PROJECT MANUAL

CONSTRUCTION DOCUMENTS

MAY 21, 2025

BULLITT COUNTY PUBLIC SCHOOLS
Moving Forward

Bullitt County Public Schools
1040 Highway 44 East
Shepherdsville KY 40165

Bullitt County Public Schools
Bullitt Central High School
Physical Science Center

Bid Package 1: General Construction

Bullitt County, KY
BG# 25-145 | ska# 2023-50.1

Bid Date: **12 June 2025**

Time of Opening: **1:00 pm EST**

Location: **Bullitt County Public Schools Central Office**
1040 Highway 44 East, Shepherdsville, KY 40165

ARCHITECT
Studio Kremer Architects Inc
1231 S Shelby Street
Louisville, KY 40203

CIVIL ENGINEER
Buzick Construction, Inc.
702 Beechwood Avenue
Bardstown, KY 40004

STRUCTURAL ENGINEER
Brown + Kubican Structural Engineers
8900 Greeneway Commons Pl. #201
Louisville, KY 40220

M E P ENGINEER
CMTA, Inc.
10411 Meeting Street
Prospect, KY 40059

Volume 3

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Bullitt County Public Schools
Bullitt CENTRAL Physical Science Center
BID PACKAGE 1: GENERAL CONSTRUCTION

Shepherdsville, Kentucky
SKA# 2023-50 | BG-1# 25-145

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SECTION 20 01 00 – GENERAL PROVISIONS - MECHANICAL

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 seven (7) days 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 from 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.
- OHSA - 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 (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 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 ensure 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 ensure 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.

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 OWNER APPROVAL ON SUBSTITUTIONS 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 ensure 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 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, 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 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 Authority Having Jurisdiction. 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 OHSA 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 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.

7.13 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.

7.14 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.

7.15 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.

7.16 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 supersede 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 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, except in the case of minor control requirements (residential type furnaces, packaged HVAC equipment with integral controls, etc.) in which case, if a competent worker is the employee of this Contractor, the worker may be utilized subject to review of their qualifications by the Engineer and after written approval from same.

8.9 All special systems (Medical Gases, 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 removal 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 Project'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 gas fired heat exchangers shall have 15 year warranty.

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

12.4 All VFD's shall have a two year warranty. (Parts and Labor).

12.5 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
- Mechanical Record Drawings & Acceptance
- Mechanical O&M Manuals & Acceptance
- Mechanical Owner Training & Acceptance
- Spare Parts

- 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
- Geothermal Materials & Labor
- Geothermal Grouting Materials & Labor
- Geothermal Flushing, Purging, Testing, Documentation, Site Survey Submittal, Acceptance, etc.
- 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
- Ductwork Air Leakage Testing, Documentation, Acceptance, etc.
- Filters and Racks Materials & Labor
- Heat Pump Equipment & Labor
- Heat Pump Startup, Testing, Documentation, Training, Acceptance, etc.
- Outside Air Handling Unit Equipment & Labor
- Outside 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 Pre-Testing
- Chemical Treatment Startup, Testing, Documentation, Training, Acceptance, etc.
- Test and Balance Materials & Labor

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.

16.2 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.

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

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, ensure 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 – TEMPORARY SERVICES:

18.1 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.

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

18.3 The Contractor shall be responsible of all utility costs associated with Electric Power Service, including payment of electric-power-service use charges for electricity used by all entities for construction. This includes the new electric meter being provided for the building. The District/Owner is not responsible for any electric-power-service use charges until substantial completion, nor is the District/Owner responsible for any temporary power for construction trailers, construction lighting/flood lighting, etc.

PART 19 – SURVEY, MEASUREMENTS AND GRADE:

19.1 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.

19.2 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.

19.3 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 20 – PROTECTION OF EQUIPMENT:

20.1 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 21 – REQUIRED CLEARANCES FOR ELECTRICAL EQUIPMENT:

21.1 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 22 – EQUIPMENT SUPPORT:

22.1 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 23 – DUCT AND PIPE MOUNTING HEIGHTS:

23.1 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. Minimum height above ceilings shall be 6” clear including insulation, unless otherwise noted.

PART 24 – BROKEN LINES AND PROTECTION AGAINST FREEZING:

24.1 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 ensure that freezing will not occur. If in doubt, contact the Engineer.

PART 25 – WEATHERPROOFING:

25.1 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.

25.2 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 26 – FINAL CONNECTIONS TO EQUIPMENT:

26.1 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 27 – ACCESSIBILITY:

27.1 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.

27.2 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.

27.3 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 28 – SCAFFOLDING, RIGGING AND HOISTING:

28.1 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 OHSA Standards and Requirements. Remove same from premises when no longer required.

PART 29 – CONCRETE WORK:

29.1 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.

29.2 In the absence of other concrete Specifications, all concrete related to Mechanical work shall be 3500 psi minimum compression strength at 28 days curing, slump: 4" ± 1", air entrainment 4.5% water to cement ratio 0.5 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.

29.3 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.

29.4 In general, unless otherwise noted, 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.

29.5 Exterior concrete pads shall be 8" thick with four (4) inches minimum above grade and four (4) inches below grade on a compacted four (4) inch dense grade rock base unless otherwise indicated or specified. Surfaces of all foundations and bases shall have a smooth finish with one-half (½) inch chamfer on exposed edges. Turn down edges 18" below grade.

PART 30 – RESTORATION OF NEW OR EXISTING LANDSCAPING, PAVING, SURFACES, ETC.:

30.1 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 31 – MAINTENANCE OF EXISTING UTILITIES AND LINES:

31.1 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.

31.2 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.

31.3 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.

31.4 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.

31.5 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.

31.6 Machine excavation shall not be permitted within 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.

31.7 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.

31.8 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 32 – CLEANING:

32.1 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.

32.2 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.

32.3 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 33 – TEMPORARY USE OF EQUIPMENT:

33.1 **The permanent heating and plumbing equipment, when installed, may be used for temporary services, with the consent of the Owner AND 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.

33.2 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.

33.3 Warranties shall begin at substantial completion regardless of temporary use of equipment or not.

33.4 A pre-start-up conference shall be held in accordance with EQUIPMENT/CONTROLS START-UP AND VERIFICATION in this section.

33.5 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 exhaust air openings install a minimum of two sets of MERV 8 filter media 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.

33.6 For Rooftop and 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 MERV 8 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 34 – NOISE, VIBRATION OR OSCILLATION:

34.1 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.

34.2 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.

34.3 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.

34.4 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 35 – EQUIPMENT STARTUP & VERIFICATION:

35.1 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.

35.2 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 to discuss the goals, procedures, etc. for start-up.

35.3 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.

35.4 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.

35.5 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. This shall include the following:

- Heat Pumps (Use the attached forms – no exceptions)
- Outside Air Units
- Variable Frequency Drives
- Water Flow Meters/BTUH Meters
- Kitchen Rangehood, Makeup Air Unit, and Exhaust Fans

35.6 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.

35.7 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.

PART 36 – INSPECTION, APPROVALS AND TESTS:

36.1 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.

36.2 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.

36.3 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.

36.4 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.

36.5 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 37 - ABOVE-CEILING AND FINAL PUNCH LISTS:

37.1 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.

37.2 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.

37.3 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.

37.4 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 38 – OPERATING INSTRUCTIONS:

38.1 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.

38.2 Along with Owner Training, the General Contractor shall also provide video recordings of any owner trainings. Copies of all videos should be submitted to the Owner/District when the O&M manuals are presented

38.3 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.

38.4 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 39 – RECORD DRAWINGS:

39.1 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 ensure 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.

39.2 All underground utilities/piping installed as part of this project shall be surveyed by a land surveyor licensed in the State in which the project is being constructed. This shall include underground geothermal piping mains, vaults, and vertical bore locations. The survey shall include actual pipe depths to top of pipe 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. The survey information shall be included in the closeout documentation.

PART 40 – INFLATION REDUCTION ACT:

40.1 This project is eligible to pursue Investment Tax Credits (ITC) as specified in the relevant U.S. code sections and subsequent notices commonly known as the Inflation Reduction Act of 2022 (IRA). For more information regarding these tax credits, refer to spec section 00 80 00 – INFLATION REDUCTION ACT DOCUMENTATION.

40.2 Energy credits related to this projects' use of a geothermal system creates opportunities for pursuing stated credits. To pursue these credits, the geothermal, mechanical, electrical, temperature controls, General contractors, and any other applicable trades are required to track all labor and material cost for all contracted work related to the geothermal system on this project. Refer to spec section 00 80 00 Part 3 for an example tracking form.

END OF SECTION 20 01 00

SECTION 20 02 00 - 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 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 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 domestic water service to 5’-0” beyond building footprint. Refer to Civil Drawings/Specifications for additional requirements.

1.17 Complete sanitary sewer service to 5’-0” beyond building footprint. Refer to Civil Drawings/Specifications for additional requirements.

1.18 Complete storm sewer service to 5’-0” beyond building footprint. Refer to Civil Drawings/Specifications for additional requirements.

1.19 Complete fire protection service to 5’-0” beyond building footprint. Refer to Civil Drawings/Specifications for additional requirements.

1.20 Complete interior and exterior geothermal system and required test results.

1.21 Domestic hot, cold, and recirculating hot water system.

1.22 Soil, waste, and vent systems.

1.23 Roof drainage systems.

1.24 All plumbing equipment, fixtures, and fittings.

1.25 100% automatic sprinkler systems.

1.26 Complete heating, ventilation, and air conditioning systems.

1.27 All mechanical exhaust systems.

1.28 All insulation associated with mechanical systems.

1.29 Condensate drainage systems.

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

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

END OF SECTION 20 02 00

SECTION 20 03 00 - 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 selecting equipment, accessories and features 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 – SHOP DRAWINGS:

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

Access Doors
Chemical Treatment and Test Reports
Double Wall Ductwork
Ductwork Accessories/Volume Dampers
Exhaust Fans
Fire Protection Sprinkler System (2.2.3)

Firestopping (2.2.6)
Floor Drains
Geothermal Piping, Vault, Specialties
Heat Pump Units
Insulation
Outside Air Handling Units
Plumbing Fixtures, Fittings and Trim
Plumbing Specialties
Pumps and Hydronic Specialties
Register, Grilles, Diffusers and Louvers
Roof Drains
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 project specific UL listed firestopping installation drawings to the authority having jurisdiction where required for their approval as required.

END OF SECTION 20 03 00

SECTION 20 11 00 - 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 Provide shop drawings indicating penetration detail for each type of wall and floor construction. Shop drawings must be specific for each individual type of penetration (one hour fire rated gypsum wall board with insulated metal pipe penetration, etc.) Provide copies to the authority having jurisdiction if 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 and properly sealed 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.

5.7 The following indicates the 3M penetration details for <u>uninsulated</u> pipe penetration of various wall and floor construction types (the list is not inclusive):

- One, two or three hour fire rated concrete floor - 3M #5300-MPC8.
- One, two or three hour fire rated solid or block concrete wall - 3M #5300-MPC16 or 3M #5300-MPC26.
- One hour fire rated gypsum wallboard - 3M #5300-MPC7.
- Two hour fire rated gypsum wallboard - 3M #5300-MPC7.

5.8 The following indicates the 3M penetration details for <u>insulated</u> pipe penetrations of various wall and floor construction types (the list is not inclusive):

- One, two and three hour fire rated concrete floor - 3M #5300-IMP2.
- One, two and three hour concrete block wall - 3M #5300-IMP2.
- One hour fire rated gypsum wallboard - 3M #5300-IMP4.

- Two hour fire rated gypsum wallboard - 3M #IMP7.

5.9 HVAC ducts penetrating a one or two hour fire rated wall or floor shall be firestopped per 3M #5300-HVD1.

5.10 Multiple pipes penetrating fire rated floors and walls may be firestopped as a group. Submit details for specific applications if this method of firestopping is chosen.

END OF SECTION 20 11 00

SECTION 20 12 00 - 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 (provide for informational purposes only) 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 tool excavation methods.

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, piping 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 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. Remove all trash, rubbish, and unsuitable material from the site at the completion of excavation work.

3.14 The Contractor shall provide and maintain barricades, trench plates and temporary bridges around excavations as required for safety. Temporary plates or bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these plates and 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 a bedding of 6" of manufactured sand or #8 crushed stone after finished excavation. Install the new pipe on the compacted fill material. Install tracer wire on all 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 offsite 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 in the following two paragraphs.

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 be 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	Geothermal Lines	36 inches below final grade.
5.1.2	Domestic Water Lines	36 inches below final grade.

5.1.3	Fire Service Lines	48 inches below final grade.
5.1.4	Storm Lines	24 inches below final grade.
5.1.5	Sanitary Lines	36 inches below final grade.
5.1.6	All Other Lines Not Listed	36 inches below final grade.

END OF SECTION 20 12 00

SECTION 20 13 00 - 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 unions 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 geothermal 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 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.

1.33 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.

1.34 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.

1.35 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.

1.36 When connecting to an existing hydronic water system (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 unions or couplings 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, thread-o-let and T-drill 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.

PART 4 – PIPE TESTING:

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.

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” per foot in direction of flow where possible but in no case less than 1/8" per foot.

5.3 SITE SANITARY LINES: Not less than one (1) % fall in direction of flow and no greater than indicated.

5.4 SITE STORM LINES: Not less than one (1) % grade in direction of flow.

5.5 ROOF LEADERS: 1/8" per foot where possible.

5.6 CONDENSATE DRAIN LINES FROM COOLING EQUIPMENT: Not less than ¼" per foot in direction of flow.

5.7 ALL OTHER LINES: Provide ample pitch to a low point to allow 100 percent drainage of the system.

PART 6 – EXTERIOR APPLICATIONS (SITE WORK):

6.1 SITE SANITARY SEWER: Refer to the Civil Plans and Specifications.

6.2 SITE STORM SEWER: Refer to the Civil Plans and Specifications.

6.3 SITE WATER: Refer to the Civil Plans and Specifications.

6.4 SITE FIRE PROTECTION: Refer to the Civil Plans and Specifications.

PART 7 – PLUMBING PIPING APPLICATIONS:

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

7.1.1 Service weight cast iron hub and spigot piping with compression gasket joints.

7.1.2 Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Plumbing Code. PVC pipe shall not be installed where waste water applications exceed 140 deg F.

