-pin 3.5mm detachable terminal blocks.
    c. Signal:
        i. Bidirectional RS-232
            1. Baud rate: up to 115,000 baud
            2. Software handshaking.
4. Input Output Port
    a. Number of built-in ports: 8
    b. One 9-pin 3.5mm detachable terminal block.
    c. Individual programmable 2Kohm pull-up resistor.
    d. Individually configurable to one of three modes.
    e. Digital Input Mode
        i. Digital contact closure inputs
        ii. Rating:
            1. 0-24 VDC
            2. Impedance: 20Kohm
            3. Logic threshold High: >3.125V
            4. Logic threshold Low: < 1.875V
        iii. Rated for 0-24 Volts DC, referenced to GND.
    f. Digital Output Mode
        i. Rating:
            1. 250 mA sync from maximum 24 VDC
    g. Analog Input Mode
        i. Rating:

1. 0-10 VDC
2. Protection: 24 VDC maximum
3. Impedance: 21Kohm

5. Relay Port
    a. Number of built-in ports: 8
    b. Two 8-pin 3.5mm detachable terminal blocks.
        i. Normally open, isolated relays.
        ii. Rating:
            1. 1 Amp, 30 Volts AC/DC.
        iii. MOV arc suppression across contacts.
6. Ethernet
    a. Number of built-in ports: 1
    b. One 8-wire RJ45 with 2 LED indicators.
        i. 10/100BaseT Ethernet port.
        ii. Ethernet Link LED indicator.
        iii. Ethernet activity LED indicator.
7. Communication Network
    a. Number of built-in ports: 1
    b. Four 4-pin 3.5mm detachable terminal block.
        i. Master net communications port.
8. USB Type 1
    a. Programming and configuration interface.
        i. Number of built-in ports: 1
        ii. Connector:
            1. USB Type-B female USB 2.0
9. USB Type 2
    a. Memory storage device port.
    b. Number of built-in ports: 1
    c. Connector:
        i. USB Type-A female USB 2.0

v. Memory Expansion Card Slot
    1. Number of built-in slots: 1
    2. Slot Type:
        a. MMC
    3. Slot Capacity

a. 32 GB maximum

vi. BACnet Protocol Implementation:

1. BACnet Standardized Device Profile:
    a. Application Specific Controller (B-ASC)
2. BACnet Interoperability Building Blocks Supported:
    a. Data Sharing-ReadProperty-A (DS-RP-A)
    b. Data Sharing-ReadProperty-B (DS-RP-B)
    c. Data Sharing - ReadProperty Multiple - A (DS-RPM-A)
    d. Data Sharing - ReadProperty Multiple - B (DS-RPM-B)
    e. Data Sharing-WriteProperty-A (DS-WP-A)
    f. Data Sharing-WriteProperty-B (DS-WP-B)
    g. Data Sharing – COV – A (DS-COV-A)
    h. Data Sharing – COV – B (DS-COV-B)
    i. Device Management-Dynamic Device Binding-A (DM-DDB-A)
    j. Device Management-Dynamic Device Binding-B (DM-DDB-B)
    k. Device Management-Dynamic Object Binding-B (DM-DOB-B)
    l. Device Management-DeviceCommunicationControl-B (DM-DCC-B)
3. Standard Object Types Supported:
    a. Device Object
    b. Analog Input Object
    c. Analog Value Object
    d. Binary Input Object
    e. Binary Value Object
    f. Multi-State Input
    g. Multi-State Value
4. Data Link Layer Options:
    a. BACnet IP
    b. BACnet IP, Foreign Device
5. Network Options:
    a. BACnet/IP Broadcast Management Device (BBMD)
        i. Supports registration by foreign devices.

6. Character Set Supported:
    a. ANSI X3.4

vii. Mounting
    1. Standard 19 inch rack mount, 1 rack unit high.
    2. Rack mounting ears shall be removable for free standing applications.

viii. Front Panel Controls
    1. Hardware reset button
    2. Software reset button

ix. Front Panel Indicators
    1. Power
    2. Control Network Communication
    3. Control Processor Error

x. Power Requirements:
    1. 15 Watts at 24 VDC

xi. Panel:
    1. Provide Crestron TSW-760-W S 7” Touch Screen as shown.

2.7.5.22 Video Matrix

xii. Manufacturers:
    1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc. with the following components and characteristics.

xiii. Description
    1. Card-cage matrix switchers with configurable input and output card modules. Through the use of interchangeable input and output modules the matrix switcher shall support various input formats up to 4K HDMI and H.264, HDMI and HDMI 4K output formats. Matrix Card-cage shall support local device input and output card types and special purpose cards for use with long distance transmitter and receiver devices by same manufacturer and HDBaseT compatible devices. Switcher shall include a built-in Ethernet switch. Switcher shall be available in 8x8, 16x16, and 32x32 chassis sizes.

Switcher shall be capable of stand-alone operation or integrated operation using a control processor from the same manufacturer. Input and output cards shall be field-interchangeable. Any input slot shall be routable to any output slot. Setup and diagnostics tools shall be built-in and accessible through the front panel interface. Additional configuration and management tools shall be available through software applications provided by same manufacturer.

xiv. Basis-of-Design Products: Crestron DM-MD8X8

1. Crestron modular matrix switchers: DM-MD8X8

xv. System Capacity

1. Main chassis shall be available in the following input and output capacities:

a. 8 Input x 8 Output

b. 16 Input x 16 Output

c. 32 Input x 32 Output

xvi. Input and Output Modules

1. The Switcher shall support the following input and output signal card types:

a. Input card:

i. Single input connection.

b. Output card:

i. One, two, or four output connections, configurable in groups of two.

xvii. Multi-Format Audio Backplain

1. The matrix Switcher shall support the option to maintain two audio formats for a single surround sound source device using a single input module.

a. Audio format 1: Native multi-channel audio generated by source.

b. Audio format 2: Stereo down-mix of native multi-channel source audio.

xviii. Audio Breakaway

1. Within a single switcher chassis, source audio inputs shall be routable to any output separately or combined with source video.

2. Switcher shall be capable of routing stereo audio and surround audio separately when an input slot is equipped with an input card with audio processing functionality.

Viii Input/Output/Power

Provide Matrix switcher with appropriate number of DMC-4K-C-HDCP2HDBaseT Input cards and CM-TX04K-100C-1G-W-T Transmitter plates. Provide DMC-4K-HDO Scaling and DMC-4K-CO-HD-HDCP2 Output cards. Provide DM-RMC-4K-C-4K Receiver at projector locations. Provide DM-PSU-8 Power Supply.

2.7.5.23 Cable

Control and I/O cable shall be Crestron DM-CBL-8G-SP1000. HDMI Patch Cables shall be Liberty E2-HDSEM-M-0.5 or equivalent.

2.8 Multi-Purpose Room AV System

2.8.1 General Description

2.8.1.1 The system is to provide sound and video reinforcement for the Multi-Purpose Area.

2.8.1.2 The Main Head End is to be housed within a sectional wall cabinet as shown on drawings.

2.8.1.3 All microphones are to be terminated in the wall cabinet.

2.8.1.4 Provide Line Level Input to mixer for future AV Presentation Input. Provide 2 Spare Inputs

2.8.1.5 Provide small DSP for speaker processing.

2.8.1.6 Audio and Video shall be combined or separated via Digital Control.

2.8.2 Qualifications

2.8.2.1 The AV system supplier shall be a “Sound System Contractor” who regularly engages in the provision and installation of professional sound reinforcement systems.

2.8.2.2 The AV System Contractor shall be responsible for the installation of all cable, speakers, control and amplification equipment, final termination, and programming. The Contractor is responsible for leaving properly sized conduits with pull wires, standard electrical boxes, and 120V power for Sound System Contractor use.

2.8.2.3 The AV System Contractor shall be Authorized Dealers of equipment as listed within this specification to provide full factory warranty for equipment provided.

2.8.3 Acoustic Performance

2.8.3.1 The frequency response of the system shall be measured in the free field with a calibrated spectrum analyzer. The Frequency Response curve shall be flat from 100 Hz to 6 kHz with a 3 dB per octave roll off above 6 kHz.

2.8.3.2 Sound Pressure is not to deviate more than 9 dB edge to edge in the seated area of the listeners.

2.8.3.3 Check system for any RFI and remove unwanted signal as required.

2.8.3.4 The Sound Contractor shall provide factory trained technicians utilizing professional grade testing equipment and software to measure sound pressure, intelligibility, and frequency response. Equipment and software manufactured by Gold Line, Terra Sonde, and SIA shall be acceptable.

2.8.4 Equipment Cabinets

2.8.4.1 Main Equipment Cabinet-

The E.I.A. Compliant, UL Listed (Standard 1678) welded rack shall be Lowell Model LWR-2123. The rack shall consist of two parts, a backbox and a mounting section with

side vents. The mounting section shall be 14.18"D and formed of 16-gauge certified U.S. steel
with triple-formed side-to-bottom and side-to-top wrapped construction to achieve strength equivalent to 3/16" thick steel. It shall include one pair of front-to-rear adjustable mounting rails tapped 10-32 (mounting hardware included), integral rails on E.I.A. spacing (top and bottom), and knockouts for BNC style antennae (top and bottom). The mounting
section shall attach to the backbox from the inside using two heavyduty, spring-loaded L-pins that are self seating and positive locking. The L-pins shall be capable of being moved to the opposite side to change swing orientation if needed. The backbox shall be 4.69"D and
formed from 16-gauge certified U.S. steel with keyhole mounting slots on 16" centers. It shall include a 10" x 10" opening for mounting over electrical pull boxes, removable knockout panels (top and bottom), embossed dimples and lacing points on the back plane, and two locks on the 4.69"D side for security between the backbox and the mounting
section. Knockout panels shall be equipped with 0.5" knockouts for BNC and compound knockouts for conduit size .75"-.5" and 1.5"-1". The mounting section and backbox shall have a black wrinkle powder epoxy finish. Provide quantity of 1 with Fully Vented Front Locking Door.

2.8.4.2 Main Speakers-

The loudspeaker system shall be a two-way, full-range ceiling mount system with an 8-inch low frequency transducer with patented Carbon Ring Cone Technology™ and a coaxially mounted 1.25-inch exit high frequency compression driver. The drivers shall be connected to an integral crossover with a crossover frequency of 1.3 kHz, with a selfresetting solid state circuit breaker for driver protection. The loudspeaker baffle assembly (part no. D8-FO), or face-only, of the loudspeaker system shall be available without the back can for installations where the back cans are pre-installed and the loudspeaker baffle is inserted at a later date. The paintable loudspeaker baffle shall be constructed of UL 94V-0 rated ABS material and include Twist-Assist™ face retainer tabs for easy insertion into the back cans. A paintable steel grille with a durable white powder coat finish shall be included. The back can provided with the ceiling loudspeaker system, or sold separately as part no. D8-BC, shall be constructed of corrosion-resistant zinc plated steel featuring spring loaded Drop-Stop™ installation assistant tabs. The back can shall include a recessed termination box with a removable locking connector with screw terminals for secure wire termination with "loop through" ability. Strain relief will be provided by a clamping mechanism for use with plenum rated cable or conduit. The system shall have an amplitude response of 80 Hz to 20 kHz (+/- 5dB) and a low impedance (8 ohm) input capability of 35V RMS. The sensitivity at 1W/1m shall be 95 dB (120 Hz to 12.5 kHz, 1/3 octave bands). The loudspeaker system shall have a conical coverage pattern of 115 degrees from 500 Hz to 6 kHz. The nominal system impedance shall be 8 ohms (in low impedance setting). The system shall be equipped with a 120W high performance autoformer for use in 70.7V or 100V distributed audio systems, with 120W, 60W, 30W and 15W taps available in 70.7V distributed systems (120W, 60W and 30W taps available in 100V distributed systems). An easily accessible front-face tap selector switch located on the front baffle, which is concealed by the supplied removable grille, shall be available for selecting autoformer and low impedance settings. A snap-on C-Ring supporting plate and two tile support bridge rails shall be included. The loudspeaker system shall have a bezel diameter of 13.209 inches (335.5 mm), a can

depth of 8.166 inches (207.4 mm) and weigh 16.4 lbs (7.4 kg). There shall be available an optional New Construction Bracket for installing the loudspeaker system in new construction before drywall or plaster is put into place. The system shall be ETL listed to comply with UL1480, UL2043 and CSA60065 and suitable for use in air handling spaces per NFPA70 and NFPA90. Speaker shall be Community model D8. Equivalent by Sound Tube shall be CS800i.

2.8.4.3 Amplifiers

Overview: Certification and Channel Modes

The power amplifier shall be Energy Star 2.1 certified. It shall provide two discrete channels of amplification, with each channel capable of independently driving either low-impedance or high-impedance (70 V) loads. The output circuit shall be an inherently bridged Class

D topology. Maximum total output with both channels driven shall be 400 W.

Power Output and Performance

The power amplifier shall offer two power output modes (Lo-Z and 70 V) selectable by a rear-panel switch. Power output per channel, both channels driven, shall be as follows in Lo-Z mode: 200 W into 2 ohms, 200 W into 4 ohms, 100 W into 8 ohms and 50 W into 16

ohms. Power output per channel, both channels driven, shall be as follows in 70 V mode: 200 W into 8 ohms, 200 W into 16 ohms, and 200 W into a 70 V system. The amplifier shall incorporate a rail voltage sensing circuit to ensure low distortion. Peak voltage output

per channel shall be 100 V (70 V rms); maximum output current per channel shall be 11 Arms. Power outputs higher than stated prior shall be possible in one channel with asymmetrical loading or with no load connected to the other channel. Gain shall be 35.2 dB in 70 V mode and 27.2 dB in Lo-Z mode. The amplifier shall exhibit the following performance parameters: Frequency response shall be 2 Hz to 40 kHz (+0/-3 dB at 1 watt into an 8 ohm load); channel separation shall be greater than 70 dB; and signal-to-noise ratio shall be greater than 112 dBA. THD at 1 watt (20 Hz - 7 kHz) shall be

less than 0.1%; THD at 1 kHz shall be no more than 0.05% at 1 dB below clipping.