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

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

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

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

7.3 GREASE, WASTE AND VENT PIPING (BELOW SLAB):

7.3.1 Service weight cast iron hub and spigot piping with compression gasket joints.

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

7.4 GREASE, WASTE AND VENT PIPING (ABOVE SLAB):

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

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

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

7.5.1 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%).

7.5.2 “ProPress” pipe/fitting system by Rigid is acceptable for piping 3” and smaller. Only ProPress Fittings with the Rigid press system. ProPress has indicated that other similar fittings by different manufacturers may leak.

7.5.3 Type L copper with grooved couplings and fittings. Fittings shall be Victaulic 607/89 or approved equivalent.

7.5.4 “Pex” Domestic Water Piping: Piping shall be PEX-a (Engel-Method Crosslinked Polyethylene) Piping: ASTM F 876/877 by Uponor. PEX-a Fittings: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold- expansion fitting manufactured from the following material types:

- UNS No. C69300 Lead-free (LF) Brass.
- 20% glass-filled polysulfone as specified in ASTM D 6394.
- Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D 6394.
- Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D 6394.
- Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D 6394.
- Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".

PEX-to-Metal Transition Fittings:

- Manufacturers: Provide fittings from the same manufacturer of the piping.
- Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
- Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and ASTM F 1960 cold- expansion end, with PEX-a reinforcing cold-expansion ring.
- PEX-a to Flange Transition: two-piece brass fitting with lead-free ProPEX adapter and steel flange conforming to ASME B 16.5.

Pex Storage: 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. Piping manufacturer and contractor shall be responsible for adjusting piping sizes for increased wall thickness

7.6 WATER HEATER RELIEF LINE: Type "M" copper tubing with sweat fittings and 95/5 solder.

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

PART 8 – HVAC PIPING APPLICATIONS

8.1 GEOTHERMAL/HEAT PUMP LOOP PIPING:

8.1.1 Mains and branches – Piping shall be virgin polyethylene with a PE 3408 piping formulation and 345464C or greater cell classification. Pipe shall be SDR 15.5, minimum pressure rating of 110 psi at 73.4°F.

8.1.2 Individual Heat Pump Runouts - Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

8.1.3 Special Note: Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the top of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

8.1.4 Transitions from HDPE to Copper – Factory Manufactured Transition required with brass or stainless steel threads. No metal threads shall be inserted into polyethylene piping, and no polyethylene threads shall be inserted into metal piping.

8.1.5 The only acceptable method for joining pipe is by a heat fusion process. Pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures. All piping work shall be performed in accordance with Specification Section – GEOTHERMAL LOOP SYSTEM. Victaulic style 905/908 couplings may be utilized on above ground HDPE applications.

8.2 EXTERIOR GEOTHERMAL PIPING: Refer to Specification Section – GEOTHERMAL LOOP SYSTEM.

8.3 AIR VENT DISCHARGE LINES: Type "L" soft copper; wrought copper fittings, 95/5 solder. Pipe to a suitable drainage location.

8.4 REFRIGERANT PIPING: Type "L" copper tubing with forged or wrought copper fittings and silver soldered joints. Solder must have a minimum of 15% silver content.

8.5 CONDENSATE DRAIN Lines: Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

END OF SECTION 20 13 00

SECTION 20 13 05 - GEOTHERMAL LOOP 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.

PART 2 – CONTRACTOR QUALIFICATIONS:

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 – SUBMITTALS:

3.1 Reference Specification Section REQUIRED SHOP DRAWINGS, ETC. for additional requirements.

3.2 Submit the following items before construction activities:

- 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.
- Manufacturer's data for geothermal vault and components.
- Manufacturer’s data for the grout mixture. Submit details on grouting procedures, methods, and equipment.
- Manufacturer’s data sheets for geothermal loop fluid.
- Written flushing, purging, pressure and flow testing plan. Include purge cart cut sheets.

3.3 Submit the following items after construction activities:

- Geothermal loop fluid test results.
- Grout testing results for 10% of vertical bores.
- Written results of flushing, purging, pressure and flow testing.
- Schedule dates for warranty period flushing, purging, etc.
- Survey/Record Drawings with dimensions from fixed benchmarks, depths, and sizes.

- Written tracer wire test results.
- Submission of the completed items above is a condition of acceptance and closeout for the Project.

PART 4 – WARRANTY:

4.1 The entire ground loop system and backfill from a point 5'-0" inside the building shall be warranted for ten years from date of substantial completion against any leakage or failure.

PART 5 – PIPING MATERIALS:

5.1 Acceptable pipe materials for the underground buried portion of the ground heat exchanger are polyethylene as specified in this Section. Piping shall be listed for closed-loop ground source geothermal application. The pipe and fittings of the buried system shall be warranted by the manufacturer for ground source heat pump service.

5.2 ACCEPTABLE MANUFACTURERS: Driscoplex 5300 Climate Guard, Centennial Plastics, Charter Plastics, Flying W Plastics, Lamson Vylon Pipe, PolyPipe, Inc.

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

5.4 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.

5.5 The pipe 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 except 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.

5.6 Pipe shall be manufactured in accordance with ASTM D-3035 and sized as follows:

- Pipe sizes 1¼" or less: DR 9 AND rated @ 200 psi.
- Pipe sizes 1 ½" – 2": DR 15.5
- Pipe sizes 3" and larger; DR 17

5.7 Sufficient information shall be permanently marked on the length of the pipe as defined by the appropriate ASTM pipe standard. Piping shall also have permanent factory length markings.

PART 6 – PIPE JOINING METHODS:

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

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

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

PART 7 – FLUSHING, PURGING, PRESSURE AND FLOW TESTING:

7.1 Refer to Specification Section PIPE FILLING, CLEANING, FLUSHING, PURGING AND CHEMICAL TREATMENT for additional information and coordination requirements.

7.2 Refer to Specification Section TESTING, ADJUSTING AND BALANCING for additional information and coordination requirements.

7.3 Include in the bid an additional, complete, piping network purge at substantial completion and at 3, 6, 9 and 12 months from substantial completion.

7.4 Successful flushing and purging is critical and shall be accomplished and documented. Notify Engineer prior to flushing and purging. Submit flushing and purging plan to engineer two (2) months prior to commencing this work.

7.5 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. All fusion joints and loop lengths shall be checked to verify that no leaks have occurred due to fusion joining or shipping damage. Heat exchangers shall be tested hydrostatically at 150% of the pipe design rating or 300% of the system operating pressure (whichever is greater). No leaks shall occur within a 120 minute period.

7.6 The type of purging cart/equipment is critical to successful flushing and purging. The purge cart shall be sterilized before each use. The purge cart shall include a pump that minimally develops 350 gpm of flow at 130 feet of head pressure developed. It shall include a large purge return tank, interconnection piping, inlet/outlet pressure gauges, water flow readout display reversing valve and 4” flexible hose connection. Coordinate so that the vault purge ports match purge cart couplings. The first circuit purged after hose connection shall be purged minimally one hour to remove extra air introduced from the hoses. Once the first circuit is purged, minimally purge other circuits for 30 minutes. Once all well circuits are purged, close all circuit valves and purge piping between vaults and building heat exchanger using building purge ports.

7.7 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.

7.8 A minimum velocity of 3 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 ensure minimum velocities are obtained. After one test is confirmed, the other wellfield rows shall be tested utilizing the same procedure. The Test and Balance Contractor shall confirm all minimum circuit, flow rates are obtained for all wellfield piping.

7.9 Final purging of air from the entire building loop and wellfield loop shall be performed by the wellfield purging contractor so that air in the building will not be transferred with the wellfield. Coordinate with the Mechanical Contractor.

PART 8 – HORIZONTAL PIPING SYSTEMS:

8.1 Refer to Section EXCAVATION, BACKFILLING AND TRENCHING AND GRADING for additional requirements.

8.2 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.

8.3 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 #8 rock. Provide a minimum of 6” cover over pipe with back filled material. Clods resulting from use of a backhoe shall be broken 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. Minimum bury depth of piping shall be 36” to top of pipe.

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

8.5 Install continuous tracer wires on each wellfield circuit in and out of the geothermal vault and the building. Provide an additional 36” of coiled tracer wire on each end and attach in vault at each circuit. Provide an additional 36’ of coiled tracer wire on each end and attach in building at each circuit riser. Perform tracer wire testing for all tracer wires in conjunction with the Owner/Engineer – this is a condition of acceptance and closeout.

8.6 Install continuous tracer wires on each wellfield circuit in and out of the building. Provide an additional 36” of coiled tracer wire on each end and attach in building at each circuit riser. Perform tracer wire testing for all tracer wires in conjunction with the Owner/Engineer – this is a condition of acceptance and closeout.

PART 9 – BORE HOLE AND GROUTING:

9.1 The Contractor shall accept the site as-is and is responsible for any and all required steel 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. No night drilling will be allowed.

9.2 The Contractor shall bore wells of a sufficient diameter to allow installation of the piping and U-bend and a 1-1/4" (minimum) HDPE tremie pipe for grout installation but shall be no less than 6"- 6 ½".

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

9.4 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 feet deeper than the U-tube length.

9.5 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.

9.6 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.

9.7 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.

9.8 Through the course of the project, sample grout specimens shall be randomly (chosen by Engineer or Owner's Testing Agent) taken of the mixed grouting material by this Contractor for 10% of the vertical bores. 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.

PART 10 – GEOTHERMAL VAULT:

10.1 External shell to be constructed of one (1) inch thick HDPE with a cell classification of 345444 with a UV stabilizer of C.

10.2 Provide with access pad that is a minimum of 10 feet long by 5 feet-2 inches wide. Refer to detail on the drawings for additional information.

10.3 Provide with two access openings, minimum 30" wide. One shall provide access to the vault. The other shall provide access to purge ports, piped to ground level. Refer to detail on the drawings for additional information.

10.4 Provide an aluminum ladder for access. Ladder to be minimum 18" wide. Refer to the detail on the drawings for mounting requirements.

10.5 Vault shall be provided with a 5 year warranty.

10.6 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 air. 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 grouted to be water tight.

10.7 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. Install at the inlet and outlet of each circuit.

10.8 BUTTERFLY VALVE: Shall be constructed of a cast iron body, 416 stainless steel stem with a lever shut off system. Refer to Section VALVES for all valve requirements. Install for each circuit supply and return.

10.9 90° ELBOWS: Shall be molded out of high density polyethylene resins in accordance with the requirements of ASTM 3261.

10.10 BRANCH AND SERVICE SADDLES: Shall be molded out of high density polyethylene resins in accordance with the requirements of ASTM 3261.

10.11 INSTALLATION: The vault shall be lowered into a pit of sufficient depth with a 6” bed of #57 gravel. Once the vault is in place, the vault shall be anchored and sufficient back-fill put in place.

10.12 Coordinate power / lighting requirements with Electrical Contractor.

PART 11 – HEAT TRANSFER FLUID:

11.1 Treated and cleaned water. Glycol is not required for this system.

PART 12 – ADDITIONAL INSTALLATION REQUIREMENTS:

12.1 Underground land survey of the entire geothermal wellfield system per GENERAL PROVISIONS - MECHANICAL. This shall include all horizontal piping, vaults, vertical bore locations and dimension from above grade fixed benchmarks. The underground survey shall be included in the closeout documentation.

12.2 DUST CONTROL: The Contractor shall be responsible for and shall provide dust control. Dust shall not be allowed to leave the construction site boundaries, and furthermore, shall not be allowed to enter the building or accumulate on the building exterior. When needed to meet these requirements, the Contractor shall provide and operate a mechanical dust collection system to control dust at the source. Mechanical dust collection system shall consist of collection hood at the source ducted to a dust collector which separates dust from the airstream. Dust shall be collected into sealed containers for disposal by the Contractor. Water spraying may be used but shall not be considered a substitute for mechanical dust collection at the source when required.

12.3 SURFACE WATER / MUD / SLURRY CONTROL: The Contractor shall be responsible for and shall provide control of all ground flowing fluids resulting from drilling operations. The Contractor shall erect silt fences or other structures as required to contain drill cuttings, mud, slurry, etc. within the construction site boundaries. In the event this requirement is not met, the Contractor shall provide all remediation measures as required by all authorities having jurisdiction over such events.

PART 13 – TEST BORES:

13.1 Test bores information and thermal conductivity testing information is provided on the drawings.

13.2 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 20 13 05

SECTION 20 13 10 – 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 Maintain a water treatment program for the closed loop piping systems. It is the Contractor's responsibility to contact the engineer 2 weeks in advance to any treatments performed on the systems. It is the Engineer's discretion whether or not this process should be monitored after notification.

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

1.6 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 area of the job site or facility.

1.7 Prior to any construction, the Contractor shall sample the existing closed loop chemicals 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.

1.8 Be advised the existing loop contains an anti-freeze mixture. Prior to any construction, the Contractor shall sample the existing closed loop and provide anti-freeze mixture data.

1.9 Furnish initial supply of the closed loop chemicals for each system. This contractor shall retest the systems after 3, 6, 9, 12, and 20 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. Provide any laboratory and technical assistance required to achieve a successful program.

1.10 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 successfully completed. The closeout documentation shall include dates for warranty testing.

1.11 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.

1.12 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:

- Geothermal Heat Pump Water

2.2 There are several precautions which must be observed during piping 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. Refer to Specification Section GEOTHERMAL LOOP SYSTEM for geothermal system requirements.

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:

2.4.1 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.

2.4.2 After initial flushing, all strainers shall be cleaned, and 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.

2.4.3 After the system is filled with this solution, the loop shall be allowed to circulate for 24 hours.

2.4.4 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.

2.4.5 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.

2.4.6 If the system is found to be still on the acid side, the cleaning by use of Trisodium Phosphate shall be repeated.

2.4.7 After the cleaning including all strainers 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:

2.5.1 The Contractor shall first close the WSHP isolation valves and open the WSHP bypass valves.

2.5.2 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.

2.5.3 After initial flushing, all strainers shall be cleaned, and 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.

2.5.4 After the system is filled with this solution, the loop shall be allowed to circulate for 24 hours.

2.5.5 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.

2.5.6 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.

2.5.7 If the system is found to be still on the acid side, the cleaning by use of Trisodium Phosphate shall be repeated.

2.5.8 After the cleaning, including all strainers 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 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 all other material foreign to the water as previously specified.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

END OF SECTION 20 13 10

SECTION 20 21 00 - 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 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.

2.3 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.

2.4 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.

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 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.

2.10 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.

2.1 BALANCING VALVE: Furnish and install balancing valves as indicated on the plans. The balancing valve shall be self contained and fully automatic without additional piping or control mechanisms. Balancing valves shall be Circuit Solver as manufactured by Therm Omega tech, Inc, or equal.

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. Victaulic 716/W716 are acceptable with grooved piping systems.

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: 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 pressure and be equal to Hammond 6000 Series. Victaulic Vic-300/W761 is acceptable with grooved piping system. Victaulic Vic-300 and Tri Service assembly is acceptable with grooved piping system.

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. Provide with balancing valves, one (1) water gpm

readout kit to be turned over to Owner which shall include a differential pressure meter with full scale overrange protection, hoses, readout probes, filters, carry and calculator.

3.10 TRIPLE DUTY VALVE: Triple duty valve shall be straight pattern type with flange ends and be constructed of cast iron. Valve to be designed to perform as a non-slam check valve, calibrated balancing valve and shut-off valve. Valve to be provided with two (2) brass readout ports with integral check valve to obtain flow measurement. Triple duty valve shall be rated for 175 psi working pressure and 250 degrees F. Valve to be similar to Bell & Gossett Model 3DS. Locate a triple duty valve at the discharge of each base mounted pump per the manufacturer's recommendations.

3.11 PUMP DROPS: Factory assembled grooved end pump drops. Assemble is installation-ready with flexible couplings to accommodate vibration attenuation and stress relief rated for 300 PSI. Victaulic Series, 380, 381, 385.

3.12 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.

3.13 AUTOMATIC AIR VENT: Bell & Gossett Model 107A high capacity float actuated automatic air vent with cast iron body and bonnet. Vent to be rated for 150 psi working pressure and 240 degrees F working temperature. Pipe discharge to nearest floor drain unless noted otherwise.

3.14 MANUAL AIR VENT: Bell & Gossett Model 78 manual air vent with cast brass body and built-in check valve. Vent to be rated for 150 psi working pressure and 240 degrees F working temperature. Install with 12" length of 1/4" soft copper discharge piping unless noted otherwise.

END OF SECTION 20 21 00

SECTION 20 22 00 – INSULATION - MECHANICAL

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 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 performed in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use.

1.4 Insulation thicknesses shall comply with the latest version of ASHRAE 90.1 and IECC at a minimum.

1.5 All insulation materials shall be installed per the latest edition of the National Commercial and Industrial Insulation Standards.

1.6 Insulation shall be installed by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineer shall be removed and properly installed at the expense of the Contractor.

1.7 The Contractor shall photograph any installations prior to concealment. This includes duct risers in chases and at rooftop equipment.

PART 2 – ACCEPTABLE MANUFACTURERS:

2.1 Johns Manville, Knauf, Owens-Corning.

PART 3 – FIRE RATINGS AND STANDARDS:

3.1 Insulations, jackets, facings, adhesives, mastics, tapes, fitting materials, etc. 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 All products and their packaging shall bear a label indicating above requirements are not exceeded.

3.3 Glass wool insulations shall contain a minimum of 40% post-consumer recycled content and shall be 100% formaldehyde free.

PART 4 – GENERAL APPLICATION REQUIREMENTS:

4.1 “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 "exposed".

4.2 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.

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

4.4 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.

4.5 Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced by the Contractor at their expense.

4.6 Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples through 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.

4.9 Unless otherwise specified or allowed, closed cell type insulation shall not be acceptable.

PART 5 – PIPING SYSTEMS:

5.1 Seal insulation and jacket at all points where insulation terminates at unions, flanges, valves, and equipment. This applies to hot water lines only as cold water lines require continuous insulation and vapor barrier.

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

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

5.4 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 and seal with approved sealant.

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

Pipe Size	Shield Gauge	Shield Length
2” and less	20	12”
2 ½”- 4”	18	12”
5”- 10”	16	18”
Over 10”	14	24”

5.6 Insulated pipes 2” in diameter and larger shall be additionally supported with wood inserts of sufficient compressive strength to carry the weight of the pipe and fluid. Inserts shall extend beyond extend beyond the hanger and shall be at least 6” in length.

5.7 Provide premolded 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 additional insert shall be used for each additional 1" of pipe insulation above 1-1/2". All joints shall be fully sealed.

5.8 PIPE INSULATION MATERIAL: Insulation shall be Knauf "Earthwool 1000° Pipe Insulation ASJ+/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 not exceeding 0.27 Btu per inch/h.ft² °F 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 0.02 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 minimum thickness of insulation as noted.

5.8.1	Domestic Cold Water:	1" thick insulation
5.8.2	HVAC Fill Lines:	1” thick insulation
5.8.3	Exterior HVAC Fill Lines:	1” thick insulation with heat trace jacketing
5.8.4	Roof Drain Piping: overflow systems)	1” thick insulation (Horizontal piping for primary &

5.8.5 Domestic Hot Water & Return Lines:

- Piping 1-1/4" and less: 1" thick insulation
- Piping 1-1/2"" and greater: 1-1/2” thick insulation

5.8.6 Refrigerant Suction Lines:

- Piping 1-1/4" and less: 1/2” thick insulation
- Piping 1-1/2" and greater: 1" thick insulation
- All exterior piping: 1-1/2” thick with jacketing

5.8.7 Geothermal Heat Pump Piping: 1” thick

5.8.8 Condensate Drain Lines: 1/2" thick

5.8.9 Floor Drain Sanitary Pipes: All floor drains that have condensate spilled to the drain, and the sanitary pipe is not below slab, shall have its respective sanitary pipe insulated with 1" thickness. Insulate the pipe until it connects to a 4" main, but a minimum of 20 feet in the direction of flow.

PART 6 – DUCTWORK SYSTEMS:

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

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

6.3 EXTERNALLY INSULATED EXPOSED SUPPLY, OUTSIDE AIR DUCTWORK:

6.3.1 Applies to all ductwork exposed to view (not concealed in ceiling space or in a mechanical room).

6.3.2 BASE BID – Double wall painted ductwork. Refer to Specification Section 231200 - Sheet Metal for additional information.

6.3.3 ALTERNATE #1 BID – 2" rigid fiberglass industrial board with foil scrim kraft vapor barrier facing, 6.0 PCF density, K=0.23 Btu in/hr. ft^2 °F @ 75°F. Owens/Corning or approved equivalent industrial installation type 705. Apply 6 oz. canvas jacket over ductwork for a clean smooth finish. Ductwork to be painted with two coats of paint. Color as directed by Architect.

6.4 EXTERNAL INSULATION FOR CONCEALED SUPPLY, OUTSIDE AIR DUCTWORK: Knauf "Friendly Feel" faced, Duct Wrap, 0.75 PCF density, 2" thick or approved equivalent. Wrap shall be factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. The installed R value shall be a minimum of 5.0. Flame spread 25, smoke developed 50, vapor barrier performance 0.02 perms per inch.

- Pre-conditioned outside air supply ductwork downstream of OA unit (under positive pressure) and exhaust air ductwork upstream of OA unit (under negative pressure) does not require insulation. All other duct including louver plenums requires installation per the above.

6.5 INTERNAL INSULATION: Duct liner shall be 1" thick flexible elastomeric insulation (Armaflex AP Duct Liner). K=0.27 BTU in./hr. ft^2 °F @ 75°F. Internal insulation to be utilized at all locations noted on drawings (Auditorium, Band, Vocal Music, and any other noise sensitive space).

6.6 DUCT SOUND ABSORBER / DUCTWRAP: In addition to the duct insulation specified, install 1" thick Kinetics KBC-100RBQ (or Sound Seal BBC-1 B-10FS QFA-1) limp barrier material (1.3 lb/sq ft), reinforced with a fiber glass screen, loaded with barium sulphate, with a quilt faced fiber glass absorber on one side. Install per manufacturer's instructions. Minimum sound transmission loss per octave band shall be 125Hz-10dB/250Hz-16dB/500 Hz-22dB/1000Hz-30dB/2000Hz-39dB/4000Hz-43dB/STC-27. Provide steel banding to ensure restraint of duct wrap.

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.fr^2 °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 20 22 00

SECTION 20 23 00 – 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 Water thermometers shall be blue-reading spirit liquid-in-glass type with 9” scale, powder coated cast aluminum case and stem socket of length as required by system. Accuracy to be plus or minus 1 scale division. Lens to be plastic. Hot water thermometer shall have a 30°F to 240°F range and chilled water and geothermal water thermometer shall have a 0°F to 120°F range.

2.5 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 and low pressure steam gauges shall have 0 to 100 PSI range and medium/high pressure steam gauges shall have 0 to 200 PSI range.

2.6 Provide direct mount Bimetal dial thermometers in HVAC ductwork. Thermometer shall be 3" diameter, with polycarbonote plastic lens and stainless steel case. Air temperature range shall be 25°F to 125°F.

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 20 23 00

SECTION 20 24 00 - 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 charts 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 on the piping and ductwork 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"
Over 10"	24"	3 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.
Domestic Cold Water	D.C.W.
Domestic Hot Water	D.H.W.
Recirculated Hot Water	R.H.W.
Refrigerant Piping	RL/RS
Fire Protection	SPRINKLER
Sanitary Sewer Piping	SAN
Sanitary Vent Piping	VENT
Storm Sewer Piping	STORM

PART 4 – NATURAL GAS PIPING IDENTIFICATION:

4.1 Not Used

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 20 24 00

SECTION 20 25 00 - 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 Support plastic pipe at intervals not to exceed four (4) feet and at the end of the branches and at the change of direction and shall be installed as to permit freedom of movement. Vertical piping shall be supported at their bases and all upward movement shall not be restricted. Hangers shall be at least one (1) inch wide and shall not compress, distort, cut, or abrade the piping to allow free movement at all times.

3.18 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.

3.19 Ensure that all bolts and nuts are tightened.

END OF SECTION 20 25 00

SECTION 20 31 00 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

PART 1 – GENERAL:

1.1 The test and balance contractor shall be hired by the owner and work under supervision of the GC/CM. Test and balance will not be "bid" as part of this project.

1.2 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.

1.3 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.

1.4 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.

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

2.3 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.

2.4 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.

2.5 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.

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

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

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

2.9 Refer to Specification Section GEOTHERMAL LOOP SYSTEM and Specification Section CONTROLS for additional requirements.

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 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 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 10% of design air flow rate.
- Heat pump total air flow, discharge, and inlet pressures.
- Hydronic and domestic pumps total water flow.
- Balance heat pump loop, circulating pumps and associated coil water flows.
- Verify calibrations of the duct static pressure and water pressure sensors for all systems.
- Balance each geothermal wellfield row.
- 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.

2.16 Balance all units rated for 2,000 cfm unit such that the total air volume delivered does not exceed 2,000 cfm, otherwise the Contractor shall furnish and install a code compliant duct smoke detection system integrated into the building's system.

2.17 The flushing and purging of the geothermal system shall be witnessed and approved. Refer to Specification Section GEOTHERMAL LOOP SYSTEM and Specification Section PIPE FILLING, CLEANING, FLUSHING, PURGING AND CHEMICAL TREATMENT for additional requirements.

2.18 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.

2.19 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.

2.20 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.

2.21 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.

2.22 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.

2.23 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 20 31 00

SECTION 21 01 00 - 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. 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 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.

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

- Fire Protection Shop Drawings
- Fire Protection Service Materials & Labor
- Fire Protection Materials & Labor
- Fire Protection Finish 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.
- Wet pipe alarm valves and wet system specialties.

- Flanged gate and check valves.
- Pipe hangers.
- Supervised butterfly valve.
- The pressure sensing switch.
- The main 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 WET ALARM VALVES: Black enamel coated ductile iron body conforming to ASTM A-536, grade 65-45-12, aluminum bronze clapper, stainless steel spring and shaft, EPDM seal, and Nitrile seat O-rings. Valve internal parts shall be replaceable without removing the valve from the installed position. Water working pressure is 300 psi. Suitable for constant and variable pressure systems with optional Series 752 retarding chamber. Victaulic FireLock® Series 751 or approved equal.

4.1.1 WET SHOTGUN RISER CHECK ASSEMBLY: Shotgun Riser Check assembly shall be ductile iron construction, incorporating a control valve (Victaulic Series 705), check valve, flow switch, test & drain assembly, adjustable relief valve, and system gauges in one compact body/footprint, and shall be manufactured for “right” and “left”-hand orientations. The test & drain assemble shall contain an adjustable relief valve, with a range of 175 to 310 psi, and a universal test orifice of K5.6 [K2.8] [K4.2]; to provide testing capabilities of systems with k-factors ranging from K5.6 [K2.8] [K4.2] and larger. Shotgun riser check assembly shall be rated for use at the maximum service pressure of 300 psi and shall be UL listed and FM approved. Basis of Design: Victaulic Series UMC or Engineer approved equal

4.2 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.

4.3 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.