Connectors, Controls, and Indicators

The following connectors and controls shall be provided on the REAR PANEL of the amplifier. The input connectors shall be electronically balanced, 3-pin detachable screw terminals. The output connectors shall be 2-pin detachable screw connectors. GPIO (General Purpose

Input/Output) functions shall be provided on two 2-pole detachable screw terminal connectors. Two detented potentiometers shall provide level adjustment from -infinity to 0 dB. A power switch shall toggle between On and Standby power states. The following LED

indicators shall be provided on the FRONT PANEL of the amplifier: One bi-color power indicator (amber standby, green on); one temperature indicator (flashing amber warning and steady amber over-temperature/mute); two LED indicators per channel, one for signal present and one for limiter active.

Power Supply, Protection, and Cooling

The power supply shall be a universal type (AC line input between 100 and 240 VAC at 50 or 60 Hz). The power supply shall offer three modes for power on/standby/off. Default mode shall be auto-power down (APD): the amplifier shall go into standby mode when no signal

is present at the inputs for 20 minutes; power on mode shall resume with restoration of input signal. Standby power consumption shall be less than 1 W. Alternative power

modes shall be manually switched on/standby or external power sequencing via GPIO connections.

The amplifier shall be cooled by a temperature-controlled, variablespeed fans with air flow from front to rear.

Physical

The amplifier shall be 483 mm (19 in.) wide, 44 mm (1.75 in / 1 U) high, and 276 mm (10.9 in.) deep. The weight shall be no more than 4.0kg (8.8 lbs). The chassis shall be black painted steel with a grey painted aluminum front-panel. The amplifier shall be approved for

use as specified by CE. The amplifier shall be the Lab.gruppen E 4:2. Equal by Crown or QSC but must meet power consumption, power output, and THD Specifications as listed above.

2.8.4.4 Digital Platform

The device shall provide eight analog inputs that are selectable as line or mic level with fine trim and phantom power plus eight analog line outputs that are adjustable with fine trim. Levels, phantom powers, signal inversions and mutes shall be controllable via software. Audio connections shall be accessed via rear panel 3.81 mm terminal block connectors. A designer software application shall be provided that operates on a Windows computer, with network interface installed, running Windows® 7 or higher operating system. Computer connection for configuration shall be via the device's rear panel Ethernet connector. All internal processing shall be digital (DSP). Available DSP components shall include (but not be limited to) various forms of: mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, onboard logic, and diagnostics. The front panel shall include a LCD and momentary switch. The display shall indicate unit name, IP address, MAC address, Site File version, and fault messages and can be switched between system overview and meter displays. External control shall include dedicated software screens as well as preset selection, I/O level control and muting using the optional ARC wall panel remote controls via industry-standard CAT5 cable with RJ45 connectors. A built-in web server shall provide four instances of ARC-WEB, which allows for user control from nearly any web browser or mobile device. Logic I/O shall consist of four contact closures or two potentiometer inputs along with four logic outputs. The logic outputs may be used to drive LEDs directly or control external relays or switchers. All program memory shall be non-volatile and provide program security should power fail. The device shall provide an on-board real-time clock to facilitate automatic, timed changing of presets and may sync to NTP. Third-party control systems may interface over IP using a published ASCII control protocol. Audio conversion shall be 24-bit, 48 kHz and internal processing shall be 32-bit or 40-bit floating point, 48 kHz. The dynamic range shall not be lower than 110 dB, A-weighted with a maximum input level of +23 dBu and maximum output level of +24 dBu.. The device shall have a power plug that accepts power from Symetrix part number 12-0034, CUI power supply part number SDI65-24-U-P5. The device shall meet UL/CSA and CE safety requirements and comply with CE and FCC Part 15 emissions limits. The device shall be RoHS compliant. The chassis shall be constructed of cold rolled steel, and mount into a standard 19" 1U EIA rack. The device shall be a Symetrix Solus NX 8x8. Provide ARC-2e remote control.

2.8.4.5 Remote Control Box

The remote control box shall be FSR WB-X2-PLT with WB-X2-CVR-WHT. Custom cut plate to accommodate the following inputs, remote control, and switches shall be enclosed within the Remote Control Box:

Lowell RPSW-MPK
Symetrix ARC-2e,
3.5 mm stereo input
2 XLR Inputs

2.8.4.6 Sequential Power

The device for sequentially activating equipment shall be Lowell rackmount Model No. SEQR-4K, which shall feature front key actuation switch, LEDs and accessible trim pot for 4- step delay adjustment of sequence operation. The rear panel shall feature four barrier strip terminals for remote power control units and dry auxiliary contacts for accessory devices. Equipment to be controlled shall be connected to the sequencer using 2-conductor wire and Lowell Remote Power Control No. RPC-20-SCD-RJ and RPC-4CD (RPC Series, order separately). The rear panel shall include contacts for connecting an optional momentary style switch No. RPSW-MP for remote operation of the sequence controller. The unit shall be equipped with an alarm interface for use where required by local building code.

2.8.4.7 Wired Microphone

Provide a Dynamic Cardioid Pattern hand held microphone with a frequency response of 50 to 15,000 Hz. Provide with 25' microphone cable and Atlas MS-10C stand. Microphone shall be Shure SM-58. Provide quantity of 1. Equivalent by CAD Audio.

2.8.4.8 Wireless Microphones

The frequency-agile FM wireless receiver shall be part of a wireless microphone system operating in the bands of 482.000–507.000 MHz, 541.500–566.375 MHz , or 655.500–680.375 MHz. It shall be capable of operating on any of 996-1001 PLL-synthesized frequencies per band. The all-metal receiver shall provide an automatic scanning function to select appropriate local usable channels for proper wireless system operation.

All configuration functions of the receiver shall be controlled by soft-touch controls on the receiver front panel. It shall be a True Diversity receiver with two independent internal receiver sections, automatically selecting the highest quality signal for the receiver's output. The system will be equipped with an advanced Tone Lock™ digital identification system to

ensure that only the desired wireless microphone transmitter allows the receiver to be un-muted. The receiver shall have an alert LED on the front panel that indicates transmitter low battery warning, signal loss and input overload. The receiver shall continuously monitor and display the battery life indicator of the wireless transmitter, the RF signal strength and the

diversity selection of internal dual tuner sections (A&B). The receiver shall have a rear panel selector to lift the ground connection from pin 1 of the XLR-type output connector to prevent ground loops. The receiver shall be able to be powered by 120V AC 60 Hz or 12–18V DC at 500 mA. Antennas shall be located on the rear of the receiver and shall incorporate

standard BNC-type connectors to allow them to be detached from the receiver to facilitate the receiver being used with external antennas or antenna distribution devices. Switchable 12V DC power shall be provided on the BNC-type connectors. An accessory bracket should allow for the antennas to be located at the front of the receiver. The receiver can be rack-mounted singly or in pairs in a single rack space. The receiver's design shall provide totally silent audio output mute when the wireless transmitter is turned off or signal is lost. The wireless receiver and the supplied metal rack-mounting

brackets shall be industrial black.
The FM wireless receiver shall be an Audio-Technica ATW-R3100b or equivalent. Provide 2 compete units. One unit to have handheld transmitter and the other with lavalier style microphone and belt pack transmitter. Equivalent by Shure. Combine Antenna and remote mount antennas as shown with plexiglass covers.

2.8.4.9 Digital Control

xix. Manufacturers

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

xx. Basis of Design Product:

1. Crestron CP3

xxi. Minimum Characteristics:

1. Operating System:
    a. Modular architecture supports multiple simultaneous running programs.
        i. Number of simultaneously running user programs: 10
    b. Real-time, preemptive multithreaded/multitasking kernel.
    c. Vector floating point coprocessor.
    d. Utilize a real time, event driven, multi-tasking, multi-threaded operating system.
2. Communication:
    a. Control Processor shall support direct communication with the following devices:
        i. Connected Ethernet devices.
        ii. Devices connected to built-in control ports.
        iii. Proprietary control network devices.
        iv. BACnet IP devices.
        v. Control processors of same type.
3. Native BACnet/IP
    a. Number of BACnet objects supported: 1000
4. File Structure:
    a. Transaction-safe extended FAT32 file system
5. Memory:

a. RAM:
    i. 512 MB
b. Flash:
    i. Built-In: 4 GB
    ii. USB or MMC slot: up to 32 GB
c. External Storage
    i. Supports up to 1 TB.

6. Network:
    a. Built-in 10/100BaseT Ethernet port.
    b. Built-In Web Server: IIS v.6.0
    c. SNMP remote management.
    d. Active Directory support.
    e. IPv6 ready.
    f. TCP/IP Communications
    g. DHCP and DNS Support
    h. Native Email Client
    i. Remote Diagnostics
    j. Remote Program Loading and Administration
    k. SSL security plug in
    l. Support user assigned or dynamic IP address.

xxii. External Ports

The control system shall be equipped with the following external connection ports:

1. Infrared Output Port
    a. Number of built-in ports: 8
    b. Connector: 2 8-pin 3.5mm detachable terminal blocks.
    c. Signal:
        i. One-way infrared: up to 1.2 MHz
        ii. One-way serial output: TTL/RS-232 (0-5 Volts)
            1. Baud rate: 9600 to 115,200 baud
2. Serial Communication Port - Type 1
    a. Number of built-in ports: 1
    b. Connector: 5-pin 3.5mm detachable terminal blocks.
    c. Signal:
        i. Bidirectional RS-232

1. Baud rate: 1200 to 115,000 baud
2. Software handshaking: off or XON

ii. Bidirectional RS-422 or RS-485

1. Baud rate: 1200 to 115,000 baud
2. Hardware handshaking: CTS, RTS, or RTS/CTS
3. Software handshaking: off or XON

3. Serial Communication Port - Type 2
    a. Number of built-in ports: 2
    b. Connector: 3-pin 3.5mm detachable terminal blocks.
    c. Signal:
        i. Bidirectional RS-232
            1. Baud rate: up to 115,000 baud
            2. Software handshaking.
4. Input Output Port
    a. Number of built-in ports: 8
    b. One 9-pin 3.5mm detachable terminal block.
    c. Individual programmable 2Kohm pull-up resistor.
    d. Individually configurable to one of three modes.
    e. Digital Input Mode
        i. Digital contact closure inputs
        ii. Rating:
            1. 0-24 VDC
            2. Impedance: 20Kohm
            3. Logic threshold High: >3.125V
            4. Logic threshold Low: < 1.875V
        iii. Rated for 0-24 Volts DC, referenced to GND.
    f. Digital Output Mode
        i. Rating:
            1. 250 mA sync from maximum 24 VDC
    g. Analog Input Mode
        i. Rating:
            1. 0-10 VDC
            2. Protection: 24 VDC maximum
            3. Impedance: 21Kohm
5. Relay Port
    a. Number of built-in ports: 8
    b. Two 8-pin 3.5mm detachable terminal blocks.

i. Normally open, isolated relays.
ii. Rating:
1. 1 Amp, 30 Volts AC/DC.
iii. MOV arc suppression across contacts.

6. Ethernet
a. Number of built-in ports: 1
b. One 8-wire RJ45 with 2 LED indicators.
i. 10/100BaseT Ethernet port.
ii. Ethernet Link LED indicator.
iii. Ethernet activity LED indicator.

7. Communication Network
a. Number of built-in ports: 1
b. Four 4-pin 3.5mm detachable terminal block.
i. Master net communications port.

8. USB Type 1
a. Programming and configuration interface.
i. Number of built-in ports: 1
ii. Connector:
1. USB Type-B female USB 2.0

9. USB Type 2
a. Memory storage device port.
b. Number of built-in ports: 1
c. Connector:
i. USB Type-A female USB 2.0

xxiii. Memory Expansion Card Slot
1. Number of built-in slots: 1
2. Slot Type:
a. MMC
3. Slot Capacity
a. 32 GB maximum

xxiv. BACnet Protocol Implementation:
1. BACnet Standardized Device Profile:
a. Application Specific Controller (B-ASC)
2. BACnet Interoperability Building Blocks Supported:

a. Data Sharing-ReadProperty-A (DS-RP-A)
b. Data Sharing-ReadProperty-B (DS-RP-B)
c. Data Sharing - ReadProperty Multiple - A (DS-RPM-A)
d. Data Sharing - ReadProperty Multiple - B (DS-RPM-B)
e. Data Sharing-WriteProperty-A (DS-WP-A)
f. Data Sharing-WriteProperty-B (DS-WP-B)
g. Data Sharing – COV – A (DS-COV-A)
h. Data Sharing – COV – B (DS-COV-B)
i. Device Management-Dynamic Device Binding-A (DM-DDB-A)
j. Device Management-Dynamic Device Binding-B (DM-DDB-B)
k. Device Management-Dynamic Object Binding-B (DM-DOB-B)
l. Device Management-DeviceCommunicationControl-B (DM-DCC-B)

3. Standard Object Types Supported:
   a. Device Object
   b. Analog Input Object
   c. Analog Value Object
   d. Binary Input Object
   e. Binary Value Object
   f. Multi-State Input
   g. Multi-State Value
4. Data Link Layer Options:
   a. BACnet IP
   b. BACnet IP, Foreign Device
5. Network Options:
   a. BACnet/IP Broadcast Management Device (BBMD)
      i. Supports registration by foreign devices.
6. Character Set Supported:
   a. ANSI X3.4

xxv. Mounting

1. Standard 19 inch rack mount, 1 rack unit high.

2. Rack mounting ears shall be removable for free standing applications.

xxvi. Front Panel Controls

1. Hardware reset button
2. Software reset button

xxvii. Front Panel Indicators

1. Power
2. Control Network Communication
3. Control Processor Error

xxviii. Power Requirements:

1. 15 Watts at 24 VDC

xxix. Panel:

Provide Crestron TSW-560-W S 5” Touch Screen as shown

2.8.4.10 Projectors

Provide the following:

Projection Technology 3LCD, 3 chip technology Resolution WUXGA 1920 x 1200 White Light Output 5,200 ANSI lumens Color Light Output 5,200 ANSI lumens Colors 16.7 million colors Aspect Ratio Native 16:10 / 4:3, 14:9 and 16:9 compatible Contrast Ratio 10,000 : 1 (using active IRIS) Throw Ratio (distance : width) 1.4 - 2.3 : 1 Focus Distance 33" - 597" Display Size 30" - 300" Lens & Operation Lens f = 19.8 - 33.9, x 1.7 manual zoom, focus & lens shift Lamp Wattage 300W Expected Lamp Life* Approximately 4,000 hours (standard mode) 6,000 hours (Eco mode) Expected Filter Life** Approximately 10,000 hours Speaker Output 16W Keystone H and V: +/- 30º Compatibility Computer VGA, SVGA, XGA, WXGA, WXGA+/SXGA/SXGA+/WSXGA+/ UXGA/WUXGA, MAC 16" H-Sync 15 kHz - 106 kHz V-Sync 50 Hz - 120 Hz Composite Video NTSC, NTSC4.43, PAL, PAL-M, -N, SECAM Component Video 480i, 480p, 576i, 720p, 1080i, 1080p HDMI 480i, 480p, 576i, 720p, 1080i, 1080p, Computer signal TMDS clock 27 MHz - 150 MHz Connectors Digital Input HDMI x 2, HDBaseT x 1 HDMI Output HDMI x 1 Computer Input 1 15-pin mini D-sub x 1 Computer Monitor Output 15-pin mini D-sub x 1, HDMI x 1 Video Input S-Video N/A Composite Video RCA jack x 1 Component Video 15-pin mini D-sub x 1 (shared with computer input) Audio Input 3.5 mm stereo mini jack x 1, RCA jack (L/R) x 1 Audio Output 3.5 mm stereo mini jack x 1 Network LAN Wired RJ-45 port (10 base-T / 100 base-TX) Network LAN Wireless USB-A, IEEE802.11 b/g/n - optional wireless adapter required HDBaseT RJ-45 port x 1 USB Type A x 1 (wireless network) Control Terminals 9-pin D-sub x 1 (RS-232 control) Ratings & Warranty Power Supply AC 100-120V/220-240V, 50/60Hz Power Consumption 440W / 420W Operating Temperature 32°F - 95°F (0°C-35°C) (Standard) 32°F - 104°F (0°C-40°C) (Eco Mode) Dimensions (W x D x H) 18.1" x 13.1" x 5.4" (excluding protruding parts) Weight Approximately 14 lbs, Model shall be Hitachi CP-WU5505 or equal.