4.4 BUTTERFLY VALVE:

4.4.1 **UL/FM** 300 psi (2065 kPa), grooved ends, black enamel coated ductile iron body (ASTM A-536, Grade 65-45-12). Electroless-nickel coated ductile iron disc, with pressure-responsive elastomer seat and stainless-steel stem. (Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.). Complete with weatherproof actuator and pre-wired supervisory switches. Victaulic Series 705 FireLock® or Series 707C FireLock® or approved equal.

4.5 BALL VALVES:

4.5.1 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 180 degrees F water temperature and 150 psi working pressure. Ball valve shall be Nibco T-585-70-66 for threaded ends and Nibco S-585-70-66 for solder ends.

4.6 CHECK VALVES:

4.6.1 2"(DN50) through 3"(DN75) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, non-slam tilting disc, stainless steel disc and spring, brass shaft, 365 psi (2517 kPa). Victaulic Series 717H or approved equal

4.6.2 4” (DN100) through 12”(DN300) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 250 psi (1725 kPa). Victaulic Series 717. Designed to accept a riser check kit. Victaulic Series 717R or approved equal.

4.6.3 FLOOR CONTROL/ZONE CONTROL ASSEMBLIES: Floor and Zone Control assemblies shall be ductile iron construction, incorporating a control valve (Victaulic Series 705), check valve, flow switch, test & drain assembly, adjustable relief valve, and system gauges in one compact body/footprint, and shall be manufactured for “right” and “left”-hand orientations. The test & drain assemble shall contain an adjustable relief valve, with a range of 175 to 310 psi, and a universal test orifice of K2.8 [K4.2] [K5.6]; to provide testing capabilities of systems with k-factors ranging from K2.8 [K4.2] [K5.6] and larger. Universal manifold check valve shall be rated for use at the maximum service pressure of 300 psi and shall be UL listed and FM approved. Basis of Design: Victaulic Series UMC or Engineer approved equal.

4.6.4 MANIFOLDS: Manifold shall be ductile iron construction, incorporating a control valve (Victaulic Series 705), flow switch, test & drain assembly, adjustable relief valve, and system gauge in one compact body/footprint. The test & drain assemble shall contain an adjustable relief valve, with a range of 175 to 310 psi, and a universal test orifice of K2.8 [K4.2] [K5.6]; to provide testing capabilities of systems with k-factors ranging from K2.8 [K4.2] [K5.6] and larger. Universal manifold assemblies shall be rated for use at the maximum service pressure of 300 psi and shall be UL listed and FM approved. Basis of Design: Victaulic Series UM or Engineer approved equal.

4.7 INTERIOR PIPE & FITTINGS: Up to 2" Schedule 40 ASTM A-53 black steel with Victaulic or similar type approved fittings or 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

4.7.1 GROOVED COUPLINGS AND FITTINGS: 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 108, 109, 009N and 107N
- Flexible Type: For use in locations where vibration attenuation and stress relief are required: Basis of Design: Victaulic Style 75, 77 and 177N.
- Installation-Ready™ fittings for Schedule [40] [10] grooved end steel piping in fire protection applications sizes NPS 1-¼ thru 2½ (DN 32 thru DN 65). Fittings shall consist of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, [orange enamel coated] [red enamel coated] [galvanized]. Fittings complete with pre-lubricated Grade “E” EPDM Type ‘A’ gasket; and ASTM A449 electroplated steel bolts and nuts. System shall be UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
- In lieu of threaded steel piping systems, the Victaulic FireLock IGS System with “Installation-Ready™ fittings and couplings may be used for NPS 1 (DN 25) Schedule 10 and Schedule 40 carbon steel pipe in fire protection applications. System rated for a working pressure to 365 psi (2517 kPa).
- Groove: IGS “Innovative Groove System” groove with shortened “A” dimension and tapered groove backside for ease of installation.
- Grooving Tool: Victaulic RG2100, with IGS Confirmation Gauge.

4.7.2 CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5 for 175 PSIG rated pressure at 150°F. Include “LISTED” and CPVC SPRINKLER PIPE” markings.

4.7.3 CPVC Fittings: UL listed for 175 PSIG rated pressure at 150°F. Include “LISTED” and CPVC SPRINKLER FITTING” markings.

4.8 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.

4.9 SPRINKLER HEADS: Tyco, Victaulic, Viking, 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 Series FL-QR semi-recessed automatic sprinkler head. Escutcheon and head shall be white.
- Upright, Quick Response – Reliable (or equal) Model F1FR or Victaulic Series FL-QR Vertical Upright automatic sprinkler head.
- Sidewall, Quick Response – Reliable (or equal) Model GFR or Victaulic Series FL-QR/SW, horizontal sidewall automatic sprinkler head.
- Concealed, Quick Response – Reliable (or equal) Model G4A or Victaulic Series FL-QR/C, Concealed automatic sprinkler head. Cover shall be white.
- Caged, Pendent, Quick Response – Reliable (or equal) Model F1FR or Victaulic Series FL-QR Vertical Upright automatic sprinkler head with D1 cage.

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

4.10.1 Multi-Use Flexible Sprinkler Fittings shall be [UL, cUL, FM] and be used in lieu of rigid pipe offsets or return bends for sprinkler drops. Flexible hose shall consist of a true 1" ID corrugated braided type 304/316 stainless steel UL listed per UL-2443 to 175psi with a 2" minimum bend radius and FM approved per FM-1637 to 200psi with a 7" minimum bend radius. Basis of Design: **VicFlex™** as manufactured by Victaulic

- Threaded connections used Vicflex™ Series AH2. [VicFlex™ Series AH2-300 for high pressure applications]
- IGS™ Connections: VicFlex™ Series AH2CC [VicFlex Series AH2CC-300 for high pressure applications]
- Brackets shall be of same manufacturer as flexible fitting; can be used on grid, hard lid, and open ceiling applications by attaching to framing, concrete deck, or walls, as recommended by manufacturer. Basis of design: VicFlex™

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

4.12 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.

4.13 Coordinate sprinkler head locations in kitchen freezer/cooler units with light fixtures and other ceiling mounted devices to ensure proper coverage is maintained. Provide these heads with cages. Flexible hose and dry sprinkler technology shall be used in conjunction to eliminate to possibility of air interchange between warm and cold environments when providing dry sprinkler protection within walk-in coolers and similar applications. Basis of Design: VicFlex™ Series AB6 Bracket

4.14 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.

4.15 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.

4.16 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.

4.17 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. Basis of Design: Victaulic Series UTD

4.18 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.

4.19 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.

END OF SECTION 21 01 00

SECTION 22 01 00 - 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 ensure 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., ensure 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.

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 ensure 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.
- FD-2 - Zurn, ZN-415 floor drain with 8"dia. nickel bronze strainer, Type "B", dura-coated cast iron body with bottom 4" outlet and trap primer connection.
- FD-3 - Zurn, ZN-415 floor drain with 8"dia. nickel bronze strainer, Type "B", dura-coated cast iron body with bottom 4" outlet.
- FD-4 - Zurn, ZN-415 floor drain with 8"dia. nickel bronze strainer, Type "B", dura-coated cast iron body with bottom 4" outlet and trap primer connection.
- FS-1 - Zurn, ZN-1900 floor drain cast iron body with white acid resisting porcelain enamel interior and top, anti-splash interior bottom dome strainer, 6" depth and 4" outlet.

PART 4 – FREEZEPROOF WALL HYDRANTS:

4.1 FREEZEPROOF WALL HYDRANTS: Provide code approved wall hydrants at each location indicated in a neat and workmanlike manner. Affix tight to walls and ensure 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.

4.2 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.

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

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

PART 5 – INTERIOR HOSE BIBBS AND DRAIN VALVES:

5.1 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.

5.2 HOSE BIBBS (HB): Provide code approved hose bibbs with vacuum breakers and male threaded spouts at each location indicated (toilet rooms, 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.

5.3 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 water heater.
- At each storage tank.
- At each pump suction.
- Install a code approved vacuum breaker where installation on to domestic water system.

PART 6 – WATER HAMMER ARRESTORS (WHA):

6.1 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.

6.2 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).

6.3 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.

6.4 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.

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

- Clothes Washers – Type "A"
- Commercial Dishwashers – Type "B"
- 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.

6.6 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 7 - OTHER SPECIALTIES:

7.1 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 a limited area fire protection system.
- 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.

7.2 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.

PART 8 – 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 ensure 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 - Zurn 100C-DP FROET FRAIN 3" FroetTM bi-functional roof drain with 45° primary outlet connection. Powder coated cast iron deep sump body with combination membrane flashing clamp/gravel guard
- ORD - Zurn Z199 3" Downspout Nozzle, All nickel bronze body, optional threaded, PVC slip-on, or No-Hub inlet and decorative face of wall flange and outlet nozzle.

END OF SECTION 22 01 00

SECTION 22 02 00 - 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 hose bibbs with manual loose key stop valves. For all other fixtures, furnish with manual permanent-key stop valves (i.e. 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 Deviation from prime specified manufacturer and model number shall be submitted to the Owner 10 days prior to bidding.

1.13 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirements and manufacturers offering plumbing fixtures and trim which may be incorporated in the work include only the following:

1.13.1 Plumbing Fixtures: American Standard, Kohler, Zurn, Sloan

1.13.2 Water Closets: American Standard

1.13.3 Plumbing Trim: Delta, Zurn Aqua-Spec, T & S, Central

1.13.4 Flush Valves: Sloan, Zurn, American Standard

1.13.5 Stainless Steel Sinks: Elkay, Just, Moen Commercial, Sterling

1.13.6 Mop Basins and Laundry Tubs: Fiat, Mustee, Acorn, Zurn

1.13.7 Water Coolers: Elkay, Haws, Sunroc, Oasis, Halsey Taylor, Acorn Aqua

1.13.8 Showers: Bradley, Symmons, Speakman Company, Powers, Acorn, Aqua Bath, Florestone, Swanstone, Willoughby, Aquarius

1.13.9 Emergency Fixtures: Bradley, Acorn, Guardian

1.13.10 Appliance Connection Boxes: Guy Gray, Oatley, Wolverine

1.13.11 Fixture Seats: Bemis, Church, Olsonite

1.13.12 Fixture Carriers: Josam, Kohler, Tyler Pipe, Zurn, Wade, Smith, Watts

1.13.13 Lavatory, Sink, Mop Basin, Urinal and Laundry Tub Strainers: American Standard, Elkay, Kohler, McGuire., Sloan, Zurn.

1.13.14 P-traps, Tailpieces, and Escutcheons: American Standard, Elkay, Kohler, McGuire, Moen Commercial, Sloan, Zurn.

1.13.15 P-trap Insulation covering for ADA Fixtures: IPS Corp., McGuire, Plumberex.

1.13.16 Water supplies and stops: American Standard, Elkay, Kohler, McGuire, Moen Commercial, Nibco, Sloan, Watts, Zurn,

PART 2 – PLUMBING FIXTURE SPECIFICATIONS:

P-1 Water Closet – Flush Valve, Floor Mounted

American Standard model 2599.001 vitreous China, elongated rim, siphon action water closet. Provide 1½" top spud, solid plastic elongated seat with open front, extended back, and check hinge. Water closet flush valve shall be as follows:

- Manual flush valve shall be Sloan Royal 111-1.28.

P-1A Water Closet – Flush Valve, Floor Mounted, – ADA Height

American Standard model 3461.001 vitreous china, elongated rim, siphon action water closet. Provide 1½" top spud, solid plastic elongated seat with open front, extended back, and check hinge. 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 Sloan Royal 111-1.28.

P-2 Lavatory – Wall-hung

American Standard model 0355.012, 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 86T1153 with polished chrome-plated cast brass body, single inlet, 3-3/4" centerline spout, and vandal resistant push-button handles. Furnish with vandal resistant 0.5 GPM aerator and 4" cover plate. Furnish and install Wilkins model ZW3870 tempering mixing valve.

P-2A Lavatory – Wall-hung – ADA Compliant

American Standard model 0355.012, 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 86T1153 with polished chrome-plated cast brass body, single inlet, 3-3/4” centerline spout, and vandal resistant push-button handles. Furnish with vandal resistant 0.5 GPM aerator and 4” cover plate. Furnish and install Wilkins model ZW3870 tempering mixing valve.

P-3 Urinal – Wall-hung

American Standard model 6590.501 vitreous china, wall-hung, 1.0 GPF urinal with 3/4” top spud, integral strainer and floor anchored concealed wall carrier. Mounting height shall be per ADA. Urinal flush valve shall be as follows:

- Manual flush valve shall be Sloan Royal 186-0.5 HEU.

P-3A Urinal – Wall-hung – ADA Compliant

American Standard model 6590.501 vitreous china, wall-hung, 1.0 GPF urinal with 3/4” top spud, integral strainer and floor anchored concealed wall carrier. Mounting height shall be per ADA. Urinal flush valve shall be as follows:

- Manual flush valve shall be Sloan Royal 186-0.5 HEU.

P-5 Bi-Level Electric Water Cooler – Bottle Filler - ADA

Elkay Model #VRCTL8WSK electric water cooler with bottle filler; 7.8 GPH of 50°F water at 90°F room temperature and 80°F entering water; vandal resistant 14 gauge satin finish stainless steel basin and housing, 1/5 HP compressor; 115/1phase/60 HZ. Mounting height shall be per ADA guidelines for children under the age of 12. Provide with loose key manual shut-off at wall. Furnish and install with plastic P-trap. Where water coolers are not installed in an alcove, furnish, and install an Elkay model 98234C cane apron accessory. Reference floor plans for exact number of water coolers not installed in an alcove.

P-6 Mop Basin

Fiat model MSB2424, 24" x 24" 10" high molded stone mop service basin with 3" drain, Provide Chicago 814-317CP faucet, hose and hose bracket, mop hanger and vinyl bumper guard. Provide with stainless steel wall guards. Provide check valves on the hot and cold water supplies to the faucet.