2.8.4.11 Matrix and HDMI

The Matrix is a four input by four output HDBaseT/HDMI matrix switcher with HDCP 2.2 and UHD/30 video support. The matrix features advanced EDID and HDCP handling, including the ability to turn input HDCP compliance ON and OFF to ensure maximum

functionality with a wide range of sources. The INT-44HDX features HDBaseT twisted pair extension for each output, and simultaneous HDMI on the first two outputs, allowing the same signal to be routed to the HDMI connector and a remote destination with an HDBaseT receiver. The HDBaseT ports support up to UHD/30 HDMI video with audio, bidirectional wide-band IR, matrix control via IR, RS232 tunneling, and HDCP (1.4 and 2.2) up to 100 meters (328 feet). Each HDBaseT output port supplies power to the attached extender, eliminating the need for a power supply at the display end. Each output features analog stereo audio deembedding and coaxial multichannel audio de-embedding for connection to amplifiers or DSPs. The INT-44HDX can be controlled via front panel buttons, front panel IR, external IR, remote IR through HDBaseT extenders, RS232, and Ethernet. The matrix includes a simple IR remote control to allow IR switching. This IR remote control can be learned into universal remotes and IR based control systems. An IR All In port is provided, which allow one IR connection to control all four remote displays. The matrix also features a full command set for RS232 and Ethernet control with third party control systems, plus control via a web browser. RS232 commands to remote displays can either be tunneled directly to the displays or be embedded in the control stream through the matrix from both the RS232 and Ethernet control ports, which will reduce the number of serial ports required for the control system. Provide Intelix INT-44HDX or equal.

Provide Liberty LBC-HDBT-T-WP HDMI Transmitters and Liberty E2-HDBT-R-LITE Receivers as shown.

2.8.4.12 Projector Screen

SUGGESTED SPECIFICATIONS: projection screen, 87”(H) x 139”(W), electrically operated 120 volt (60Hz), not more than 2.4 amp with a quick connect male plug-in connector on the motor. Shall have specially designed motor mounted inside the roller, to be three wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the “up” and “down” positions. Junction box shall be externally integrated into the housing making it possible to install the housing and wire to the building’s electrical system during construction. The junction box shall contain a quick connect connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly. The roller to be of rigid metal. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site. Roller mounting brackets to be adjustable to allow centering or offsetting of the screen within the case. Screen to be designed for left or right-hand motor installation. Screen fabric to be flame retardant and mildew resistant fiberglass with black masking borders standard. Bottom of fabric shall be formed into a pocket holding a metal rod. Heavy duty plastic caps shall protect the ends of the rod. Top, front and back of case to be made of extruded aluminum powder coated white. End caps to be of heavy gauge steel, powder coated white. Bottom of case to have a removable access door. Door to be of extruded aluminum powder coated white. Bottom of case to be self-trimming, with a built-in flange around the bottom of the case. To be complete with integrated low voltage control unit and three position control switch and cover plate. Suitable for use in environmental air space in accordance with section 300-22 (c) of the National Electric Code, and sections 2-128, 12-010 (3) and 12-100 of the Canadian Electrical Code, part 1, CSA C22.1. Screen to be listed by Underwriters’ Laboratories

2.8.4.13 Projector Lift

Provide projector lift with the following:

23 ½” W x 23 ½” D, maximum projector size should be 20” x 20”, weight Capacity of 35

lbs, and a lowering distance of 48". Lift specification based on Draper model 300198 Micro Lift.

2.8.4.14 Cable

Speaker cable shall be equivalent to West Penn 224 18/2 Stranded. Microphone cable shall be equivalent to West Penn 291. Video Control and I/O Crestron DM-CBL-8G-N

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Make the same connections one for one on the new equipment installed as are on the existing equipment: Ie: electronics, patch panels, wall plates speakers etc. Add intercom jack next to rack in the control room for the intercom. Protect and reuse the antennas and cables for the wireless microphones.

3.1.2 Furnish components, racks, wire, cabinetry, connectors, materials, parts, equipment and labor necessary for the complete installation of the systems, in full accordance with the recommendations of the equipment manufacturers and the requirements of the drawings and specifications.

3.1.3 Installation shall follow standard broadcast wiring and installation practice, and shall meet or exceed industry standards for such work, with particular attention given to any installation instructions in Part 2 of these Specifications.

3.1.4 Equipment shall be held firmly in place with proper types of mounting hardware. All equipment affixed to the building structure must be self-supporting with a safety factor of at least three. All equipment shall be installed so as to provide reasonable safety to the operator. Supply adequate ventilation for all enclosed equipment items which produce heat.

3.1.5 Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed, or manufactured to UL standards.

3.1.6 Provide all audio circuits balanced and floating, except as noted in the Specifications or directed by the Consultant at the time of final equalization and testing. Shields of audio cables shall be grounded at one end only, at the inputs of the various equipment items in the system.

3.1.7 Route cables and wiring within equipment racks and cabinetry according to function, separating wires of different signal levels (video, microphone level, line level, amplifier output, 120VAC, intercom, control, etc.) by as much physical distance as possible. Neatly arrange and bundle all cables loosely with plastic cable ties. Cables and wires shall be continuous lengths without splices.

3.1.8 All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heatshrink type tubing shall be used to insulate and dress the ends of all wire and cables. Include a separate tube for the ground or drain wire.

3.1.9 All cables in conduits shall be insulated from each other and from the conduit the entire length and shall not be spliced. All cables and wires are to be continuous lengths without splices.

3.1.10 All solder joints and terminations shall be made with resin-core silver solder.

3.1.11 Temperature regulated soldering irons rated at least 60 watts shall be used for all soldering work. No soldering guns or temperature unregulated irons shall be used on the job site.

3.1.12 Mechanical connections shall be made using approved connectors of the correct size and type for the connection. Wire nuts will not be accepted.

3.1.13 Each mechanical connector shall be attached using the proper size controlled-duty-cycle ratcheting crimp tool which has been approved by the manufacturer of the connectors. Conventional non-ratcheting type crimping tools are unacceptable, and shall not be used on the job site.

3.1.14 Label all wires in racks and console as to destination and purpose. Clearly and permanently label all jacks, controls, and connections, at the front and back of the rack, with permanent engraved laminated plastic labels or by engraving and filling mounting plates, unless otherwise noted. Attach laminated plasticlabels with contact cement. Embossed or printed label tape, and press-on or lift-off lettering systems will not be accepted. All labeling shall be completed prior to final system inspection.

3.1.15 All installations shall be made by workmen skilled in the specific trade. The installation contractor shall have a minimum of 8 years experience in the installation of sound systems. The installation contractor shall show satisfactory evidence upon request that they maintain, within a fifty mile radius of the project, a fully equipped service organization with standard replacement parts. All installation and service performed shall be by factory trained personnel on staff.

3.1.16 Conduit shall be provided for all cables except cables above accessible ceilings to be run as open wiring. Power AC cables must be ran in EMT conduit. Cables shall be grouped according to function, i.e.: microphone, line level and control, speaker, and power etc. Cables of one group shall not be run in the same conduit with a different group, such as power or network wire etc. In the equipment rack, the different groups shall be separated as much as possible in cable routing. All cables shall be distinctively labeled at each end with Brady tags or equivalent showing where they are terminated to. Cables shall terminate with spade-lug connectors on screw-type terminal blocks, Speakon connectors or XLR type connectors. Cables are to be neatly grouped and bound with plastic cable ties. Splices are not allowed except in terminal cabinets and equipment housings and must be made with crimp-on, pigtail connectors using a Thomas & Betts crimping tool. Splices that are soldered and taped are not acceptable.

3.1.17 Unipoint grounding technique shall be used with a #6 THHN insulated, stranded conductor in separate conduit connecting the equipment rack with earth ground. All conduit shall be electrically isolated from the equipment rack and any electronic housing with plastic connectors.

3.1.18 Conduits, boxes, and installation of same shall be as hereinbefore specified.

3.1.19 Wall outlet boxes to be single gang box with single gang cover.

3.1.20 In case of conflict, notify architect.

3.1.21 Testing: Test complete system for proper operation.

3.2 IN-SERVICE TRAINING

3.2.2 The installation contractor along with the manufacturer's technical representative shall provide 16-hours of training for school personnel (to be held in four 4-hour sessions) on the operation and 4 hours of technical training for the personnel of the MCPS Electronic Maintenance Department. Training must be scheduled within 30 days of final completion.

3.2.3 These training sessions shall be videotaped by the Installer and copies provided to the Owner with the as-built documentation.

3.2.4 The training phase shall be accompanied by complete as-built documentation and the technical systems operation manual.

3.2.5 Brochures: Furnish Owner a complete set of operating instructions and diagrams.

3.3 REGULATORY AND TESTING AGENCY REQUIREMENTS

3.3.1 The entire installation shall comply with all applicable electrical and safety codes and be installed per the manufactures and specifications.

3.3.2 Return all replaced existing audio equipment to the school. Return all existing microphone wall plate to school.

END OF SECTION 272800

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 281316 – SECURITY AND DATABASE MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

D. All layout and installation of communications infrastructure shall be in accordance with ANSI / TIA 568 and the BICSI TDMM.

E. Division 26 - Electrical

1.2 SUMMARY

A. SECURITY AND DATABASE MANAGEMENT SYSTEM shall include all items, articles, and materials necessary for a complete system. This includes all labor, materials, cabling, equipment, and incidentals, necessary and required for a complete and operational security system.

B. SECURITY AND DATABASE MANAGEMENT SYSTEM shall include all items, articles, and materials necessary for a complete system. This includes all labor, materials, cabling, equipment, and incidentals, necessary and required for a complete and operational security system.

C. The installing contractor must have been in the business of installing and programming security systems for at least (5) years. This includes programming control panels, keypads, and all addressable devices. The installing contractor shall be a manufacturer-certified installer or have equivalent training or experience for the type of equipment being installed.

D. The installing contractor must provide all programming for control panels, keypads, expansion modules, and other addressable devices as per the manufacturer recommendations for correct security system operation. This includes zoning, entry/exit delays, reporting codes, partitions or any other system parameter as required for a fully functional system.

1.3 QUALITY ASSURANCE

A. Source Quality Control: Materials and equipment shall be new, unused and U.L. listed for use as a security intrusion system.

B. The system and components shall be supplied by manufacturers of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to refer to similar installations rendering satisfactory service.

C. The Security Intrusion Alarm System hereinafter shall be known as the "Security Intrusion Alarm System". The Security Intrusion Alarm System shall be installed by the manufacturer's authorized installation contractor, hereinafter known as the "Security Intrusion System Trade." The Security Intrusion System installation shall include wiring, components, connections, adjustment, testing and certification. The Electrical Trade shall provide conduit, junction boxes and pull boxes as indicated and required by the Security intrusion System manufacturer's drawings or Trade instructions. The Security Intrusion System Trade shall furnish any special back boxes, cabinets, enclosures and similar items to the Electrical Trade for installation by the Electrical Trade in accordance with the manufacturer's drawings, instructions, and as indicated.

D. The Security Intrusion System Trade shall furnish a list of similar or equal installation (a minimum of ten) and shall show at least five (5) years of company experience in this type of work.

E. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

F. 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.

1.4 REFERENCES

A. The complete installation, including additions and modifications, shall be in accordance with:

1. National Electrical Code Article 725 & 800.
2. Minimum standards of Electronic Industries Association (EIA).

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.7 SUBMITTALS

A. Submit shop drawings product data in accordance with Section 260503.

1. Shop Drawings: The Security Intrusion System manufacturer and Trade shall provide a one-line riser diagram indicating route and conduit size, external wiring and connections of system proposed, also furnish complete operating instructions, including schematic and wiring diagrams of the system, engineering data sheets on each component and complete servicing data including part numbers of the various components. A schematic diagram of the complete system is not shown on the contract documents.

2. Product Data: Submit application, technical, and installation data.

1.8 WARRANTY, SERVICES

A. The Security Intrusion System Manufacturers and Trade shall warrant this System for a minimum of one (1) year from date of acceptance by Owner against defective parts and/or workmanship and shall provide parts and labor to fulfill this warranty at no cost to Owner. This warranty shall not apply if damage is caused by abuse, accident, improper operation or negligence.

B. Qualified service and parts shall be available to call on within a 50 mile basis.

C. The Security Intrusion System Trade shall include in his quotation the cost of three (3) inspections of the system during the two (2) years subsequent to the installation. The Trade installing this equipment shall be prepared to offer the Owner a service contract after the guarantee period has ended. On-the-premises service furnished at other than normal working hours shall also be available and shall be charged at current labor rates.

D. INSTALLATION WARRANTY. The Contractor shall warrant the cabling system unconditionally against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. Replacement of faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

E. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

1.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL.

B. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide thirty (30) days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 General

A. All new hardware shall be installed and programmed to Owner’s Existing Enterprise level Access Control System. It is to include all necessary licenses and fully integrated with existing District Wide Video Surveillance System. All controller, door monitor

contacts, and card readers are to be installed by Factory Authorized Video Insight Dealer. No Exceptions.

B. All door locking hardware to be provided by others.

C. The security management system shall be deployed through IP network infrastructure with a two-tiered hardware hierarchy. The IP Door Controller shall be capable of running on an existing TCP/IP network and shall be accessible, configurable, and manageable from any network-connected PC with a browser.

D. Browser access for configuration and administration of the system shall be possible from a PC on the same subnet, through routers and gateways from other subnets, and from the Internet. Control and management of the system shall therefore be geographically independent.

E. The top hardware tier shall be the MonitorCast v3 Server based platform. Installed applications on the MonitorCast v3 Server is to be an operating system, a web MonitorCast v3 Server, security application software, and the database of personnel and system activity.

F. The bottom hardware tier shall be the IP Door Controller. The IP Door Controller shall make and manage access control decisions with data provided by the MonitorCast v3 Server, and it shall control the communication between the IP Door Controller and door hardware connected to the IP Door Controller inputs, outputs, and readers. This modular design shall make it possible, even during network downtime, for the system to continue to manage access control and store system activity logs. When network connectivity is re-established, the system activity logs shall be automatically re-integrated to the host MonitorCast v3 server.

G. The system shall integrate, within a browser interface; access control and video monitoring. These applications shall be a fully bi-directional integrated software architecture.

1. The database tier shall use Microsoft SQL Server residing on the MonitorCast v3 Server. Microsoft SQL Server on the MonitorCast v3 Server shall be a full featured, high performance database management system. This shall provide a small footprint, low administration, and a high reliability relational database that is embedded without requiring the use of a separate PC MonitorCast v3 Server.
2. The MonitorCast v3 Server tier shall be based on a Microsoft™ MonitorCast v3 Server 2008 R2 or 2012 MonitorCast v3 Server. This application shall provide a graphically rich security management application through a standard web browser.

H. All equipment and materials used shall be standard components, regularly manufactured,
and regularly utilized in the manufacturer’s system.

I. All systems and components shall have been thoroughly tested and proven in actual use.

J. All systems and components shall be provided with a manufacturer warranty of one year for software and two years for hardware.

2.2 OVERALL SYSTEM CAPABILITY

A. The security management system shall meet the requirements of business and government access control systems. The system shall monitor and control facility access, and shall perform alarm monitoring and integration to camera and video monitoring. The system shall also maintain a database of system activity, personnel access control information, and system user passwords and user role permissions. The system shall be controlled from a web browser and require no software installation or client licenses. The system shall provide control and access to users on Local Area Networks (LAN), Wide Area Networks (WAN), wireless networks, and the Internet. The system shall provide email and/or text message alerts for all alarm conditions and threats.

B. System Partitioning: The system administrator shall have the ability to divide the system into partitions, allowing subsets of the overall population and/or resources to be managed separately.
    1. From the default Master partition, one or more additional partitions shall be able to be created.
    2. Each partition shall contain some number of administrators, card holders with their credentials, and resources.
    3. When performing administrative functions, the administrator of a partition shall have the ability to create or modify only the cardholders and resources in that partition. However, resources shall be able to be shared across partitions through the mapping of access levels from one partition to another.
    4. System partitioning shall have a precision feature that allows administrators in one or more partitions to view and perform edit functions on person records that belong to another partition.
    5. Administrators shall have the ability to search for person records across all partitions to which they have access. The system administrator shall have the ability to make such cross-partition searches the default for users who have access to multiple partitions.
    6. After finding a personnel group record located in another partition, an administrator shall be able to click a button to switch to that partition directly from the personnel group record—and possibly edit the record, depending on his or her access rights in that partition. Alternatively, an option for making every person record seamlessly visible across all partitions shall be provided.

C. The system shall provide the following Access Control capabilities:
    1. Integrated photo ID creation capability with video verification.
    2. User interface secured access under encrypted password control.
    3. Multiple Site Control
    4. System-wide timed anti-pass back function.
    5. “First-in-unlock” rule enforcement.
    6. Multiple access levels and cards per person.
    7. Detailed time specifications.
    8. Simultaneous support for multiple card data formats.
    9. Compatibility with various input devices, including biometric readers.
    10. Activation/expiration date/time by person with one minute resolution.
    11. Access level disable for immediate lockdown.
    12. Multiple holiday schedules.

13. Timed unlock schedules.
14. Dual-reader portal support.
15. Wiegand Reader support.
16. Magnetic-stripe reader support
17. Wiegand keypad PIN support for 4-digit or 6-digit PINs.

D. The system shall provide the following native or VMS integrated monitoring capabilities:
    1. The Home page shall allow users to view a full system summary, including an Activity Log, Auto-Monitor, and dashboard functions.
    2. Common alarm panel integration for disarm on access, and arm on egress.
    3. Integrated real-time IP-based NVR systems with stored video replay for events.
    4. Provides alarms on communication loss.
    5. Provides the ability to record video and link to video for alarm events.
    6. A monitoring desktop that integrates video, system activity logs, floorplans, ID photos, and alarm notifications.
    7. Graphic floorplans with active icons of monitor and access control points.
    8. Secure access to the user interface under encrypted password control.
    9. Delivery of alerts via VMS Rules Manager or Automation and email.
    10. Remote logging of system messages to local host.

E. The system shall provide the following integrated VMS Video Management capabilities:
    1. Playback of event-related video.
    2. Integrated alarm inputs from the video management system.
    3. Digital playback of video events.
    4. Linking of video and events based on triggers provided by the system or video system.
    5. Support for multiple NVRs.
    6. Multiple pre-programmed supported cameras.
    7. Monitoring and control through a web browser interface.

F. The system shall provide the following Security Database capabilities:
    1. Maintain data of system activity, personnel access control information, system user passwords and custom user role permissions for whole or partial access to system resources and data.
    2. LDAP integration for single-user logon authentication.
    3. Network-secure API for external application integration.
    4. Easy to use custom report generator.
    5. Record recall by vehicle tag, name, or card.
    6. An API for adding to, deleting from, and modifying the database.
    7. Storage of system user passwords and permissions.
    8. Storage and recall of ID photos and emergency personal information.
    9. Pre-defined reports on system configuration, system activity history, and people.

10. Custom report writer interface that allows the interactive creation of custom reports. Reports may be saved for later reuse. No third party software (such as Crystal Reports) shall be necessary.
11. Selectable custom report output formats, including PDF & CSV.
12. Custom report repository location. Users shall be able to review, cancel and delete reports from this data storage location.
13. Email and text messaging (SMS) alert notifications.

2.3 HARDWARE REQUIREMENTS

A. The security management system shall employ a modular hardware concept that enables simple system expansion and utilizes a two-tiered hardware hierarchy:
   1. At the top tier shall be a MonitorCast v3 Server, which shall contain the database engine, web MonitorCast v3 Server, application software, and configuration data. It is at this level that System Users, through a browser interface, shall interact with the system, set configurations, monitor activities, run reports, and manage alarms.
   2. At the bottom tier shall be the IP Door Controller, an intelligent device with native TCP/IP & PoE support, which shall make and manage access control decisions, a set of inputs, outputs and readers.
   3. The network device shall run on existing building TCP/IP PoE networks and shall be configurable for access from separate subnets, through gateways and routers, and from the Internet.

B. A MonitorCast v3 Server shall contain a processor, flash memory, and storage. External battery backup shall be used to provide uninterrupted operation in the event of external power loss. The IP Door Controller shall contain IIS for communication with the IP Door Controllers and a network interface port. A MonitorCast v3 Server shall have the following capabilities:
   1. IP Door Controller: 512
   2. Access cards: No Limit
   3. Card formats: 15 per Controller
   4. Alarm input points: 2,048 per Controller
   5. Control point outputs: 2,048 per Controller
   6. Ethernet ports: 1
   7. Time specifications 512 per Controller
   8. Holidays 255 per Controller
   9. Access levels per person 15 per person (32,000 per Controller)
   10. Cards per person No Limit
   11. Concurrent system users Unlimited

C. The IP Door Controller shall make and manage access control decisions with data provided by the MonitorCast v3 Server, and it shall manage the communication between the IP Door Controller connected to the system's inputs, outputs, and readers. The IP Door Controller shall be powered with PoE power input 12.95W (802.3af or 12Vdc 900ma power supply) protocol. Each IP Door Controller shall have the following capabilities:
   1. Access control doors 1
   2. Readers 2

3. Supervised Inputs 2
4. General Input 2
5. Relay Outputs 2
6. Connectivity 10/100 Ethernet
7. Credential storage 20,000
8. Activity Log records 27,000

D. The IP Door Sub-Controller single door shall make and manage access control decisions with data provided by the MonitorCast v3 Server through the IP Door Sub-Controller, and it shall manage the communication between the IP Door Sub-Controller connected to the system's inputs, outputs, and readers. The IP Door Controller shall be powered with PoE power input 12.95W (802.3af or 12Vdc 900ma power supply) protocol. Each IP Door Controller shall have the following capabilities:

9. Access control doors 1
10. Readers 1
11. Supervised Input 4
12. Relay Outputs 2
13. Connectivity 10/100 Ethernet

E. The Door Sub-Controller single door shall make and manage access control decisions with data provided by the MonitorCast v3 Server through the IP Door Controller, and it shall manage the communication between the IP Door Sub-Controller connected to the system's inputs, outputs, and readers. The IP Door Sub-Controller shall be connected to IP Door Controller using RS-485 protocol. Each IP Door Sub-Controller shall have the following capabilities:

14. Access control doors 1
15. Readers 1
16. General Input 2 (programmable)
17. Dedicated Input 1
18. Relay Outputs 2
19. Connectivity RS-485

F. The Door Sub-Controller two door shall make and manage access control decisions with data provided by the MonitorCast v3 Server through the IP Door Controller, and it shall manage the communication between the IP Door Sub-Controller connected to the system's inputs, outputs, and readers. The IP Door Sub-Controller shall be connected to IP Door Controller using RS-485 protocol. Each IP Door Sub-Controller shall have the following capabilities:

20. Access control doors 2
21. Readers 1
22. General Input 8 (programmable)
23. Dedicated Input 2
24. Relay Outputs 6
25. Connectivity RS-485

G. The Serial Input Sub-Controller shall make and manage access control decisions with data provided by the MonitorCast v3 Server through the IP Door Controller, and it shall manage the communication between the IP Serial Input Sub-Controller connected to the system's inputs & outputs. The IP Serial Input Sub-

Controller shall be connected to IP Door Controller using RS-485 protocol. Each IP Serial Input Sub-Controller shall have the following capabilities:

26. General Input	16 (programmable)
27. Dedicated Input	2
28. Relay Outputs	2
29. Connectivity	RS-485

H. The Serial Output Sub-Controller shall make and manage access control decisions with data provided by the MonitorCast v3 Server through the IP Door Controller, and it shall manage the communication between the IP Serial Output Sub-Controller connected to the system's inputs & outputs. The IP Serial Output Sub-Controller shall be connected to IP Door Controller using RS-485 protocol. Each IP Serial Output Sub-Controller shall have the following capabilities:

30. General Output	16
31. Dedicated Inputs	2
32. Connectivity	RS-485

2.4 HARDWARE PACKAGING REQUIREMENTS

A. The security management system shall have various hardware enclosures and configurations available to support different installation requirements. Enclosures shall be available for wall or rack mounting. The wall-mount enclosures shall have a lock requiring a key

2.5 MONITORCAST V3 SERVER AND IP DOOR CONTROLLER SPECIFICATIONS

A. The MonitorCast v3 Server shall be powered by platinum efficiency hot plug redundant 495W or 750W power supply.

1. OS	Windows Server 2008 R2/2012
2. Storage	200GB (minimum)
3. Processor	Intel i5 class processor or higher
4. RAM	8GB
5. Ethernet Ports	1
6. Warranty	3 Years

B. Each IP Door Controller shall be powered by PoE 803.that conforms to the IEEE 802.3af standard. With PoE as the power source the total power available for all external outputs is 12Vdc @ 650mA. IP Door Controllers shall have the following characteristics:

1. TTL reader connectors	2
2. RS-485 reader connectors	1
3. Power available for output	650 milliamps
4. Input connectors	2
5. Output connections	2

C. Each IP Door Sub-Controller shall be powered by PoE 803.that conforms to the IEEE 802.3af standard. With PoE as the power source the total power available for all external 12V. IP Door Controllers shall have the following characteristics:

6. TTL reader connectors	1
7. Power available to readers	150 milliamps
8. Input connectors	4

9. Output connections 2

D. Each Single Door Sub-Controller shall be powered by may be supplied with 12-24 VDC at 3 amps. With a 12VDC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:

10. TTL reader connectors 1
11. Power available to readers 150 milliamps
12. Input connectors 3
13. Output connections 2
14. Communication protocol RS-485

E. Each Two Door Sub-Controller shall be powered by may be supplied with 12-24 VDC at 3 amps. With a 12VDC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:

15. TTL reader connectors 2
16. Power available to readers 150 milliamps
17. Input connectors 10
18. Output connections 6
19. Communication protocol RS-485

F. Each Serial Input Sub-Controller shall be powered by may be supplied with 12-24 VDC at 3 amps. With a 12VDC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:

20. General Input connectors 16
21. Dedicated Input connectors 2
22. Output connections 2
23. Communication protocol RS-485

G. Each Serial Output Sub-Controller shall be powered by may be supplied with 12-24 VDC at 3 amps. With a 12VDC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:

24. General Output connectors 16
25. Input connections 2
26. Communication protocol RS-485

2.6 SOFTWARE REQUIREMENTS

A. Operating System and Application Software shall have the following characteristics::

1. The MonitorCast v3 Server operating system shall Windows Server 2008 R2 or Windows Server 2012 operating system.
2. The system database shall be SQL Server Express requiring a small footprint and providing high reliability. The MonitorCast v3 Server shall provide users with access and operate the system using a standard web browser.
3. The system shall support the following web browsers:
    a. For the security management system, the listed browsers shall include Internet Explorer, Firefox, Safari.

B. Software Licensing shall have the following characteristics:
   1. Software licensing shall be based upon the number of cameras licenses you have per server and individual lifetime licensing in situations where doors out number cameras at the project site.
   2. Licensing shall be controlled by a Serial Key and an Activation Code. The Serial Key shall contain the licensed system limits. System upgrade licensing to enable more cameras or more doors shall require a Serial Key re-activation. The key shall be locked to the system license number

C. Software upgrades shall be possible from a browser on any network-connected PC, by uploading a software update to the IP Door Controller. No client software installation shall be necessary.