P-7 Washing Machine Connection Box

Guy-Gray Model WB200, 2” drain outlet, 16 gauge steel with epoxy finish. Field paint exposed portions of box to match adjacent wall surfaces.

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.

P-9 SHOWER FITTING SET

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.

- Refer to Architectural plans for coordination of ceramic tile floor. Provide Zurn Z-415, with 9" diameter top drain.

P-9A SHOWER FITTING SET – ADA

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.

- Refer to Architectural plans for coordination of ceramic tile floor. Provide Zurn Z-415, with 9" diameter top drain.

P-10 THREE COMPARTMENT SINK

ELKAY – 14-3C16X20-R-18X – THREE COMPARTMENT SINK. Elkay Dependability Stainless Steel 72-1/2" x 25-13/16" x 43-3/4" 16 Gauge Three Compartment Sink w/ 18" Right Drainboard and Stainless-Steel Legs. Sink is manufactured from 16-gauge 300 series Stainless Steel with a #4 Finish, Center drains placement.

- 8" stainless steel wall mount mixing faucet, S-0231 - stainless steel 12" swing nozzle with stream regulator outlet, stainless steel compression cartridges with spring checks, stainless steel lever handles, and stainless steel 1/2" NPT female inlets. Certified to ASME A112.18.1/CSA B125.1, NSF 61-Section 9 and NSF 372. Meets ADA ANSI/ICC A117.1 requirements.

END OF SECTION 22 02 00

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 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 - 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 – HIGH EFFICIENCY WATER HEATERS:

2.1 ACCEPTABLE MANUFACTURERS: AO Smith, State and Lochinvar.

2.2 The water heater(s) shall be of the seamless glass lined steel tank construction in which the glass coating is applied to the water side surfaces of the tank after the tank has been assembled and welded. The heater shall be factory assembled and tested. The heater(s) shall be approved for 0" clearances to combustibles. The control shall be an integrated solid state temperature and ignition control device with integral diagnostics, LED fault display capability and a digital display of temperature settings. The tanks shall be foam insulated and equipped with a ASME rated temperature pressure relief valve. The water heater shall be UL listed and exceed the minimum efficiency requirements of ASHRAE/IES 1999.

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 22 03 00

SECTION 23 01 00 - 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 – PERMANENTLY LUBRICATED INLINE PUMPS:

2.1 Permanently Lubricated Inline Pumps shall be Series PL as manufactured by Bell & Gossett or equal by Taco, Armstrong, Patterson.

2.2 The pumps shall be of the horizontal permanently lubricated type, specifically designed for quiet operation. Suitable for 225 degrees F operation at 150 PSIG working pressure.

2.3 The pumps shall have a solid high-strength alloy steel shaft supported by XL11 permanently lubricated sealed precision bearings. Bearings are to be permanently oil lubricated. Pump shaft shall connect to a non-metallic noryl impeller.

2.4 Pump shall have integral stainless steel face plate and double sided stainless steel neck rings for increased life and seasonal start-up capabilities.

2.5 Pump volute shall be of cast bronze. The connection style on bronze pumps shall be flanged with isolation valves.

2.6 The motor shall be isolated from circulating fluid through use of a carbon/silicone seal attached on a stainless steel shaft sleeve.

2.7 Motors shall be of an Open Drip-Proof design and shall be non-overloading at any point on the pump curve. Motors shall be UL and CSA listed.

2.8 Pump shall be of a maintenance free design and be capable of operating in variable speed (varying voltage) applications.

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 23 01 00

SECTION 23 02 00 - HVAC 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 The Contractor shall provide in complete working order the 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 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.

1.4 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 Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for minimum required Schedule of Values breakdown.

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

1.7 Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer’s Checklists. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for additional requirements. 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. This shall include the following:

- Heat Pumps (SCHEDULED)
- HVAC Air Handlin Units (SCHEDULED)
- Split Systems (SCHEDULED)
- Exhaust Fans (SCHEDULED)
- Fans (SCHEDULE)

1.8 All HVAC equipment shall comply with the latest provisions of ASHRAE Standard 90.1 and all provisions of the International Energy Conservation Code.

1.9 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.

1.10 The contractor and vendor shall confirm connection sides for each piece of equipment specific to this project.

1.11 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.

1.12 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 - ELECTRIC MOTORS, ETC. for additional requirements. All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

1.13 Review the Specification Section - CONTROLS to determine controls, including variable frequency drives, to be furnished. Where manufacturer's temperature controls are specified, they shall be in full compliance with NFPA 90A including automatic smoke shut down provisions.

1.14 Review the Specification Section – TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS. 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.

PART 2 – GEOTHERMAL HEAT PUMPS:

2.1 ACCEPTABLE MANUFACTURERS: Trane, FHP, WaterFurnace and Climate Master.

2.2 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.

2.3 Any mechanical closet dimension modifications or access requirements due to the manufacturer specifics shall be the burden of the approved manufacturer.

2.4 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.

2.5 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.

2.6 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.

2.7 Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for special warranty requirements.

2.8 CASING AND CABINET: The cabinet shall be constructed of galvanized steel and factory painted with ½" fiberglass on interior, discharge duct collar and return collar. Lift-out removable access panels shall be provided for access to the compressor and blower assembly compartments.

2.9 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 will direct the condensate to the drain connection. When the unit is installed per the manufacturer's instructions, the drain pan shall be tested as follows: (1) Temporarily plug the drain pan, (2) fill the drain pan with 2" of water or the maximum allowed by the drain pan depth, whichever is smaller, (3) remove the temporary plug and verify the drain pan removes the water within 3 minutes.

2.10 COMPRESSOR: The compressor or compressors shall be high-efficiency, single- or 2-stage speed scroll type with internal vibration isolation (as scheduled on the drawings). Compressors motors shall be equipped with overload protection. Refer to the drawing schedules as multiple compressor types shall be utilized.

2.11 AIR-TO-REFRIGERANT HEAT EXCHANGER: The air-to-refrigerant heat exchanger shall be constructed of staggered copper tubes with die formed corrugated aluminum fins mechanically bonded to the tubes. The air-to-refrigerant heat exchanger shall have a working pressure rating of 400 PSIG. Multiple compressor equipment shall provide a single air-to-refrigerant heat exchanger for each compressor.

2.12 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.

2.13 REVERSING VALVE: The reversing valve shall be a pilot operated sliding piston type with replaceable encapsulated magnetic coil. The reversing valve shall be energized in the cooling cycle.

2.14 REFRIGERANT TUBING: Refrigerant tubing shall be constructed of copper. All low temperature refrigerant lines shall be insulated with an elastomeric insulation that has a 3/8" thick wall,

flame spread rating of less than 25 and smoke density rating of less than 50, as tested in accordance with ASTM-84. The elastomeric insulation shall have a UL 94V-5 rating.

2.15 REFRIGERANT METERING: The equipment shall be provided with a thermal expansion valve. This device shall allow operation of the equipment in the range of 25 to 110º F entering fluid temperatures and 40 to 95º F entering air temperatures. The equipment shall only operate with one variable (enter water temperature, entering air temperature, cfm, or gpm) at an extreme condition. All other variables must be within the nominal range of operation.

2.16 REFRIGERANT SYSTEM SERVICE ACCESS: The equipment shall be provided with factory supplied high and low pressure Schrader ports for easy refrigerant pressure or temperature testing.

2.17 BLOWER AND MOTOR ASSEMBLY: See Schedules for motor type. The motor shall have permanently lubricated and sealed bearings. All motors shall have internal thermal overload protection. The fan assembly shall be arranged for back, left, or right discharge. The discharge must also be capable of being changed in the field. 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 service access. Where available, provide one hand-held motor programming module to the Owner to utilize for startup and test and balance.

2.18 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: (1) 24 Vac, energy limiting class II transformer. (2) Blower motor controller shall be a 24 Vac relay. (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. (4) Electrically operated safety lockout relay. This device shall prevent operation and 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. (5) High pressure switch shall protect the compressor against operation at refrigerant system pressures in excess of 395 PSIG. (6) Low pressure switch shall prevent compressor operation underneath low charge or catastrophic loss of charge situations.

2.19 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 72” x 48” air filter system (Six 24 X 24 filters). See plans for sizes and quantities. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for Temporary Use of Equipment Requirements and filter quantities.

2.19.1 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. Access doors shall be provided with gaskets.

2.19.2 Filters shall be 30% 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 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.

2.20 HOSE KIT & PIPING PACKAGE: 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!

2.20.1 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.

2.20.2 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.

2.20.3 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.

2.21 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.

2.22 Provide eight (8) hours of onsite training for this system. All training shall occur after building completion. Systems shall function properly, and O&M staff shall be able to operate the system prior to turnover.

PART 3 – OUTSIDE AIR UNITS (INDOOR TYPE):

3.1 GENERAL

3.2 Provide factory built and factory tested air handling units as indicated, as manufactured by Daikin, Trane, JCI AAON, Innovent, Unison, or Addison 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.

3.3 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.

3.4 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.

3.5 UNIT CASING

3.5.1 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.

3.5.2 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.

3.5.3 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.

3.5.4 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.

3.5.5 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).

3.5.6 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.

3.5.7 Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.

3.5.8 Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft2*°F/BTU.

3.5.9 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.

3.5.10 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.

3.5.11 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.

3.5.12 Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

3.6 ACCESS DOORS:

3.6.1 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.

3.6.2 All doors downstream of the cooling coil shall be provided with a thermal break construction of door panel and door frame.

3.6.3 Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

3.6.4 Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

3.6.5 Handle hardware shall be designed to prevent unintended closure.

3.6.6 Access doors shall be hinged and removable without the use of specialized tools to allow.

3.6.7 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.

3.6.8 Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

3.6.9 All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.

3.6.10 Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

3.7 FAN SECTIONS:

3.7.1 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.

3.7.2 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.

3.7.3 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.

3.8 MOTORS AND DRIVES:

3.8.1 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.

3.8.2 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.

3.8.3 Fan Motors shall be heavy duty, open drip-proof operable. Motor efficiency shall meet or exceed NEMA Premium efficiencies.

3.8.4 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.

3.8.5 Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

3.8.6 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.

3.8.7 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.

3.9 COIL SECTIONS AND DRAIN PANS:

3.9.1 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.

3.9.2 Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

3.9.3 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.

3.9.4 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.

3.9.5 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.

3.9.6 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.

3.9.7 All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan.

3.9.8 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.

3.9.9 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.

3.9.10 All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.

3.9.11 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.

3.9.12 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.

3.9.13 Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

3.10 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.

3.11 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.

3.12 ENERGY RECOVERY SECTION: Manufacturers: Thyvent, Fresh Air Solutions, Semco, Novell-aire, XETEX. Energy Recovery Modules shall be installed in casing structure to match the OA unit construction throughout. A removable panel shall be provided to access the energy recovery cassette for service and inspection. Energy recovery wheel shall be mounted in a slide out cassette. A wiring box shall be provided for permanent connection of a power source. The Energy Recovery Cassette shall contain a 4 Angstrom total energy recovery wheel for sensible and latent energy recovery. A wheel drive motor having permanently sealed ball bearings shall be provided with plug-in connection to a receptacle mounted within the cabinet. Provide the ERW with a factory installed starter/disconnect. The total enthalpy wheel shall be supplied by the module manufacturer and be constructed of a light weight polymer material with a permanently bonded silica gel desiccant coating. Eight energy transfer sections shall be removable from the energy recovery wheel without the use of special tools. The units shall not require a condensation pan. Energy transfer ratings must be ARI Certified to Standard 1060 and bear the ARI certification symbol for ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program based on ARI 1060.

3.13 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.

3.14 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.

3.15 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 4 – **OA VARIABLE AIR VOLUME TERMINAL BOXES:**

4.1 ACCEPTABLE MANUFACTURERS: ETI, Trane, Titus, Carrier, JCI/York, Price.

4.2 Terminals shall be certified by ARI and bear the ARI 880 seal.

4.3 Terminals shall be constructed of not less than 22 gauge galvanized steel, able to withstand a 125 hour salt spray test per ASTM B-117. The terminal casing shall be mechanically assembled (spot-welded casings are not acceptable). Terminal shall include control enclosure and hanger brackets. The terminal shall be provided with a removable bottom access panel.

4.4 Casing shall be insulated with ½" thick fiberglass insulation, rated for a maximum air velocity of 5000 f.p.m. Maximum thermal conductivity shall be 0.24 (BTU · in) / (hr · ft² · °F). Insulation must meet all requirements of ASTM C1071 (including C665), UL 181 for erosion, and carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and NFPA 90A. Raw insulation edges on the discharge of the unit must be covered with metal liner to eliminate flaking of insulation during field duct connections. Simple "buttering" of raw edges with an approved sealant is not acceptable. Insulation shall be covered with scrim backed foil facing. All insulation edges shall be covered with foil or metal nosing. Insulation shall meet ASTM C1136 for mold, mildew, and humidity resistance. All appurtenances including control assemblies and control enclosures, shall not extend beyond the top and bottom of the unit casing. At an inlet velocity of 2000 f.p.m., the static pressure drop across the basic terminal shall not exceed .08" W.G. for all unit sizes.

4.5 The primary air valve shall consist of a minimum 22 gauge cylindrical body that includes embossment rings for rigidity. The damper blade shall be connected to a solid shaft by means of an integral molded sleeve which does not require screw or bolt fasteners. The shaft shall be manufactured of a low thermal conducting composite material, and include a molded damper position indicator visible from the exterior of the unit. The damper shall pivot in self lubricating bearings. The damper acturator shall be mounted on the exterior of the terminal for ease of service. The valve assembly shall include internal mechanical stops for both full open and closed positions. The damper blade seal shall be secured without use of adhesives. The air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" W.G. inlet pressure.

4.6 The differential pressure airflow sensor shall traverse the duct along two perpendicular diameters. Cylindrically shaped inlets shall utilize the equal cross sectional area or log-linear traverse method. Single axis sensor shall not be acceptable. A minimum of 12 total pressure sensing points shall be utilized. The total pressure inputs shall be averaged using a pressure chamber located at the center of the sensor. A sensor that delivers the differential pressure signal from one end of the sensor is not acceptable. The sensor shall output an amplified differential pressure signal that is at least 2.5 times the equivalent velocity pressure signal obtained from a conventional pitot tube. The sensor shall develop a differential pressure of 0.03" W.G. at an air velocity of <450 FPM. Brass balancing taps and airflow calibration charts shall be provided for field airflow measurements. Terminal shall have access door for inspection and cleaning.

PART 5 - GEOTHERMAL HEAT PUMP CHILLERS:

5.1 ACCEPTABLE MANUFACTURERS: ARCTI-CHILL, CLIMACOOL, WATERFURNACE, 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 – SPLIT SYSTEMS:

6.1 ACCEPTABLE MANUFACTURERS: Lennox, Trane, Carrier or York.

6.2 Refer to the drawing schedules.

6.3 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.

6.4 AIR FILTER SYSTEM: The Contractor shall completely assemble an Air Filter System for each unit and install ready to use. Provide one 24” X 48” air filter system; two 24 X 24 filters. See plans for sizes and quantities. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for Temporary Use of Equipment Requirements and filter quantities.

6.4.1 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.

6.4.2 Disposable Filter Media: Filter Media shall be 2” thick fiberglass Air Filter Media Pads with an initial maximum pressure drop of 0.20”wg @ 500 fpm.

6.4.3 Retainer Frame and Backing Wire Frame: Provide for each filter to support the disposable filter media. Products shall be factory assembled. Retainer Frame shall be 10 gauge minimum and shall be provided with additional angled support prongs to prevent sagging filter pad. Frame shall be 18 gauge minimum and shall have flush mitered corners. Frames shall also be provided with 16 gauge galvanized 1x1 welded wire support backing.

6.5 EQUIPMENT START-UP: Prior to utilization of equipment, start-up service shall be performed by factory authorized representative. Refer to Specification Section GENERAL PROVISIONS – MECHANICAL for additional requirements.

6.6 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 7 – CENTRIFUGAL ROOF EXHAUST FAN - BELT DRIVEN:

7.1 ACCEPTABLE MANUFACTURERS: Twin City, Greenheck, Cook.

7.2 PERFORMANCE: Fans shall be tested in accordance with AMCA 211 and AMCA 311 test codes for air moving devices and shall be guaranteed by the manufacturer to deliver rated published performance levels. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air. Models shall be UL 705 listed.

7.3 CONSTRUCTION: Fan housings shall be constructed of spun aluminum and shall offer finish durability and aesthetic appearance. Fan spinnings shall have a rolled bead edge for rigidity. All units have a deep venturi inlet to prevent snow and rain entry into the building. The curb cap shall include prepunched mounting holes for ease of installation. A conduit chase constructed of electrical metallic tubing shall be provided to the motor compartment. The curb base shall have continuously welded corners for maximum leak protection. Lifting lugs shall be provided inside the motor compartment for ease of handling and installation. Fans shall bear a permanently attached nameplate displaying model and serial number of the unit for future identification. Housing shall be upblast or downblast as scheduled.

7.4 MOTOR AND DRIVE ASSEMBLY: Motor and drive assembly shall be mounted on vibration isolators to eliminate vibration and noise transmission into the ductwork. Motors and drives shall be mounted out of the exhaust airstream.

7.5 WHEEL: Fan wheels shall be of the centrifugal backward inclined type, constructed of aluminum and containing a matching inlet venturi for optimum unit performance. Wheels shall be statically and dynamically balanced.

7.6 SHAFT: Fan shafts shall be precision-ground and polished. Shafts shall have a first critical speed of at least 125% of the fan's maximum operating speed.

7.7 BEARINGS: Bearings shall be of the one-piece, pillow block type with relubricable zerk fittings. Bearings shall be designed for air handling service with a minimum L-10 life in excess of 100,000 hours; L-60 500,000 hours at the maximum cataloged operating speed. Bearing mounting plate shall have self- aligning tabs for exact locating and alignment of bearings.

7.8 DRIVE: Drive assembly shall be constructed of heavy-gauge galvanized steel. Drives shall be sized for a minimum of 150% of driven horsepower. Machined, cast iron motor sheaves shall be adjustable for final system balance.

7.9 MOTOR: Motors shall be heavy-duty ball bearing type, closely matched to the fan load. All

single-phase motors shall contain thermal overload protection. All motors shall be UL and/or CSA recognized. Motor adjustment shall allow precise belt tensioning for optimum belt life and one-person adjustment and servicing.

7.10 DISCONNECT SWITCH: Where scheduled, a NEMA 1 disconnect switch shall be supplied with wiring leading from the motor to the junction box (ODP and TEFC motors).

7.11 ACCESSORIES: Backdraft damper, 16" roof curb, curb hinge with retaining chain, and aluminum bird screen. Refer to the drawings for additional requirements.

7.12 Provide with four (4) sets of belts for the Owner's use upon Substantial Completion.

END OF SECTION 23 02 00

SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS

PART 1 – GENERAL

1.1 RELATED WORK

A. Division 22 - Plumbing
B. Division 26 - Electrical

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, general contractor, 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 general contractor, the owner and design team on the status, integration, and performance of HVAC 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 general contractor, 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.

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

J. 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

DDC Control System

HVAC Pumps
Heat Pumps
Air Handling Unit
Outside Air Handling Unit
Exhaust Fans
Fans
Variable Speed Drives
Water Heaters
Domestic water pumps

3.3 HVAC 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)
General contractor (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 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.
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 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.
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 HVAC 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 respective sequence of operations. 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 HVAC and related equipment.

   a. AHU's will be tested in designed operating modes. Proper operation will be verified at minimum OA, maximum OA, automatic control, and other modes, if necessary, to achieve BOD conformance.

   b. Hydronic system will be tested in designed operating modes. Proper operation will be verified at minimum loads, maximum loads, waterside economizing mode, Manual control, automatic control, and other modes.
   c. Hot water system will be tested.
   d. EF's will be tested for conformance to BoD.
   e. Hydronic pumps will be tested under relevant operating conditions.
   f. DDC control systems will be tested as necessary.
   g. HVAC systems will be tested to assure that the building as an integrated system operates properly.

h. 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.

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 oversee 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 HVAC related problems are being addressed and corrected in a timely and efficient manner.
4. 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. General contractor (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 HVAC commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical 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. Mechanical Contractor (MC)

1. Each contractor in this division shall include in their quote the cost of participating in the commissioning process.
2. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
3. Assure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.
4. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.
5. Attend commissioning meetings scheduled by the CA.
6. Assist the CA in system verification and performance testing.
7. 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.
8. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of HVAC equipment.
9. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
10. Notify the CA a minimum of two weeks in advance of scheduled system start-up.
11. Update drawings to as-built condition and review with the CA throughout the construction process.
12. Schedule vendor and subcontractor provided training sessions as required by project specifications.
13. 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.

    a. HVAC equipment including fans, air handling units, dehumidification units, ductwork, dampers, terminal devices, etc.

b. Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.
c. That BAS is functioning in accordance with design intent.

14. Participate in the Functional Performance Tests.
15. Participate in the off-season mode testing.
16. Participate in O&M Training as required by project specifications.
17. 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.

C. Test and Balance Contractor (TABC)

1. Include cost for commissioning requirements (participation) in the contract price.
2. Attend commissioning meetings scheduled by the CA.
3. Submit the TAB procedures and preliminary TAB report to the CA for review at least two weeks prior to beginning TAB work.
4. Notify the CA a minimum of two weeks in advance of scheduled TAB work.
5. Provide partial, preliminary TAB Reports by phase, by building section, by system, or as required by the CA.
6. Assist the CA in system verification and performance testing.
7. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
8. 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.
9. Participate in the Functional Performance Tests as required to achieve design intent.
10. Provide sound and vibration where required to assist in diagnosis of areas exhibiting unacceptable levels of noise or vibration.
11. Participate in the off-season mode testing as required to achieve design intent.
12. Participate in O&M Training as required by project specifications.

D. Temperature Control Contractor (TCC)

1. Include cost for commissioning requirements in the contract price.
2. Review control sequence and component selection for conformance with design intent.

a. Attend a submittal review meeting with the CA and Engineer to ensure clear understanding of scope of work and expectations.
b. Verify that specified safeties and interlocks have been selected.
c. Verify proper selection of control valves and actuators based on design parameters.
d. Verify proper selection of control dampers and actuators based on design parameters.
e. Verify that sensor selection conforms to design intent.

3. Attend commissioning meetings scheduled by the CA.
4. Provide the following submittals to the CA:

a. Hardware and software submittals.

b. Control panel construction shop drawings.
c. Narrative description of control sequences for each HVAC system and subsystem.
d. Schematics showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access.
e. 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.
f. 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.
g. Hardware operation and maintenance manuals.
h. Application software and project applications code manuals.
i. Panel and equipment insert documents.
j. Assist CA with remote monitoring capabilities. Supply any software and/or hardware needed.

5. Verify that specified interfaces provided by others are compatible with BAS hardware and software.
6. Coordinate installation and programming of BAS with construction and commissioning schedules.
7. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
8. Provide control system technician to assist during equipment startup.
9. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
10. Participate in the Functional Performance Tests as required by the project specifications.
11. Provide a control system technician to assist during verification and performance testing.
12. Provide system modifications to achieve system operation as defined by the design intent.
13. 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.
14. 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.
15. Participate in the Functional Performance Tests as required to achieve design intent.
16. Participate in the off-season mode testing as required to achieve design intent.
17. Participate in O&M Training as required by project specifications. Include training on hardware operations and programming

END OF SECTION 23 08 00

SECTION 23 11 00 - REGISTERS, GRILLES, DIFFUSERS AND 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, Nailor Industries, 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.

END OF SECTION 23 11 00

SECTION 23 12 00 - 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 constructed and installed per the latest edition of the International Mechanical Code.

1.4 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.

1.5 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.

1.6 For healthcare projects, provide a SMACNA duct cleanliness level “C” per the latest SMACNA standards.

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. Utilize Aluminum in MRI Scan Rooms.

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., including longitudinal and transverse joints, seams and connections 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. Duct supports shall not exceed 12 ft intervals. 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 two (2) 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 ARCHITECTURAL ACCESS DOORS IN CEILINGS OR WALLS: Provide Kees D Panel, Cesco, Milcor or equal. Panels shall be 24”x24” in size and constructed with 16 gauge galvannealed steel for door and frame. Provide with primer finish to accept specified finish. Door shall include three (3) screwdriver operated cam latches and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors. For fire rated units, provide manufacturer’s standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to insure a complete project.

2.23 VOLUME DAMPERS (RECTANGULAR): Ruskin MD35 or Air Balance, Pottorff, rectangular volume dampers. Frames shall be 16 gauge galvanized steel. Blades shall be opposed blade 16 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 2" 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 VOLUME DAMPERS (ROUND): Ruskin MDRS25 or Air Balance, Pottorff round volume dampers. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20 gauge steel and 6" long. Damper blades shall be 20 gauge crimped galvanized steel. Axle shall be 3/8"x6” square plated steel. Bearing shall be 3/8” nylon. Provide with Ventfabrics 2" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

2.25 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 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.

PART 3 – EXPOSED DUCTWORK:

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 1-1/2" 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 35 feet. Deduct 5 feet from the allowable length for every 4” 90 degree elbow and 4” 2.5 feet for every 45 degree fitting. These lengths may vary per local codes and dryer manufacturer’s recommendations. Install per 2012 IMC Section 504 Clothes Dryer Exhaust. 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 23 12 00

SECTION 25 01 00 - 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-greaseable, 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 where required to control equipment indicated on 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 25 01 00

OA: OUTSIDE AIR/EXHAUST AIR SYSTEMS POINT LIST											
	BINARY			**ANALOG**			**FUNCTION**				
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	START/ STOP	LOW LIMIT	RESET	DAY/ NIGHT	SUMMER /WINTER
Supply Fan	X	X	X				X				
Exhaust Fan	X	X	X				X				
Energy Recovery Wheel (E.R.W.)	X	X	X				X				
Outside Air Damper	X	X									
Exhaust Air Damper	X	X									
EA Damper				X							
EA damper Diff. Pressure				X							
OA Duct Static Pressure				X	X	X					
Outside Air Temp. Upstream of E.R.W.				X							
Outside Air Temp. Downstream of E.R.W.				X	X	X					
Exhaust Air Temp. Upstream of E.R.W.				X							
Exhaust Air Temp. Downstream of E.R.W.				X		X					
Unit Discharge Air Temp.				X							
Face and By-pass Damper				X							
Coil L.A.T.				X	X	X					
CO_2 OA Intake		X	X	X							
CO_2 EA Outlet		X	X	X							
Supply Airflow (Total				X	X	X					

From Terminal Boxes)											
END OF OUTSIDE AIR/EXHAUST AIR SYSTEMS POINT LIST											

VARIABLE AIR BOXES (VAV) BOXES POINT LIST											
	BINARY			**ANALOG**			**FUNCTION**				
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	START/STOP	LOW LIMIT	RESET	DAY/ NIGHT	SUMMER /WINTER
Room Thermostat				X	X	X					
Primary Air CFM				X							
Damper Actuator Position				X							
END OF VARIABLE AIR (VAV) BOXES POINT LIST											