D. Online Help and Documentation - The system shall be provided with complete online documentation. The online documentation shall include:
   1. Technical Support Notes - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
   2. Installation Guides - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
   3. Video Integration Guides - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
   4. End-User Task Guide - This document shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics

E. Language Support - The system shall be provided with multiple language support. The ability to switch from one language to another shall be accomplished through the user interface. Translation of the user interface, online help and documentation into other languages shall be available. The languages supported shall include:
   1. English

F. Date Formats - The system shall support global date formats as follows:
   1. mm/dd/yyyy
   2. dd/mm/yyyy
   3. yyyy/mm/dd

G. Floor plans - The system shall provide graphic floorplan capability including graphic display of door status and entry direction. Floor plans shall have the following characteristics:
   1. The Network Administrator shall be able to graphically configure device icons onto the floorplan images, and to upload additional floorplan images. JPEG images shall be supported, and the maximum size for a floorplan image shall be 256K.

H. Personnel Data - The system shall maintain person data relating to access control, system user privileges, photo identification, system activity, and contact information.
   1. All person data in the system shall be integrated onto one page for viewing, editing, and deletion by system users.

2. A system user holding at least an “Administrator” user role shall be able to create, delete, and modify person records, including access levels, schedules & resource groups.
3. A system user holding at least a “Administrator” user role shall be able to configure the display of person records.

I. Access Control:

1. The system shall be able to make access control decisions, define a variety of access levels and time specifications, write system activity into a log file, maintain a personnel enrollment database, receive signals from input devices such as door switch monitors, card readers and motion detectors, energize devices such as door locks and alarms via outputs.
2. Card Formats - The system shall support the use of readers that use the Wiegand Reader Interface. The system shall also support the use of the Magnetic Stripe ABA track 2 card data formats.
    a. It shall be possible to create new card formats, designate start bits and bit lengths for facility codes and card ID numbers, as well as designate parity bits. The system shall support up to 32 different card formats.
3. Access Levels - The system shall be capable of storing unlimited access levels in each partition.
    a. The definition of an access level shall require the assignment of a reader or reader group, and a time specification.
4. First-in Unlock Rule - The system shall support the use of a First-in unlock rule. It shall be possible to use this rule to control the unlock behavior of portal groups with assigned unlock time specs.
    a. The First-in unlock rule shall require a card read of a specified access level. The portals in the group shall unlock only when the rule is satisfied and the unlock time spec is valid.
5. Holidays - The system shall be capable of storing up to 5 holidays per system. Each holiday shall be assigned a unique alphanumeric name with high character in out values. The definition of a holiday shall require a start date and an end date. Holidays shall have the ability to span several days using only one holiday slot. Holiday definitions shall support the designation of a start time and an end time. If no start time is designated then the system shall default to 00:00 (start-of-day). If no end time is designated then the system shall default to 24:00 (end-of-day). Holidays shall require the use of 24-hour time format, e.g. 17:00 is 5:00PM.

J. Reports:

1. The system shall be capable of producing a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system.
2. The system shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters shall be inserted into reports to prompt for data input at report runtime. Report results shall be printed, output to a PDF file or put into a spreadsheet.
3. The system shall be capable of sorting users by various criteria, including email address, and allow for email groups to be selected for auto-distribution.

4. Report generation shall not affect the real-time operation of the system.
5. The specific reports provided shall include the following:
    a. Configuration Reports
        i. Access History - Displays access history based on an entered query. The system user can specify the query using either the keyboard or point-and-click selection.
        ii. Custom Report - This provides the capability to create custom reports of historical data.
        iii. General Event History - Displays time, type of activity, and activity details for a variety of event types. The system user can select the specific event types for the report.
        iv. Audit Trail: Displays an audit trail of system changes and the name of the system user that made the changes. It shall be possible to specify the dates and times covered in the report.
    b. People Reports
        i. Access Levels - Displays all access levels entered into the system including time specification, reader/reader group, and floor group.
        ii. Credential Audit - Lists existing credentials by their current status settings (such as Active, Damaged, Lost, or Not Used). Before running the report, users can filter the data to see only credentials with a particular status setting, or only credentials that were not used with a specific number of days from the date they were issued.
        iii. Current Users - Displays a list of all security system users currently logged in to the security system website.
        iv. Custom Report - This provides the capability to create custom reports of personnel data. A graphic interface provides the user with the ability to interactively create and save reports for later use. Parameters can be inserted into reports to prompt for data input at report runtime. Custom report configuration shall include page size, orientation, column width and shall automatically notify the user if the selected configuration exceeds the selected page size.

K. Administration - The system shall provide for the performance of system administration tasks from any network-connected computer with a browser. These administrative tasks shall include but not be limited to:
1. Generating reports:
    a. The system shall be capable of producing a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system.
    b. Alternatively, the system shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters can be inserted into reports to prompt for data input at report runtime. Report results can be printed, output to a pdf file or put into a spreadsheet.
    c. A system user holding “Administrator” permissions shall be able to view and create reports.

2. Database backups:
    d. It shall also be possible for the system users to create such database backups at any time. Any database backups onboard the MonitorCast v3 Server may also be downloaded to IP Door Controller storage by the system user at any time.
3. System restore:
    a. The system shall be able to restore its database, or the full system data, from a backup. Restoration of the system shall only be possible from a backup copy onboard the MonitorCast v3 Server. It shall, therefore, be possible to upload a copy of a database backup from any network attached storage.
4. Software updates:
    a. Software updates, upgrades and patches shall be provided from time to time. The system shall be able to update its software from these files. Update of the application software shall only be possible from an update file onboard the Server. It shall, therefore, be possible to upload a copy of the software update from any network attached storage or from any PC drive or desktop.
    b. Software updates may involve the Server only or may include updates for the IP Door Controller also. The monitoring of the security system may be unavailable for several minutes during this process.
5. Enrolling new people - All person data entered into the system shall be held in the system database and shall be available only to system users holding at least the Administer user role. Person data can be added, deleted, and edited by such system users.
6. Configuring network resources:
    a. DNS - The system shall support setting IP addresses for up to two domain name MonitorCast v3 Servers.
    b. Email settings - The system shall support the use of email notifications of alarm events. The system user must setup the email MonitorCast v3 Server IP address or DNS name and the email address of the Network Controller. A network administrator must setup the network mail MonitorCast v3 Server to relay email for the IP address of the Network Controller.
    c. Time MonitorCast v3 Servers - The system shall support the use of network time MonitorCast v3 Servers. Up to three time MonitorCast v3 Servers can be designated. Use of a network time MonitorCast v3 Server ensures that the Network Controller and its nodes will be regularly synchronized with the exact time used by all other network resources.
    d. A system user holding “Setup” permissions shall be able to configure network resources.
7. LDAP - It shall be possible to configure an Active Directory MonitorCast v3 Server with the system.
    a. This shall provide single user-login capability.
    b. Password rules and authentication shall be governed by the LDAP MonitorCast v3 Server.

2.7 CERTIFICATIONS

A. UL 294 listed.

B. ISO 9000 listed.

C. CE Compliant

D. RoHS

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

3.2 CABLING AND WIRING INSTALLATION

A. A complete cabling and wiring system shall be provided, which shall adhere to the highest workmanlike standard of quality and appearance. Cables and wires shall be installed square with building lines, subject to the approval of the engineer or Owner.

B. Identify components with engraved, laminated-plastic or metal nameplate for central-station control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems." Cabling shall be concealed above the finish ceilings and within the finished walls where possible. Open cables above lay in suspended ceilings, unfinished attics, basements, tunnels, and crawl spaces shall be run through and supported by J-hooks at four foot intervals. Cables above plaster and drywall ceilings shall be installed in electrical metallic tubing (EMT).

C. Cables in unfinished areas and mechanical rooms may utilize exposed EMT. Cables in finished “occupied” areas must utilize concealed conduit.

D. Open cabling (not in raceways) shall be plenum rated. Cables and associated raceways shall be supported directly to the building structure and walls. Cables and raceways shall not be supported to pipes, conduits, ducts, suspended ceilings or equipment. Cables shall not touch or lay on ceilings, light fixtures, pipes, ducts, or equipment.

E. Cables run to ceiling mounted sensors shall have a minimum of 20 feet of cable (coiled and secured above sensor) to allow for the sensors relocation when needed.

F. The contractor shall provide two (2) telephone cables from MDF Room telephone demark to master security control panel. All final connections of both ends of the telephone cables shall be made by Contractor.

G. Cabling for zone sensors and equipment alarms shall be 22 gauge unless the run exceeds 1000 feet, then 18 gauge shall be used.

H. All cabling shall be a continuous run whenever possible. Any junctions of cable conductors shall be made in a metal enclosure, then soldered and taped. No mechanical connections will be accepted. All cabling shall be labeled on both ends as to wire location with a permanent type of labeling system.

I. All cabling and raceway must be routed in the control panel, and expansion modules as to not interfere with the electronics removal or replacement.

J. Cables and raceways shall be installed in strict accordance with the cable manufacturers' recommendations and the National Electric Code.

K. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

L. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables," unless otherwise indicated.

M. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

N. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

O. Electrical work required for the control panel and the remote expansion modules shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for a complete system.

P. Electrical power for the control panel and expansion modules shall be fed from a dedicated circuit or circuits from an electrical power panelboard and shall not be taken from receptacles, lighting or equipment circuits. The circuit(s) within the electrical panelboard shall be marked "Security Intrusion Alarm System". If available power should be taken from a panel that has standby reserve capability.

Q. Provide at each panel location a SS duplex receptacle.

3.3 INSTALLATION

A. Security intrusion alarm system control panel shall be installed and tested in accordance with manufacturer's installation instructions.

B. Coordinate interfaces with Owner's representative where appropriate.

C. Provide backboxes, pullboxes, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.

D. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.

E. Coordinate with other trades to provide proper sequencing of installation.

F. Comply with UL 1641.

G. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

H. Occupancy Adjustments: When requested within 12 months of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.4 GROUNDING

A. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

C. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.5 TECHNICAL ASSISTANCE

A. Instruction: The installation supervising technician for the Security Intrusion System Trade shall instruct the proper designated authority on the correct operation of the system after the installation is completed. The Owner shall be instructed to walk-test the motion detectors periodically (daily preferred) to assure the protect area is not accidentally blocked or obscured.

3.6 FIELD QUALITY CONTROL

A. General: Upon completion of the installation, the Security Intrusion System Trade's factory-trained technician shall perform all necessary electrical tests and adjustments and who shall then submit a Letter of Verification to the Owner/Architect/Engineer that the system functions and conforms to all requirements of the manufacturer of the equipment, these specifications, and all requirements of Uniform Statewide Building Code and UL for type of building in which the system is installed.

B. The factory trained technician shall perform all electrical and mechanical tests. All test and report costs shall be in the Contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate. The report shall include, but not be limited to:

1. A complete list of equipment installed and wired.
2. Indication that all equipment is properly installed and functions and conforms to these specifications.
3. Tests of individual zones as applicable.
4. Technician's name and date.

C. After completion of all tests and adjustments listed above, the Security Intrusion System Trade shall submit the following information to the Architect/Engineer.

1. "As-built" conduit layout diagrams including wire color code and/or tag number.
2. Complete "as-built" wiring diagrams.

D. Final tests and inspection shall be held in the present of Architect/Engineer's representatives and to their satisfaction. The Security Intrusion System Trade shall supply personnel for this test without additional cost.

E. The completed Security Intrusion Alarm System shall be tested to ensure that it is operating properly. Failure of the devices to properly operate shall be considered a failure of the system and all such devices in that system shall be readjusted or replaced. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the Security Intrusion System Trade shall readjust or replace the Defective component and begin another ninety (90) day test period. This test shall not start until the Owner has obtained beneficial use of the building under tests.

F. If the requirements provided in the paragraph above are not completed within one (1) year after beginning the tests described therein, the Security Intrusion System Trade shall replace the defective portion of the system with another acceptable manufacturer and the process repeated until acceptance of the equipment by the Architect/Engineer.

G. After completion of all tests and adjustments listed above, the Security Intrusion System Trade shall turn over all data disks and other information used in configuring the Security System. All such information shall be the property of the Owner upon the acceptance of the system by the Project Manager.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain intrusion detection. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 281316

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 282000 – VIDEO SURVEILLANCE

PART 1 -GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

D. Division 26 - Electrical

1.2 SUMMARY

A. Section includes a new video surveillance system consisting of cameras, data transmission wiring, equipment rack, monitors and a control station with its associated equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

C. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

D. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.

E. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.

F. Wiring Diagrams: For power, signal, and control wiring.

G. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.4 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period. If any defects are found within the warranty period, the defective equipment shall be replaced at no extra charge to Owner for parts or labor.

B. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS:

2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work.

A. CAMERAS

a. Approved interior fixed mini-dome cameras mounted less than or equal to 9’-6” AFF to bottom of lens:

b. Approved interior fixed mini-dome cameras mounted higher than 9’-6” AFF to bottom of lens:

c. Approved interior fixed mini-dome cameras at entry areas:

d. Approved exterior fixed mini-dome cameras:

2.2 CAMERA-SUPPORTING EQUIPMENT

A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

B. Protective Housings for Fixed and Movable Cameras: Steel or 6061 T6 aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.

C. Duplex Receptacle: Internally mounted if required. Extend branch circuit to nearest branch circuit

D. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.

E. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.

F. Sun shield shall not interfere with normal airflow around the housing.

G. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.

H. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.

PART 3 – EXECUTION:

3.1 WIRING

A. Provide 15’ supported loop above accessible ceiling of cable/wire at each camera location.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. For LAN connection and fiber-optic and copper communication wiring, comply with Division 27.

D. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

a. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

b. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

i. Prepare equipment list described in "Informational Submittals" Article.

ii. Verify operation of auto-iris lenses.

iii. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.

iv. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.

v. Set and name all preset positions; consult Owner's personnel.

vi. Set sensitivity of motion detection.

vii. Connect and verify responses to alarms.

viii. Verify operation of control-station equipment.

c. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

d. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to six (6), 8 hour visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

a. Check cable connections. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.

b. Adjust all preset positions; consult Owner's personnel.

c. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.

d. Provide a written report of adjustments and recommendations.

3.4 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment. Provide 16 hours of training.

B. Training shall be recorded. Provide the Owner with 4 sets of DVD’s of the training.

END OF SECTION 282000

DIVISION 28– ELECTRONIC SAFETY AND SECURITY

SECTION 283100 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Contractor's attention is directed to Section 260501 - General Provisions, Communications, and all other Contract Documents as they apply to his work.

1.2 SCOPE OF WORK

A. The work covered by and the intent of this section of the specifications includes the furnishing of all labor, equipment, materials, testing, programming and performance of all operations in connection with the installation of the Fire Alarm System as shown on the drawings, as herein specified and as required by the applicable codes.

B. The requirements of all other applicable conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.

C. The complete installation shall conform to the applicable sections of KBC 909.8, NFPA-71, NFPA-72A, B, C, D, NFPA 92 & 92B, Local Code Requirements and National Electrical Code (Article 760). The requirements of any local fire department and the Authority Having Jurisdiction shall also be observed in the system installation and device layout.

D. The work included in this section shall be coordinated with related work specified elsewhere in these specifications.

E. Furnish and install a complete digital multiplex Fire Alarm System as described herein and as shown on the plans; to be wired, connected, completely tested, and left in first class operating condition. The system shall use individually-addressable digital multiplex device circuit(s) with individual device supervision, appliance circuit supervision, incoming normal and stand-by power supervision. In general, systems shall include a control panel, manual pull stations, automatic fire detectors, horns, flashing lights, annunciator (if indicated), interface with campus notification system, raceways, all wiring, connections to devices, connections to valve tamper switches, water flow switches and mechanical controls, outlet boxes, junction boxes, and all other necessary materials for a complete, operating system. All hardware, software, programming, devices and connections to the campus central monitoring system shall be provided under this contract. All functions available at the central monitoring station shall be included.

F. The fire alarm control panel shall allow for loading or editing of any special instructions or operating sequences as required. No special tools, modems, or an off-board programmer shall be required to program the system to facilitate future system expansion, building parameter changes, or changes as required by local codes. All instructions shall be stored in a resident non-volatile programmable memory.

G. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name of each component. Any catalog numbers specified under this section are intended only to identify the type, quality of design, materials, and operating features desired.

H. The listing of specific catalog numbers and equipment parameters is not intended to limit competition among other manufacturers that propose to supply equivalent equipment and services.

I. Equipment submissions for shop drawing review must include a minimum of the following:

1. Complete descriptive data indicating UL listing for all system components.
2. Complete sequence of operations of the system.
3. Complete system wiring diagrams for components capable of being connected to the system and interfaces to equipment supplied by others.
4. A copy of any state or local Fire Alarm System equipment approvals.
5. An AutoCAD (latest version) produced wiring diagram illustrating the basic floor plan of the building, showing all system wiring and equipment, as well as zoning boundaries and schedule of zone legends as intended to appear on annunciators. Provide three CD-Rom copies of as-built drawings and all system operational software at close of project, to be included in operation and maintenance manuals.

J. No work shall be done until the drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include horn/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, Level IV minimum.
c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Deliver copies to authorities having jurisdiction and include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
4. Detector Bases: Quantity equal to 2 percent of amount installed, but no fewer than 1 unit.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: Ten (10) of each type installed.
7. Fuses: Two of each type installed in the system.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Every component, device, transmitter, software, etc., that are included in the work, to make up a complete Fire Alarm System shall be listed as a product by the manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label.

F. The system power, signal and controls wiring shall be UL listed for Power Limited Applications per

G. NEC 760. All circuits shall be marked in accordance with NEC Article 760.

H. Existing Fire Alarm System is EST. Existing Fire Alarm Control Panel is EST IO500.

1.8 WARRANTIES

A. The Contractor shall unconditionally guarantee (except for vandalism) the completed fire alarm system wiring and equipment to be free from inherent mechanical, software and electrical defects for a period of one (1) year from the date of Owner's acceptance.

B. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72H and NFPA-92B guidelines.

C. INSTALLATION WARRANTY. The Contractor shall warrant the cabling system unconditionally against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. Replacement of faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

D. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

E. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 OPERATION

A. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:

1. The appropriate initiating device circuit indicator (red color) shall flash on the control panel until the alarm has been silenced at the control panel. Once silenced, this same indicator shall latch on. A subsequent alarm received after silencing shall flash the subsequent zone alarm indicator on the control panel and resound alarms and flashing signals. These same conditions shall occur at any remote annunciator.
2. A pulsing alarm tone shall occur within the control panel until silenced.
3. All alarm indicating appliances shall sound in a temporal code pattern until silenced by an alarm silence switch at the control panel (or the remote annunciator, if any).
4. All doors normally held open by door control devices shall close. Doors shall also be released in the event of incoming normal power failure.
5. A supervised signal to notify the local fire department or an approved central station (as required by local codes) shall be activated.

6. A supervised signal sent to the mechanical control system(s) shall activate, shut down or reconfigure the air handling systems as required by NFPA or as otherwise indicated herein. Provide necessary interlock wiring as required to control mechanical equipment.
7. The Contractors shall coordinate with each other as necessary to provide all required auxiliary contacts, DDC systems interfaces, equipment, etc., as needed to shut down or otherwise control air handling systems per NFPA and all applicable codes.
8. The system shall be wired with two circuits to all Notification devices so that when an alarm is acknowledged, silencing the audibles, the visual units shall continue in operation until the main control panel has been reset. If local codes require other than this arrangement, the system shall be wired in accordance with the code that is applicable.

B. The alarm indicating appliances shall be capable of being silenced only by authorized personnel operating the alarm silence switch at the main control panel or by use of a similar key operated switch at the remote annunciator (where remote units are provided). A subsequent alarm shall reactivate the signals. Operation of the alarm silence switch shall be indicated by trouble light and audible signal.

C. The alarm activation of any elevator lobby shaft, pit or equipment room smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:

1. If the alarmed detector is in any location or on any floor other than the main level of egress, the elevator cars shall be recalled to the main level of egress.
2. If the alarmed detector is on the main egress level elevator lobby, the elevator cabs shall be recalled to the pre-determined alternate recall level.
3. Provide auxiliary contacts within the base of each elevator lobby smoke detector, with each separate landing to be wired back separately to the elevator controller. Coordinate all equipment terminations and sequence of operation with the elevator installer. The use of digital to analog controllers to accomplish this function will be acceptable, if in compliance with codes.

D. The activation of any standpipe water valve tamper switch or sprinkler zone valve tamper switch shall activate a distinctive system supervisory audible signal and illuminate a "Sprinkler Supervisory Tamper Switch" indicator at the system controls (and the remote annunciators). There shall be a distinction in the audible trouble signals between valve tamper switch activation and opens or grounds on fire alarm circuit wiring.

1. Activating the trouble silence switch will silence the supervisory audible signal while maintaining the "Sprinkler Supervisory Tamper" indicator showing the tamper contact is still activated.
2. Restoring the valve to the normal position shall cause the audible signal and visual indicator to pulse at a fixed rate.
3. Activating the trouble silence switch shall silence the supervisory audible signal and restore the system to normal.

E. The activation of the campus or local mass notification system shall cause all building notification strobes to flash and shall broadcast the emergency message via all building fire alarm speakers.

F. The alarm activation of any duct mounted smoke detector shall cause the control panel to indicate and report a supervisory trouble only. It shall not sound the general building alarm. It shall initiate an HVAC system shutdown as described above.

G. Include with the control panel, as an auxiliary function, a built-in test mode that, when activated, will cause the following operation sequence:

1. The city connection circuit shall be disconnected.
2. Control relay functions shall be bypassed.
3. The control panel shall show a trouble condition.
4. The panel shall automatically reset itself.

5. Any momentary opening of an initiating or indicating appliance circuit shall cause the audible signals to sound for a minimum of two seconds to indicate the trouble condition.

H. A manual evacuation switch shall be provided to operate the system indicating appliances and/or initiate "Drill" procedures.

I. Activation of an auxiliary bypass switch shall override the automatic functions either selectively or throughout the system and initiate a trouble condition at the control panel.

J. Include any and all detection equipment and interface relays as required to provide a 100% code approved and supervised pre-action Fire Suppression system. Coordinate with the Fire Protection installer as required.

2.2 SUPERVISION

A. The system shall contain Class "B" (Style "B") independently supervised initiation circuits as required for the zoning indicated. Circuits shall be arranged so that a fault in any one zone shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

B. There shall be supervisory initiation circuit(s), as required, for connection of all sprinkler valve tamper switches. Wiring methods which require any fire alarm initiation circuits to perform this function shall be deemed unacceptable; i.e., sprinkler and standpipe tamper switches (N/C contacts) shall NOT be connected to circuits with fire alarm initiation devices (N/O contacts). These independent initiation circuit(s) shall be each labeled "Sprinkler Supervisory Tamper Switch" and shall differentiate between tamper switch activation and wiring faults. Provide individual annunciation for the main post indicator valve and each tamper switch as indicated by the zoning schedule on the plans or as otherwise required by codes. For these circuits and all exterior underground copper circuit wiring, provide proper surge suppression and protection for circuit.

C. There shall be independently supervised and independently fused indicating appliance circuits as required for alarm audible signals and flashing alarm lamps.

D. All auxiliary manual controls shall be supervised so that all switches must be returned to the normal (automatic) position to clear system trouble.

E. Each independently supervised circuit shall include a discrete (amber color) "Trouble" indicator to indicate disarrangement conditions, per each circuit.

F. The incoming power to the system shall be supervised so that any power failure shall be audibly and visually indicated at the control panel and the annunciator. A green color "power on" indicator shall be displayed continuously while incoming power is present.

G. The system batteries shall be lead-acid type, supervised so that disconnection or failure of a battery shall be audibly and visually indicated at the control panel (and the annunciator).

H. Wiring to a remote annunciator (if provided for system) shall be supervised for open and ground conditions. An independent annunciator trouble indicator shall be activated and an audible trouble signal shall sound at the control panel.

2.3 POWER REQUIREMENTS

A. The control panel shall receive 120 VAC power via a dedicated circuit. The incoming circuit shall have suitable overcurrent protection within the control panel, as well as at the circuit source. If additional circuits are required for this or other control units, they shall be provided by the Contractor.

B. If the facility is equipped with an emergency standby power generator, the fire alarm equipment shall be connected to this system, per NEC.

C. The system control panel and auxiliary equipment, such as power supplies shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of time as required by codes for the building

occupancy. There shall be reserve battery capacity to drive all alarm appliances for five-minute indication at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operating shall be automatic. Batteries, once discharged, shall recharge at a rate that will provide a minimum of 70% capacity in 12 hours, or sooner if required by codes.

D. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

E. Power supplies for Notification signals, whether in the main panel or within remote power supply cabinets, shall be designed to provide a minimum of 20% spare capacity for future signals.

2.4 FIRE ALARM CONTROL PANEL

A. Where shown on the plans, expand or provide and install a new Fire Alarm Control Panel, as required for addition/renovation. Construction shall be modular with solid state, microprocessor based electronics. All visual indicators shall be high contrast, light-emitting diode type.

B. The control panel shall contain the minimum following features as per plans:

1. Minimum Capacity of 512 Control or Monitor Points
2. Initiation Device Circuits
3. Alarm Indicating Appliance Circuit
4. Supervised Annunciator Circuits
5. Local Energy City Connection, as required
6. Form C Alarm Contacts (2.0 Amps ea., 2 total)
7. Earth Ground Supervision Circuit
8. Automatic Battery Charger
9. Standby Battery, Nickel-Cadmium Alkaline
10. Resident non-volatile programmable operating system memory for all operating requirements
11. Supervised Manual Evacuation Switch
12. Power supplies as required for auxiliary functions as indicated
13. Auxiliary contacts or relays for auxiliary functions as indicated
14. All Custom Software and Programming as required to suit the project requirements

2.5 REMOTE ANNUNCIATOR

A. Where indicated on the plans, provide and install annunciator/control panel. The panel shall contain an alphanumeric display to display zone trouble-alarm information. The panel shall also contain the following control functions, activated by a master system enable key switch on front panel:

1. Remote system reset switch, to complement main control panel reset switch.
2. Remote alarm signal silence switch.
3. Remote manual evacuation switch, to initiate fire drill functions, same as at main control panel.
4. Remote trouble silence switch to silence trouble alarms in annunciator panel and main control panel.
5. Install panel on outlet box, 54" AFF to centerline. Panel shall contain tamper-resistant L.E.D. test switch in panel, local audible alarm, system power on and trouble L.E.D. indicators and master system enable key switch, keyed alike with the main control panel.

B. Annunciator window English language legends shall be custom, to display both zone number and brief legend indicating the area or device associated with that zone. The fire alarm system vendor shall coordinate the legends with the Engineer at shop drawing review.

C. Wiring between main control panel and annunciator(s) shall be fully supervised.

D. Provide all programming and software necessary to place annunciators and controls in full operation. System set-up shall allow for expansion of annunciators without rewiring or addition

of supervision modules. Furnish initial programming and reprogramming as needed to accommodate changes in the system up to the time of system acceptance by the engineer without extra charge.

2.6 PERIPHERAL DEVICES

A. Note: On fully digital multiplex systems, provide addressable bases, heads or modules for devices listed herein. Each device shall be an individual address on the system. Addressable bases, heads or modules shall be U.L. listed for the device served.

B. MANUAL PULL STATIONS

1. Manual stations shall be installed within 5ft of all building entrances and exits and mounted no higher than 48 inches above the finished floor. The manual station shall be non-coded, dual action and shall be constructed of high impact, red lexan or cast metal with raised contrasting lettering and a smooth high gloss finish. Stations that utilize screwdrivers, allen wrenches, or other commonly available tools shall not be used. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock in a visually indicating manner. Furnish one key for each manual station to owner at close of project. During installation, new and as not operable devices shall have paper covers that read “This device not in service” then removed when placed in service. Provide pull stations with protective shields with audible alarms as noted on the drawings. Shield shall be “Stopper II” or equal. Stoppers shall not be required for non-public areas, e.g. mechanical rooms, penthouse locations etc.