AHU-1: AIR HANDLING SYSTEM SYSTEMS POINT LIST											
	BINARY			ANALOG			FUNCTION				
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	START/ STOP	LOW LIMIT	RESET	DAY/ NIGHT	SUMMER /WINTER
Supply Fan	X	X	X				X				
Exhaust Fan	X	X	X				X				
Energy Recovery Wheel (E.R.W.)	X	X	X				X				
Outside Air Damper	X	X									
Exhaust Air Damper	X	X									
OA Duct Static Pressure				X							
Outside Air Temp. Upstream of E.R.W.				X							
Outside Air Temp. Downstream of E.R.W.				X	X	X					
Exhaust Air Temp. Upstream of E.R.W.				X							
Exhaust Air Temp. Downstream of E.R.W.				X	X	X					
Unit Discharge Air Temp.				X							
Face and By-pass Damper				X		X					
Coil L.A.T.				X							
CO_2 OA Intake				X							
CO_2 EA Outlet				X	X	X					
Supply Airflow		X	X	X							
END OF POINT LIST											

HEAT PUMP POINT LIST											
	BINARY			**ANALOG**			**FUNCTION**				
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	START/ STOP	LOW LIMIT	RESET	DAY/ NIGHT	SUMMER /WINTER
Supply Fan	X		X				X		X		
Two-way Valve	X	X	X				X				
Zone Temperatures				X							
Supply Air Temp				X	X	X					
Smoke Detectors (Where required)		X									
Room CO_2		X	X	X	X	X					
Outside Air CO_2		X	X	X	X	X					
Outside Air CFM**				X	X	X					
END OF TERMINAL HEAT PUMP UNITS POINT LIST											

**OA supplied from zone terminal box.

HEAT PUMP CHILLER POINT LIST							
	BINARY			**ANALOG**			**POINT**
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	DETAILS
HPC-1	X	X	X				On/Off/Auto
HPC Three-way Valve				X			% Open
HPC CWS/HWS temperature				X			Degrees
HPC Comp #1	X	X	X				On/Off
HPC Comp #2	X	X	X				On/Off
HPC Heating Mode Status	X	X	X				On/Off
HPC Cooling Mode Status	X	X	X				On/Off
P-2A/B	X	X					On/Off
P-2A/B VFD		X		X			Hz
END OF POINT LIST							

GEOTHERMAL PUMP LOOP POINT LIST							
	BINARY			**ANALOG**			**POINT**
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	DETAILS
Pump P-1A/B/C		X	X	X			On/Off
Pump VFD's		X	X	X			Hz
System GPM (in loop main)				X			GPM
Supply Temp.				X			Degrees
Return Temp.				X			Degrees
Heat Pump Loop BTUH				X			BTUH
Differential Pressure Sensor(s)				X			PSI
END OF POINT LIST							

MISCELLANEOUS FAN POINT LIST											
	BINARY			ANALOG			FUNCTION				
	STATUS	ALARM	MAINT	POINT	HIGH ALARM	LOW ALARM	START/ STOP	LOW LIMIT	RESET	DAY/ NIGHT	SUMMER /WINTER
Exhaust Fans	X	X	X								
Exhaust Fan temp sensor	X	X	X								
Exhaust Fan damper	X	X									
HPC-1	X	X	X				X				
HPC Two-way Valve	X	X	X				X				
HPC CWS/HWS temperature	X	X	X				X				
HPC Comp #1											
HPC Comp #2	X	X	X								X
HPC Heating Mode Status	X	X	X								X
HPC Cooling Mode Status	X	X	X								X
Well Field Supply Temp.	X	X	X								X
Well Field Return Temp.				X	X	X					
P-1A/B/C VFD				X	X	X					
P-2A/B VFD	X	X	X				X				
P-1A/B/C DIFF PRESS	X	X	X				X				
HVLF Fan speed	X	X	X				X				
HVLF Fan status				X	X	X					
Loop Filter LF-1				X	X>8 PSI						
AC-X Unit Room Temp				X							
Domestic WH	X										
Domestic WH Pump	X										
Heat Pump Loop	X										

Make-up Water Control Valve											
END OF MISCELLANEOUS FAN POINT LIST											

END OF SECTION 25 04 00

SECTION 25 04 00 - CONTROL - DIRECT DIGITAL (WEB BASED)

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 MANUFACTURERS: Trane, JCI, and Schneider Electric by Comfort Systems USA.** 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 ensure 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 The existing BAS and control system in Old Mill Elementary School is a Trane Tracer SC+ and shall be integrated into Bullitt County School's enterprise Trane Ensemble Server. It is the responsibility of the contractor to install and update the server with the existing buildings. The scope of work for this project involves removal of some existing HVAC systems in Old Mill, and it is imperative that these system be replaced/removed without disruption to existing BAS operations. The following is the scope of work for this project:

1. The central mechanical/Boiler room in Old Mill is to be be completely demolished (boilers to be relocated to a new mechanical room and existing VAVs re-piped). The Trane UC600 panel with display, Pump 3A and 3B VFD's, differential pressure transmitter, and temperature sensors in this mechanical room shall be removed from service and re-used in the new mechanical room. The BACnet MS/TP cabling to this controller shall be spliced together in a junction box and kept continuous.
2. All Rooftop and ERV's are to remain, except for RTU-6, which is to be relocated and converted to a VAV RTU and revised sequence of operation for RTU-GYM. The BACnet MS/TP cabling to RTU-6 and RTU-GYM shall be spliced together in a junction box and kept continuous.
3. VAV terminals with Trane BACnet controllers that are being removed shall be turned over to the school district. The BACnet MS/TP cabling to these VAV terminals shall be spliced together in a junction box and kept continuous.
4. All new HVAC system controls in the Fine Arts Center shall be BACnet MS/TP or BACnet over Zygbee Wireless and shall be integrated into the existing Trane Tracer SC+ Building Controller in Old Mill and made accessible from the owner's existing enterprise BAS system.

5. Any existing Trane Controls removed from service and not reused shall be turned over to the school district.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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 24 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 one 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. Training sessions shall be recorded with video for owner’s future use.

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 DIVISION 26 - ELECTRICAL SPECIFICATIONS. Rough-in and stub-up installation shall be within the scope of the TCC. Dedicated j-hooks to be provided by the EC parallel to the cable tray pathway for temperature controls cabling. All intermediate j-hook supports for temperature controls cabling to this pathway to be by TCC.

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. **Where category cabling is provided, the jacket color shall be purple for all temperature controls.**

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 Controller 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 affected 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 ensure 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 serpentine 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 (geothermal 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 control's 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 interfaces 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 - VARIABLE FREQUENCY DRIVES (VFDs):

17.1 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.

17.2 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).

17.3 VFDs shall be consist of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

17.4 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.

17.5 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.

17.6 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.

17.7 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.

17.8 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.

17.9 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.

17.10 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.

17.11 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.

17.12 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.

17.13 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.

17.14 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 permissive 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.

17.15 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.

17.16 All VFDs shall be provided and installed in strict accordance with the manufacturer's recommendations.

17.17 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.

17.18 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 18 – GRAPHICS SCREENS AND TRENDS:

18.1 All graphics screens shall be submitted for review by Engineer. Provide the following animated, color graphics screens minimally:

18.2 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 and room temperatures. 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.

18.3 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.

18.4 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.

18.5 All new graphics shall match the existing system graphics, unless noted otherwise.

18.6 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.

18.7 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.

18.8 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.

18.9 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.

18.10 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.

18.11 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

18.12 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)
- Geothermal wellfield main supply and return temperatures
- Geothermal wellfield 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 19 - TIME SCHEDULES (ALL TIMES SHALL BE USER ADJUSTABLE):

19.1 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.

19.2 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:

19.3 CLASSROOM AREAS: Monday through Friday Occupied mode at 8:15 AM, Unoccupied mode at 4:30 PM. Unoccupied for Saturday and Sunday.

19.4 MEDIA CENTER: Monday through Friday Occupied mode at 8:15 AM, Unoccupied mode at 4:30 PM. Unoccupied for Saturday and Sunday.

19.5 AUDITORIUM: Monday through Friday Occupied mode at 8:15 AM, Unoccupied mode at 4:30 PM. Unoccupied fo0r Saturday and Sunday.

19.6 KITCHEN AREA: Monday through Friday Occupied mode at 6:00 AM, Unoccupied mode at 2:00 PM. Unoccupied for Saturday and Sunday.

19.7 GYMNASIUM: Monday through Friday Occupied mode at 8:15 AM, Unoccupied mode at 3:30 PM. Unoccupied for Saturday and Sunday.

19.8 Administration areas: Monday through Friday Occupied mode at 8:00 AM, Unoccupied mode at 5:00 PM. Unoccupied for Saturday and Sunday.

19.9 Cafeteria: Monday through Friday: Occupied mode at 7:15 AM, Unoccupied at 12:30 PM. Unoccupied for Saturday and Sunday.

19.10 Building outside air handling unit shall operate Monday thru Friday, 8:50 AM to 3:40 PM.

19.11 Each piece of equipment shall have its own adjustable time schedule.

19.12 All schedules shall be coordinated and confirmed with the Owner prior to final implementation.

PART 20 – ELECTRICAL METERING

20.1 The electrical switchgear's meter shall be monitored through the DDC system via BACnet MS/TP Connection. Coordinate and provide appropriate interface for meter provided by electrical contractor. TCC shall provide active Modbus to BACnet converters from switchgear interface as required for data acquisition. TCC shall provide and install control wiring to the power meter. The following points shall be monitored:

Main Meter

	Hardware Points				**Software Points**					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Current Phase A					×			×		×
Current Phase B					×			×		×
Current Phase C					×			×		×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Current Neutral					×			×		×
Voltage A-B					×			×		×
Voltage B-C					×			×		×
Voltage C-A					×			×		×
Voltage A-N					×			×	x	×
Voltage B-N					×			×	x	×
Voltage C-N					×			×	x	×
Real Power - kW					×			×		×
Apparent Power - kVA					×			×		×
Power Factor					×			×		×
Frequency					×			×		×
Real Energy - kWh					×			×		×
Totals	**0**	**0**	**0**	**0**	**15**	**0**	**0**	**15**	**3**	**15**

20.1.1 In the event of a phase loss all HVAC and plumbing equipment shall be turned off. Upon phase correction, equipment shall be allowed to turn back on. Stage equipment in blocks to minimize power surges. Coordinate phasing with owner.

20.2 The electrical switchgear's Solar PV meter shall be monitored through the DDC system via BACnet MS/TP Connection. Coordinate and provide appropriate interface for meter provided by electrical contractor. TCC shall provide active Modbus to BACnet converters from switchgear interface as required for data acquisition. TCC shall provide and install control wiring to the power meter. The following points shall be monitored:

PART 21 - LIGHTING CONTROL SYSTEM:

21.1 Lighting controls for loads/zones indicated (exterior lighting) shall be controlled through native BAS controller modules (Trane Tracer UC400 or equal) and lighting contactors with master HOA override switches per zone. BAS contractor shall provide astronomical time clock and photo cell control. Temperature controls contractor shall provide and install tie in to electrical contractor furnished and wired exterior lighting control panel and zones as required for control by circuits on electrical drawings.

21.2 Provide a second level of password entry to the system that allows the administration staff to schedule lighting only. No access to HVAC or other BAS controls shall be allowed through this access.

21.3 Provide a full graphic page of the building and site lighting zones, indicating the different areas that can be scheduled. A graphic "light bulb" located in the specific area shall indicate whether lights are on or off. The following areas shall be independently scheduled:

Exterior Lighting (Site)
Exterior Lighting (Building Mounted)

21.4 Exterior lighting shall be controlled through photocell tied into BAS system. BAS contractor shall provide and install for a complete system. System and programming shall give the user the ability to control each zone separately via the photocell input for normal, auto on operation when called for by the photocell as well as scheduled on or off events from the BAS system that would override the photocell.

21.5 Lighting Points Lists:

CIRCUIT (ZONE)	**BINARY**	**CONTROL PANEL**		**Function**			
	STATUS	UC4000 CTRL	POWER	PHOTOCELL START/STOP	SCHDL SWEEP ON	SCHDLS WEEP OFF	MANUAL OVERRIDE TIME
Exterior Building Mounted Lighting Zones (refer to electrical plans)	X	X	X	X	X	X	X
Exterior Pole Mounted Lighting Zones (refer to electrical plans)	X	X	X	X	X	X	X

PART 22 – DEDICATED OUTSIDE AIR SYSTEM (DOAS-X):

22.1 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.

22.2 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

22.3 In the unoccupied mode:

- The supply fan and exhaust shall be off.
- The energy recovery wheel shall be off.
- The outside air damper and exhaust air damper shall be fully closed,
- The face damper shall be full coil face.

22.4 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-2) has reached temperature setpoint.

- 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/VFD and exhaust fan/VFD 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.

22.5 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

22.6 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.

22.7 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-2 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.

22.8 If any of the room humidity sensors measure humidity above 60% RH (adj.), then the unit shall operate in Cooling Mode regardless of Outside Air Temperature. Once all of the room humidity sensors read below 55% RH (adj.), the system shall return to normal operation.

22.9 The supply air fan shall be controlled through a variable frequency drive (VFD). One pressure sensor is located in the supply air duct, (refer to plans for location) shall control the operation of the supply fan VFD. A minimum pressure of 1.25" WC (adj.) shall be maintained. Fan supply static pressure optimization shall be utilized by polling of associated VAV box damper positions and resetting of pressure setpoint as allowed. A current sensor shall prove fan status.

22.10 The exhaust air fan shall be controlled through a unit-mounted variable frequency drive (VFD). The exhaust fan speed shall track the supply fan speed. Set this offset at 90% (adj.). A current sensor shall prove fan status.

22.11 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.

22.12 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 23 – VARIABLE FREQUENCY DRIVES (VFD'S):

23.1 VFD shall include a communications port for LonWorks or BacNet compatible protocol. Coordinate with TCC. Start-stop, status for chiller and control signal shall be hardwired. Provide input points for two preset speeds. Provide two programmable Form C relays rated 2 amps to activate At Speed for pump applications.