C. CEILING-MOUNTED SMOKE DETECTORS, PHOTOELECTRIC TYPE

1. Furnish and install where indicated on the plans, smoke detectors. Provide base with auxiliary relay, or standard base, as required.
2. Smoke Detectors shall be listed to U.L. Standard 268 and shall be compatible with their control equipment. Detectors shall be listed for this purpose by Underwriters' Laboratories, Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. Loss of the operating voltage shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Detectors shall be capable of being reset at the main control panel.
3. No radioactive materials shall be used. Detector construction shall provide mounting base with twist-lock detector head. Contacts between the base and head shall be of the bifurcated type using spring-type, self-wiping contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide full solid state construction, and compatibility with other normally open fire alarm detection loop devices such as heat detectors, pull stations, etc.
4. To minimize nuisance alarms, voltage and RF transient suppression techniques shall be employed as well as a smoke verification circuit and an insect screen. The detector head shall be easily disassembled to facilitate cleaning. Where indicated or required, provide 2098-9715 wire guard.
5. Remote LED alarm indicators shall be installed where indicated.
6. Special Note: The Contractor installing smoke detectors shall use care in the final positioning of all devices. They shall not be installed closer than 30" from an air diffuser or return grille, closer than 24" from a ceiling/wall intersection, or similar location that would diminish detector performance. Refer to NFPA 72E, "Standard On Automatic Fire Detectors".

D. AUTOMATIC HEAT DETECTORS

1. Automatic heat detectors shall be combination rate-of-rise and fixed-temperature type. When the fixed-temperature portion is activated, the units shall be non-restorable and give visual evidence of such operation.

E. AUTOMATIC HEAT DETECTORS (FIXED TEMPERATURE TYPE):

1. Where indicated on the plans, provide automatic (conventional) heat detectors of the non-restorable type, of the temperature rating as indicated or required. Detector heads shall be mounted to an outlet-box mounted base. Provide addressable module for each detector as required. Wire Class “B”.

F. HORNS AND AUDIO VISUAL UNITS

1. The horns shall be polarized and shall be operated by 24 VDC. Each horn assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors shall not be accepted. The audio visual units shall be (Xenon) which shall be semi-flush mounted on 4" square outlet box. The white "LEXAN" lens shall have the word "FIRE" in red lettering on the sides and shall project out from the backplate. Lettering shall be oriented upright to the standing viewer.

G. VISUAL FLASHING LAMPS

1. Visual indicating appliances shall be Xenon flasher. These devices shall be UL listed and be wall mounted. The "LEXAN" lens shall project out from backplate. Lettering shall be oriented upright to the standing viewer. Visual units shall be of the stand alone type or be incorporated as part of the horn unit, as indicated.
2. All visual signals shall develop an output of 15, 30 or 110 candela to suit the size of coverage area, and be mounted on walls. All visual units shall be in compliance with the latest version of the Americans with Disabilities Act requirements. Provide additional units as needed to meet these requirements.

H. DOOR HOLDERS

1. Fire Alarm Contractor shall provide all new door hold opens indicated on floor plans. Interconnect with, and control existing door holders, or install new door holders where shown on prints. Magnetic door holders shall be 24 volt A.C., and shall have an approximate holding force of 25 lbs. The door portion shall have a plated steel pivot mounted armature with shock absorbing nylon bearing. Unit shall be capable of being either surface, flush, semi-flush or floor mounted as required. Door holders shall be UL listed for their intended purpose. Where door mounted, locate armature 6" down from top and 6" in from strike side of leaf. Where door swing prevents direct contact between armature and holder pole piece, provide plated chain to close gap as tightly as possible. Verify holder positioning with architect prior to mounting any devices. Unless otherwise indicated, provide semi-flush mounted holders 6" below top of door leaf as noted above, with blocking in wall to support force of door impact against holder and outlet box. Control: The use of addressable relay controllers on the SLC loop to accomplish door release function will be acceptable, if in compliance with codes. Magnetic door holders shall be 24 volt A.C., and shall have an approximate holding force of 35 lbs. The door portion shall have a stainless steel pivotal mounted armature with shock absorbing nylon bearing. Unit shall be flush mounted. Door holders shall be UL listed for their intended purpose. Where door mounted, locate armature 6" down from top and 6" in from strike side of leaf. Verify holder positioning with architect prior to mounting any devices.
2. Door holders shall be FM 998 approved.
3. Install a smoke detector on each side of any door equipped with a hold open device.

I. DUCT SMOKE DETECTORS

1. Duct smoke detectors shall be of the solid-state photoelectric type operating on the light scattering photodiode principle. The detectors shall ignore invisible airborne particles or smoke densities that are below the set alarm point. No radioactive materials shall be used. The basic construction of duct smoke detectors shall be the same as that listed above for ceiling-mounted smoke detectors. Duct housing couplings shall be slotted to

insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm LED visible through a transparent cover or view panel.

2. The Contractor shall furnish and install per manufacturer's instructions air duct smoke detectors in new, or existing HVAC units. Furnish appropriate length sampling tube(s) as needed to monitor 2/3rds of duct width, and or in accordance with manufacturer's recommendations to give maximum sampling rate of airflow. Provide multiple detectors, as required, if a single device will not provide adequate sensing due to duct size or air velocity. Field verify quantity of detectors needed to provide NFPA-compliant coverage of the air handling unit and provide as required.
3. The Electrical Contractor shall furnish air duct smoke detectors with template to the Mechanical Contractor for installation. Coordinate length of sampling probe required with the Mechanical Contractor and furnish appropriate length. Probe tube shall be located in accord with manufacturer's recommendations, to give maximum sampling rate of airflow. Provide multiple detectors, as required, if a single device will not provide adequate sensing due to duct size or air velocity. Wire multiple detectors as separate zones.
4. The Mechanical and Electrical contractors shall coordinate location of these probes and housing in accord with manufacturer's recommendations. Detectors not so done will be relocated.
5. Detector supervised power and alarm wiring (from F.A. control panel) is to be provided by the Electrical Contractor. Interlock wiring from auxiliary contacts to stop air handling unit fan motor is to be provided by the Electrical Contractor. Interlock shall be wired so that the unit shall stop with the starter in either "hand" or "auto" position. Provide auxiliary contacts as required. Zone wiring and indication for air duct smoke detectors shall be maintained separate from area detection devices. Detector shall be capable of being reset at the main control panel, in addition to the reset station.
6. At each duct smoke detectors, a remote alarm/power indicating L.E.D. key reset station shall be installed. Locate these stations typically adjacent to an automatic temperature control panel as directed. These remotes shall be ganged together, and labeled accurately as to which unit is reporting an alarm condition.
7. Where air duct smoke detectors are indicated to be furnished at concealed air handling units above ceilings or smoke damper locations, furnish as outlined above. Also provide remote indicating alarm L.E.D. flush in corridor wall at 7'-0" A.F.F. immediately below installation, or as close as practical to installation. The Mechanical Contractor is to provide control wiring, E.P. switches, etc., as required to operate smoke dampers.
8. Ionization - type detectors will not be permitted for air duct smoke detection.
9. All air duct smoke detector installations and materials shall be in accord with NFPA-90A, and any other applicable codes.
10. Written documentation shall be provided to prove proper air flows at and thru sampling tubes.
11. Zone wiring and indication for air duct smoke detectors shall be maintained separate from area detection devices. Detector shall be capable of being reset at the main control panel, and at a local test/reset station if called for on print.
12. Where air duct smoke detectors are located in other than Mechanical Rooms or in spaces not easily visible or accessible, a remote alarm/power indicating L.E.D. key reset station shall be installed. Locate these stations typically adjacent to an automatic temperature control panel as directed. These remotes shall be ganged together, if required, and labeled accurately as to which unit is reporting an alarm condition.

J. WEATHERPROOF DEVICES AND EXPLOSION-PROOF DEVICES

1. Where the anticipated atmosphere or installation conditions require weather-proof, explosion-proof or other specially housed devices, they shall be U.L.-listed and NFPA-compliant and provided as indicated or required. Verify installation conditions and indicate type of device on shop drawing submission.

K. REMOTE REPORTING TELEPHONE DIALER

1. Provide a digital alarm communicator/transmitter (D.A.C.T.). Install at telephone terminal board or telephone service entrance and provide supervised wiring to fire alarm control panel as required.
2. The installation and connection of the D.A.C.T. shall be in compliance with all provisions of N.F.P.A. 71 and any and all other applicable codes. The installation and connection shall be acceptable to the Authority Having Jurisdiction, as well as the telephone company (or companies) over whose lines the signal(s) will be transmitted. Include any costs associated with telephone company work and services required in bid. Telephone connection shall be in compliance with NFPA 71, chapter five.
3. The D.A.C.T. shall be capable of transmitting all information relative to system status changes due to alarm, trouble, water flow, and any other information as required by current codes applicable to the facility. This information shall be transmitted to a U.L. listed Central Receiving Station, that also is maintained in accord with the requirements of NFPA 71.
4. As a part of this contract, the services of a Central Receiving Station (as above) shall be engaged for a period of one year from the date of substantial completion, this date as defined elsewhere in these documents. The Contractor shall initiate this service, provided on a contract basis, and shall include any costs associated with this provision in his bid. The actual beginning date of the contract with the central receiving station may be adjusted at the discretion of the Engineer, but in no case shall be for less than one year. The contractor shall notify the owner in writing by certified mail that this service has been contracted for and explain the provisions of this service adequately. A copy of this communication and the return receipt shall be forwarded to the Architect and the Engineer.

L. WATER FLOW AND SPRINKLER SUPERVISORY SWITCHES:

1. Where indicated on the plans, interconnect to existing water flow and supervisory switches with addressable modules. Or, install as new, water flow and supervisory switches as shown on the prints and monitored by addressable monitor modules. Set retard time on paddle type of water flow switches at a minimum of 30 seconds on branch/floor flows, and 60 seconds on main flows. (If building has one flow only, set at 45 seconds). Flow switches shall give the flow alarm description by area involved e.g. Water Flow “FLR1 W. Wing Areas”. Supervisory switches shall be monitored by one module per switch, and programmed to indicate their physical location, and area they control as described earlier. Manufacturers: Potter, System Sensor, or equal.

M. AUTOMATIC CARBON MONIXIDE DETECTOR

1. Automatic Carbon Dioxide Detectors: Provide manufacturer’s standard construction Carbon Monoxide detector. Control panel shall be programmed to provide trouble alert at carbon monoxide level determined by the owner and engineer. Control panel shall be programmed to go into alarm at higher carbon monoxide level determined by the owner and engineer.

N. END OF LINE RESISTOR

1. End-of-line devices (if required) shall be flush-mounted, located at 7'-0" A.F.F. in corridor walls or as indicated.

O. REMOTE POWER SUPPLY UNITS FOR PERIPHERAL

1. Provide remote power supply(ies) as required for proper system operation.
2. Remote power supplies shall be provided with local intelligence compatible with the digital multiplex network, so they have a unique address, providing the ability to monitor the supply for loss of power, shorts, grounds and other supervisory functions.
3. Where required by the fire alarm system manufacturer, remote power supplies shall be provided that will provide sufficient current to drive audio/visual or other required devices.

4. These units shall be located in electrical closets, mechanical rooms or similar spaces. They shall not be installed in finished areas, storage rooms, etc., without the permission of the Engineer. All locations shall be indicated on the shop drawing submissions.
5. Provide dedicated 120 volt power circuit(s) from nearby panelboards as required, whether indicated on the plans or not.

PART 3 - INSTALLATION

3.1 Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be in a completely separate conduit system from power wiring or other raceway systems. Minimum conduit size shall be 3/4" trade size. Maximum wire fill shall be 40%, for any raceway system.

3.2 All junction boxes shall have coverplates painted red and labeled "Fire Alarm". A consistent wiring color code shall be maintained throughout the installation. The number of wiring splices shall be minimized throughout. Excessive wire splicing (as determined by the Engineer), shall be cause for rejection of the work.

3.3 All conductive cabling associated with this system that extends beyond the building envelope shall be provided with surge suppression. Suppression installed shall be approved by the fire alarm equipment manufacturer and in accordance with Division 26 specifications.

3.4 Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate tradesmen or other contractors.

3.5 The Contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of installation.

3.6 The manufacturer's authorized representative shall provide on-site supervision of installation, and shall perform the initial "power-up" of the system after he has thoroughly checked the installation.

3.7 Operation and maintenance manuals submitted for this project shall list names, license numbers, and telephone numbers of at least two installers that are employed full time by the supplier/manufacturer to install and test fire alarm systems in the installation location.

3.8 A floor plan drawing indicating fire alarm devices and wiring only, shall be provided by the manufacturing company for job site use. These drawings shall be approved by the State Fire Marshal's Office or Local Authority Having Jurisdiction, as appropriate and in accord with code requirements. A copy of this drawing shall be submitted to the Engineer for his review, approval and project records.

3.9 TESTING

A. The completed fire alarm system shall be fully tested in accordance with NFPA-72H by the contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of a successful test, the Contractor shall certify the test results in writing to the Fire Marshal, Owner, General Contractor, Architect and Engineer. Provide written 72 hour advance notice of the test to all concerned parties.

B. All auxiliary devices the fire alarm system is connected to, including tamper switches, flow switches, etc., shall be fully tested for proper operation where interfacing with the fire alarm system.

C. The Contractor shall provide a minimum of eight hours of instructional time to the Owner in the operation and maintenance of all equipment and components. A receipt shall be obtained from the Owner that this has been accomplished, and a copy forwarded to the Engineer.

3.10 BUILDING MAP

A. Building map shall be provided adjacent to the main control panel and shall consist of floor plans inked on mylar with color coded zones. Zone indications shall depict the exact zone number and alphanumerical labeling as shown on the FACP zone labels. Building map shall be a detailed floor plan with all room numbers, fire alarm zones, detectors, horns, alarm initiators, flow switches, sprinkler heads, sprinkler zones, and all other devices shown. "Zone No." shall be in 1/4" high letters. Maps shall be properly oriented and shall be 1/16" = 1' scale or 1/32' = 1' scale with written exception of the owner. Provide durable aluminum frames and all required mounting hardware and mount where indicated on plans. Aluminum frame must be such that it can be removed, disassembled and reassembled to allow replacement or revisions to the mylar. The layers of the map in the frame from back of the frame to the front of the frame shall be as follows:

1. 1/8" Plexiglas
2. White backing mat
3. Pastel backing color layers for zones
4. Inked mylar with floor plan, room #s, fire alarm zones, detectors, horns, alarm initiators, flow switches, sprinkler heads, sprinkler zones, and all other devices.
5. Spacer mat to allow mylar to be suspended from top of frame and reduce washboarding.
6. 1/8" ultraviolet blocking plexiglass
7. 1/8" clear Lexan to prevent scratching

B. Building map(s) shall be installed, complete with "as built" corrections before system is left in operation and before the University will consider the project for substantial completion.

3.11 WARRANTY

A. The Contractor shall unconditionally guarantee (except for vandalism or misuse) the completed fire alarm system wiring and equipment to be free from inherent mechanical, software and electrical defects for a period of one year from the date of substantial completion.

B. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72H and NFPA-92B guidelines.

END OF SECTION 283100

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 283111 – SECURITY INTRUSION ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

C. Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

D. All layout and installation of communications infrastructure shall be in accordance with ANSI / TIA 568 and the BICSI TDMM.

E. Division 26 - Electrical

1.2 SUMMARY

A. The Security System shall include all items, articles, and materials necessary for a complete system. This includes all labor, materials, cabling, equipment, and incidentals, necessary and required for a complete and operational security system.

B. The Security System shall include all items, articles, and materials necessary for a complete system. This includes all labor, materials, cabling, equipment, and incidentals, necessary and required for a complete and operational security system.

C. The installing contractor must have been in the business of installing and programming security systems for at least (5) years. This includes programming control panels, keypads, and all addressable devices. The installing contractor shall be a manufacturer-certified installer or have equivalent training or experience for the type of equipment being installed.

D. The installing contractor must provide all programming for control panels, keypads, expansion modules, and other addressable devices as per the manufacturer recommendations for correct security system operation. This includes zoning, entry/exit delays, reporting codes, partitions or any other system parameter as required for a fully functional system.

1.3 GENERAL OPERATION AND DESCRIPTION

A. General: The intrusion alarm system shall consist of an U.L. commercial burglar control platform that supports hardwired, polling (multiplex) loop zones; supervision of alarms, keypads, power supplies; motion detectors, remote point modules; remote cabinets; relay modules; interface devices; conduit and wiring; cabling; remote annunciators;

DACT; as required and specified herein in accordance with applicable codes listed hereinafter.

1. The system shall be capable of being expanded at any time up to the pre-determined maximum capacity of the system that shall include eight (8) partitions.
2. The system shall be capable of operating motion detection devices, reed switches, manual panic switch, key pads, series or shunt circuit wiring via hardwiring, or multiplex polling methods.
3. The control panel shall provide power, annunciation, polling, supervision and control for the detection and alarm system. The control panel shall contain equipment meeting the requirements of this specification necessary for proper operation.
4. The system shall be designed such that alarm indications override trouble conditions.
5. On/off capability of individual zones and/or partitions by use of coded numbers at the indicated multiple locations (32 maximum).
6. Time delay for entry or exit with an adjustable timing mechanism.
7. Supports up to nine (9) style - B hardwired zones and 120 additional multiplex zones with built-in multiplex interface for monitoring points of motion.
8. Emergency power supply for 60 hours of standby surveillance.
9. External circuit supervision shall not require additional wires other than the pair used for detection or alarm. Two wires shall be used from the control panel to each loop of initiating devices and two wires for the audible devices. These two wires shall provide both supervision and alarm signals.
10. Alpha-numeric annunciator display panels are indicated on the electrical drawings and shall provide for alarm and trouble indications in the security intrusion alarm system.
11. Stand-alone UL listed digital communicator for transmission of security intrusion system to monitoring station shall be included. Coordinated with Owner for exact DACT requirements and parameters. Provide two (2) years of monitoring service.

B. Operation:

1. Trouble Mode: The system shall be electrically supervised against both short and open wiring faults in the alarm initiating circuits, the annunciation circuits, an open in the system alarm and trouble relay coils and a.c. power loss. An open wiring fault occurring in these circuits shall cause an audible and visual trouble indicator at the control panel.
2. Alarm Mode: The general alarm portion of the system shall function as follows when any motion detector is actuated.
3. Automatically transmit individual zone digital signals via telephone lines to an existing contracted 24 hour central station's digital receiver.
4. Display zone number-message on alpha-numeric displays.
5. Supervision Mode (Local Alarm): The supervision mode of the system shall function as follows when a supervisory alarm input is activated:
6. Sound a distinct local visual and audible alarm at the control panel and remote annunciator.
7. Display a zone number -error message on alpha-numeric display.
8. System shall turn off walk-through lighting 5 minutes after the system is armed and turn walk-through lighting on when the system is disarmed. Control of lighting shall be through contactors as indicated on the floor plans.

1.4 QUALITY ASSURANCE

A. Source Quality Control: Materials and equipment shall be new, unused and U.L. listed for use as a security intrusion system.

B. The system and components shall be supplied by manufacturers of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to refer to similar installations rendering satisfactory service.

C. The Security Intrusion Alarm System hereinafter shall be known as the "Security Intrusion Alarm System". The Security Intrusion Alarm System shall be installed by the manufacturer's authorized installation contractor, hereinafter known as the "Security Intrusion System Trade." The Security Intrusion System installation shall include wiring, components, connections, adjustment, testing and certification. The Electrical Trade shall provide conduit, junction boxes and pull boxes as indicated and required by the Security intrusion System manufacturer's drawings or Trade instructions. The Security Intrusion System Trade shall furnish any special back boxes, cabinets, enclosures and similar items to the Electrical Trade for installation by the Electrical Trade in accordance with the manufacturer's drawings, instructions, and as indicated.

D. The Security Intrusion System Trade shall furnish a list of similar or equal installation (a minimum of ten) and shall show at least five (5) years of company experience in this type of work.

E. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

F. 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.

1.5 REFERENCES

A. The complete installation, including additions and modifications, shall be in accordance with:

1. National Electrical Code Article 725 & 800.
2. Minimum standards of Electronic Industries Association (EIA).

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.8 SUBMITTALS

A. Submit shop drawings product data in accordance with Section 260503.

1. Shop Drawings: The Security Intrusion System manufacturer and Trade shall provide a one-line riser diagram indicating route and conduit size, external wiring and connections of system proposed, also furnish complete operating

instructions, including schematic and wiring diagrams of the system, engineering data sheets on each component and complete servicing data including part numbers of the various components. A schematic diagram of the complete system is not shown on the contract documents.

2. Product Data: Submit application, technical, and installation data.

1.9 WARRANTY, SERVICES

A. The Security Intrusion System Manufacturers and Trade shall warrant this System for a minimum of one (1) year from date of acceptance by Owner against defective parts and/or workmanship and shall provide parts and labor to fulfill this warranty at no cost to Owner. This warranty shall not apply if damage is caused by abuse, accident, improper operation or negligence.

B. Qualified service and parts shall be available to call on within a 50 mile basis.

C. The Security Intrusion System Trade shall include in his quotation the cost of three (3) inspections of the system during the two (2) years subsequent to the installation. The Trade installing this equipment shall be prepared to offer the Owner a service contract after the guarantee period has ended. On-the-premises service furnished at other than normal working hours shall also be available and shall be charged at current labor rates.

D. INSTALLATION WARRANTY. The Contractor shall warrant the cabling system unconditionally against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. Replacement of faulty materials and the cost of labor to make the replacement shall be the responsibility of the Contractor.

E. The Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

1.10 SOFTWARE SERVICE AGREEMENT

A. Comply with UL.

B. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide thirty (30) days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Intrusion Detection Devices: Furnish quantity equal to five percent of the number of units of each type installed, but no fewer than one of each type.
2. Fuses: Three of each kind and size.
3. Tool Kit: Provide three (3) sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. System shall be based on BOSCH.

B. Equal Manufacturers: Subject to compliance with requirements: CADDX, Simplex, Sonitrol, Ademco and GE equals.

2.2 MATERIALS AND EQUIPMENT

A. General: All materials, equipment, accessories, devices and other facilities and appurtenances shall be new, best suited for its intended use and shall conform to applicable and recognized standards for their use. All equipment shall be the standard cataloged products of BOSCH.

B. Equipment:

1. Control Panel: Bosch D9412GV4-C Burglar Package with control board, enclosure lock, key power transformer, Bosch D8125 derial data port module, Bosch D9217t address module (80 port), Bosch D166 telephone jack, Bosch D162 telephone cord, Bosch B420 Ethernet communication module, Bosch D126 7 Amp hour batteries (2), Bosch D122L battery harness with long leads, Bosch D110 enclosure tamper switch, batteries, circuit loop cards, additional cabinet as required. Provide all components in quantities as required for all for a fully functioning system.
2. LCD Key Pads, Bosch D1260. Provide quantities as indicated on the electrical drawings.
3. Wall Mounted Motion Detector, Bosch ISC-PDL1-WA18X, Tri Tech + Detectors with Anti- mask. Provide quantities as indicated on the electrical drawings.
4. Ceiling Mounted Motion Detector, Bosch DS9370, Tri Tech + Detector. Provide quantities as indicated on the electrical drawings.
5. Remote control panel with cards as required.
6. Provide Bosch D829 relay module with eight separate relays to interface with Division 26 lighting contactors to turn walk-through lighting off and on when the system is armed or disarmed. System shall turn off walk-through lighting 5 minutes after the system is armed and turn walk-through lighting on when the system is disarmed. Control of lighting shall be through contactors as indicated on the floor plans.
7. 18 gauge twisted pairs, non-shielded, mid capacitance and plenum rated by General Wire or Belden or West Penn. Provide the proper number of conductors for each cable run and coordinate with devices and panels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

3.2 CABLING AND WIRING INSTALLATION

A. A complete cabling and wiring system shall be provided, which shall adhere to the highest workmanlike standard of quality and appearance. Cables and wires shall be installed square with building lines, subject to the approval of the engineer or Owner.

B. Identify components with engraved, laminated-plastic or metal nameplate for central-station control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems." Cabling shall be concealed above the finish ceilings and within the finished walls where possible. Open cables above lay in suspended ceilings, unfinished attics, basements, tunnels, and crawl spaces shall be run through and supported by J-hooks at four foot intervals. Cables above plaster and drywall ceilings shall be installed in electrical metallic tubing (EMT).

C. Cables in unfinished areas and mechanical rooms may utilize exposed EMT. Cables in finished “occupied” areas must utilize concealed conduit.

D. Open cabling (not in raceways) shall be plenum rated. Cables and associated raceways shall be supported directly to the building structure and walls. Cables and raceways shall not be supported to pipes, conduits, ducts, suspended ceilings or equipment. Cables shall not touch or lay on ceilings, light fixtures, pipes, ducts, or equipment.

E. Cables run to ceiling mounted sensors shall have a minimum of 20 feet of cable (coiled and secured above sensor) to allow for the sensors relocation when needed.

F. The contractor shall provide two (2) telephone cables from MDF Room telephone demark to master security control panel. All final connections of both ends of the telephone cables shall be made by Contractor.

G. Cabling for zone sensors and equipment alarms shall be 22 gauge unless the run exceeds 1000 feet, then 18 gauge shall be used.

H. Color of cabling: Purple

I. All cabling shall be a continuous run whenever possible. Any junctions of cable conductors shall be made in a metal enclosure, then soldered and taped. No mechanical connections will be accepted. All cabling shall be labeled on both ends as to wire location with a permanent type of labeling system.

J. All cabling and raceway must be routed in the control panel, and expansion modules as to not interfere with the electronics removal or replacement.

K. Cables and raceways shall be installed in strict accordance with the cable manufacturers’ recommendations and the National Electric Code.

L. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

M. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables," unless otherwise indicated.

N. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

O. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

P. Electrical work required for the control panel and the remote expansion modules shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for a complete system.

Q. Electrical power for the control panel and expansion modules shall be fed from a dedicated circuit or circuits from an electrical power panelboard and shall not be taken from receptacles, lighting or equipment circuits. The circuit(s) within the electrical panelboard shall be marked “Security Intrusion Alarm System”. If available power should be taken from a panel that has standby reserve capability.

R. Provide at each panel location a SS duplex receptacle.

3.3 INSTALLATION

A. Security intrusion alarm system control panel shall be installed and tested in accordance with manufacturer’s installation instructions.

B. Coordinate interfaces with Owner’s representative where appropriate.

C. Provide backboxes, pullboxes, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner’s approval for exact location of all boxes, conduit, and wiring runs prior to installation.

D. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.

E. Coordinate with other trades to provide proper sequencing of installation.

F. Comply with UL 1641.

G. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

H. Occupancy Adjustments: When requested within 12 months of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied

conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.4 GROUNDING

A. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

C. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.5 TECHNICAL ASSISTANCE

A. Instruction: The installation supervising technician for the Security Intrusion System Trade shall instruct the proper designated authority on the correct operation of the system after the installation is completed. The Owner shall be instructed to walk-test the motion detectors periodically (daily preferred) to assure the protect area is not accidentally blocked or obscured.

3.6 FIELD QUALITY CONTROL

A. General: Upon completion of the installation, the Security Intrusion System Trade's factory-trained technician shall perform all necessary electrical tests and adjustments and who shall then submit a Letter of Verification to the Owner/Architect/Engineer that the system functions and conforms to all requirements of the manufacturer of the equipment, these specifications, and all requirements of Uniform Statewide Building Code and UL for type of building in which the system is installed.

B. The factory trained technician shall perform all electrical and mechanical tests. All test and report costs shall be in the Contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate. The report shall include, but not be limited to:

1. A complete list of equipment installed and wired.
2. Indication that all equipment is properly installed and functions and conforms to these specifications.
3. Tests of individual zones as applicable.
4. Technician's name and date.

C. After completion of all tests and adjustments listed above, the Security Intrusion System Trade shall submit the following information to the Architect/Engineer.

1. "As-built" conduit layout diagrams including wire color code and/or tag number.
2. Complete "as-built" wiring diagrams.

D. Final tests and inspection shall be held in the present of Architect/Engineer's representatives and to their satisfaction. The Security Intrusion System Trade shall supply personnel for this test without additional cost.

E. The completed Security Intrusion Alarm System shall be tested to ensure that it is operating properly. Failure of the devices to properly operate shall be considered a failure of the system and all such devices in that system shall be readjusted or replaced. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the Security Intrusion System Trade shall readjust or replace the Defective component and begin another ninety (90) day test period. This test shall not start until the Owner has obtained beneficial use of the building under tests.

F. If the requirements provided in the paragraph above are not completed within one (1) year after beginning the tests described therein, the Security Intrusion System Trade shall replace the defective portion of the system with another acceptable manufacturer and the process repeated until acceptance of the equipment by the Architect/Engineer.

G. After completion of all tests and adjustments listed above, the Security Intrusion System Trade shall turn over all data disks and other information used in configuring the Security System. All such information shall be the property of the Owner upon the acceptance of the system by the Project Manager.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain intrusion detection. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 283111