23.2 Current VFD status and operating conditions shall be monitored through its communications interface port. The following points shall be monitored and trended through the VFD interface as follows:

	Hardware Points				Software Points					
Point Name	AI	AO	BI	BO	AV	BV	Sched	Trend	Alarm	Show On Graphic
Motor Speed RPM					×			×		×
Motor Frequency Hertz					×			×		×
Motor Current Amps					×			×		×
Motor Runtime					×					×
VFD Status						×		×		×
In Fault Condition						×		×	×	×
In Bypass						×		×	×	×
Totals	0	0	0	0	4	3	0	6	2	7

Total Hardware (0) Total Software (15)

PART 24 – GEOTHERMAL HEAT PUMP WATER LOOP CONTROL:

24.1 The Geothermal Water Loop System consists of the following major equipment:
- Geothermal Loop Pumps P-1A/B/C

24.2 The Geothermal Water Loop System shall operate under the control of a local, stand-alone, microprocessor based DDC controller. The Geothermal 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 Geothermal Water Loop Controller

shall be placed into the occupied mode until communication is restored.

24.2.1 Pump P-1A, P-1B and P-1C are selected for 50% of the fully connected On-Peak geothermal water flow rate. All pumps are variable flow with 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. The lead pump shall be selected, alternated and started by the Geothermal Water Loop Controller. If flow is not proved, then additional pumps shall start to maintain differential pressure setpoint. If the lag pump shall fail to start and an alarm shall be generated. If no pumps can be proved, then Geothermal Water Loop System shall not operate and an alarm shall be generated.

24.2.2 Provide one differential pressure sensor 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:

24.2.2.1 Pump VFD controller for enable/disable control on each pump.
24.2.2.2 One differential pressure sensor.
24.2.2.3 Temperature sensors
24.2.2.4 Flow meter
24.2.2.5 No flow alarms

24.2.3 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 the differential pressure sensor is 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 decrease. If additional pumps are required to maintain the system pressures, the controller will activate and deactivate pumps as required to maintain minimum water flow rate.

24.2.4 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.

24.2.5 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.

24.2.6 The geothermal loop water flow rate shall be determined from an Onicon F-3200 series in-line electromagnetic flow meter located in the Mechanical Room with 0.2% accuracy from 12-750 gpm. This meter shall also be used in conjunction with the well field supply and return temperature sensors to provide system BTU Calculation.

24.2.7 As geothermal loop water flow rate falls below 100 GPM, as determined by the electromagnetic flow meter, VHP-150-8A/8B and VHP-096-24 Heat Pump 2-way valves shall open to maintain minimum building pump flow. As building flow increases above 150 GPM, the minimum flow Heat Pump 2-way valves shall be released for their open position to maintain minimum building pump flow from 100-150 GPM.

PART 25 - GEOTHERMAL HEAT PUMP UNITS

25.1 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.

25.2 Each unit shall be placed into the occupied/unoccupied mode based upon the building's Global Time Schedule.

25.3 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.

25.4 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.

25.5 During the occupied mode, the heat pump shall cycle as required to satisfy space thermostat/sensor setpoint. The unit shall automatically changeover from heating to cooling. When space temperature is satisfied the fan and compressor shall be off.

25.6 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.

25.7 During occupied mode, for heat pumps equipped with hot gas reheat, if the space humidity is greater than 65% RH the heat pump shall be in full cooling mode and the hot-gas reheat coil shall modulate capacity to reduce space humidity below 55% RH.

25.8 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.).

25.9 Some of the heat pumps operate with averaging sensors, the space temperature setpoint shall be adjustable only thru the BAS. The average space temperature of the sensors will determine the space temperature used to determine operation of the unit.

PART 29 –EXHAUST FANS:

29.1 The annex building exhaust fans shall operate continuously.

29.2 Fan status shall be monitored using a current sensor.

PART 30 – MFD & IFD ROOMS:

30.1 Provide a temperature in room to monitor space temperature.

PART 31 – AC-X & CU-X:

31.1 Provide manufacturers required control wiring for split system equipment for stand-alone operation and space temperature control.

PART 32 – DOMESTIC WATER HEATER

32.1 The DDC System shall enable/disable the domestic hot water building circulating pump.

32.2 The DDC System shall monitor domestic hot water supply temperature at each heater.

PART 33 – GEOTHERMAL LOOP ENERGY MONITORING:

33.1 Install temperature sensors on the supply and return of the geothermal loop to the building to be trended at the BAS.

33.2 Install flow meters in the returns of the geothermal loop from the building to be trended at the BAS. Coordinate pipe diameters required before and after the flow meter with manufacturer.

33.3 Provide and install a packaged BTUH meter system for the geothermal loop serving the building. The BAS shall measure and record gpm, “peak” gpm with time and date, BTUs, instantaneous BTUH, “peak” BTUH with time and date & OA temperature.

PART 34 – FLOW METER ALARM AND EMERGENCY SHUTDOWN FOR MAKE-UP WATER:

34.1 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 35 – GEOTHERMAL WATER TO WATER HEAT PUMP CHILLER SYSTEM:

35.1 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.

35.2 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-2 shall be off.

35.3 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-2 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.

35.4 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.

35.5 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.

35.6 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.

35.7 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 36 – OUTSIDE AIR SYSTEM VARIABLE VOLUME TERMINAL UNITS:

36.1 Outside air to occupied spaces shall be introduced directly into spaces or ducted into heat pump return air ductwork.

36.2 Each air terminal labeled "VAV" shall be allowed to modulate from 0% to 100% of cfm value indicated on the plans based on occupancy within the room. Occupancy sensors are installed by others; however, wiring shall be installed by the TCC from the sensor to a DDC controller provided by the TCC.

36.3 When building is in occupied mode and the space is occupied based on room occupancy sensor, the VAV shall provide Max airflow as set on Ventilation schedule.

36.4 When the building is in occupied mode and the space is unoccupied based on room occupancy sensor, the VAV shall reduce airflow for unoccupied mode. Where one unit controls more than one room, or one space has more than one sensor, all spaces occupancy sensors must sense no occupancy.

36.5 During unoccupied mode, the VAV shall close 100% .

PART 37 –HIGH VOLUME LOW SPEED (HVLS) FANS:

37.1 Fan shall be enabled/disabled via BAS time of day schedule. BAS shall monitor HVLS status through factory "BAFCON with SmartSense" touch-screen wall controller. Controls contractor shall coordinate with fan manufacturer to ensure proper communication between BAFCON controller and central BAS, for required point monitoring, enable/disable and alarm functionality.

37.2 Cooling Mode: When the Practice field AHU's are in occupied AND cooling modes, the HVLS fan shall be enabled via a 0-10-volt signal. The fan shall operate to achieve 100 FPM air velocity 48" AFF. Exact fan speed shall be determined after construction by balancing and temperature contractors from field measurements.

37.3 Heating Mode: When Practice field AHU's are in occupied AND heating modes, the HVLS fan shall be enabled via a 0-10-volt signal. The fan shall operate to achieve 50 FPM air velocity 48" AFF. Exact fan speed shall be determined after construction by balancing and temperature contractors from field measurements

37.4 The BAS shall receive a set of contacts from the fire alarm system to shutdown fans when provided an alarm from the Fire Control Panel. Wiring from the fire alarm contacts to the BAS panel is the responsibility of the TCC.

PART 41 – AIR HANDLING UNITS:

42.1 "Automatic/Unoccupied" mode shall be accomplished through a switch at the MCP and the global programmed time schedule. "Summer/Winter" mode shall be accomplished through the

"Summer/Winter" switch located at the MCP. Outdoor air damper to be fully closed 100% of the time.

42.2 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

42.3 In the unoccupied mode:

- The supply fan and exhaust shall be off.
- The energy recovery wheel shall be off.
- The outside air damper and exhaust air damper shall be fully closed,
- The face damper shall be full coil face.

42.4 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
55 deg F (adj.)	Cooling Mode
Varies	Economizer Mode
95 deg F (adj.)	Heating Mode

42.5 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 integral heat pump system shall remain off.

42.6 OCCUPIED MODE: Supply fan shall run continuously.

42.7 WINTER MODE: If cooling is required, the mixed air shall be controlled with return air dampers at no cooler than 55 degrees as determined by the space sensor and mixed air sensor. If heating is required, the outside air damper shall be at its minimum position, and the unit shall modulate as required to maintain space temperature.

42.8 A manual reset freeze thermostat shall be provided to shut down the air handing unit if temperature of the air entering the coil reaches 35 degrees. Provide pilot light or LED indication of freezestat shutdown at the MCP.

42.9 SUMMER MODE: Space sensor will modulate the 3-way control valve to maintain space temperature. Outdoor air damper and return air dampers shall be positioned to maintain minimum outdoor air flow.

42.10 Programmed set-points:

Heating mode adjustable 69 thru 75 degrees F.

Cooling mode adjustable 72 thru 77 degrees F.

42.11 UNOCCUPIED MODE (WINTER): AHU to stop operation. Motorized dampers for supply and return air to unit to close. The space sensor shall cycle the unit fan to maintain a lowered night setback temperature of no lower than 55 degrees. Utilize a 4 degrees differential (on at 55 off at 59). The outdoor air dampers shall open on a different occupied schedule than the AHU.

42.12 UNOCCUPIED SUMMER MODE: AHU to stop operation. Motorized dampers for supply and return air to unit to close. All systems de-activated. The outdoor air dampers shall open on a different occupied schedule than the AHU.

42.13 A smoke detector shall be located in the supply and return air stream. If smoke is detected, the supply fan shall de-activate and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and unit shall return to normal operation. Smoke detectors to be tied to central fire alarm syste

SECTION 26 05 00 - 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 Bidder/Proposer 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 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 (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 they will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.5 All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the Contractor to the Architect, then to the Engineer.

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 Plans and Specifications 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 In general, once the facility is in operation, and to the extent possible, all work shall be accomplished without interruption of the 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.

1.8 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, 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.

1.9 DEFINITIONS:

1.9.1 Prime Contractor - The Contractor (General Contractor) who has been engaged by the Owner in a contractual relationship to accomplish the work.

1.9.2 Electrical Contractor - The Contractor whether bidding or working independently or under the supervision of the General Contractor, 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.

1.9.3 Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.

1.9.4 Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

1.9.5 Architect - The Architect of Record for the project, if any.

1.9.6 Furnish - Deliver to the site in good condition.

1.9.7 Provide - Furnish and install in complete working order.

1.9.8 Install - Install equipment in complete working order furnished by others.

1.9.9 Contract Documents - All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to: Plans, Specifications, Addenda, Instructions to Bidders, (both General and Sub-Contractors), Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Construction Manager's Assignments, Architect's Supplemental Instructions, Periodical Payment Requests, etc.

1.10 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.

PART 2 – INTENT

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. In addition, 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. Special attention shall be provided towards the phasing plan for this requirement.

2.2 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.

2.3 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.

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 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 (10) 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. The Electrical Contractor and their Sub Contractors shall review all drawings in detail as they may relate to the 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.

3.3 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 their own measurements in the field and shall be responsible for correct fitting. The Contractor shall coordinate their 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 such adjustments are 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 they will be relieved of the work which is specified in the contract documents 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, contact the engineer for clarification.

3.9 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 drawings 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.

3.10 This project has a separate bid package for the data/voice scope. This Contractor and his Sub-contractor are responsible for coordinating closely with the other bid package.

PART 4 - EXAMINATION OF SITE AND CONDITIONS

4.1 Each Contractor shall inform the General Contractor of all of the conditions under which the work is to be performed, site work, 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 the work.

4.2 Each Contractor shall fully acquaint the General Contractor 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 the 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.

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 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 additional devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer and owner, are equivalent to those specified are acceptable, may be added by Addenda. The contractor must include in the bid, one of the listed manufacturers. Requested substitutions shall be submitted to the Engineer and owner a minimum of ten (10) days prior to Bid for consideration. 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.

5.3 Wherever any equipment and material is specified <u>exclusively</u> only such items shall be used unless substitution is accepted in writing by the Owner and Engineer.

5.4 Each Contractor shall furnish with their bid proposal a list of specified equipment and materials which the Bidder/Proposer proposes to provide as stated in the form of proposal. Where several makes are mentioned in the Specifications and the Contractor fails to state which the Bidder/Proposer proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

5.5 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 6 - SUPERVISION OF WORK

6.1 Each Contractor and Sub-Contractor 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 them in matters related to the project.

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, low voltage inspections, state, and local inspections, etc. in connection with the work. As necessary, they 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 the work and deliver same to the Engineer and Owner before request for acceptance and final payment for the work. **Allowances are incorporated into the project to pay for site utility fees. All other fees are by the contractor.**

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 to the Owner, 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 Kentucky Department of Housing, Building & Construction, 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 the 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 (10) working days prior to bid date, otherwise the Contractor shall make the required changes at their 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 BREAKDOWNS

8.1 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 for approval prior to the first application for payment. 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.

8.2 The breakdown shall be minimally as follows. 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.:

- Electrical Shop Drawings
- Electrical Record Drawings & Acceptance
- Electrical O&M Manuals & Acceptance
- Electrical Owner Training & Acceptance
- Electrical Startup, Testing, Verification, Documentation, Acceptance, Owner Training, etc. (shall equal ½% of Electrical Contract Value)
- Electrical Identification Materials & Labor
- Coordination Drawings (Electrical)
- Fire Alarm System Startup, Testing, & Verification (shall equal 5% of Cost)
- Electrical Distribution Equipment Startup, Testing, & Verification (shall equal 2.5% of Cost)
- Lighting and Lighting Controls Startup, Testing, & Verification (shall equal 5% of Cost)
- Intercom (shall equal 5% of Cost)
- Video Systems (shall equal 5% of Cost)

PART 9 - GUARANTEES AND WARRANTIES

9.1 The Contractor shall guarantee all equipment, apparatus, materials, and workmanship entering into this 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 warranty start date of completion of the work shall be the date of the Substantial Completion certificate.

9.2 Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of the substantial completion of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of substantial completion of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of substantial completion. 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 the Owner's negligence.

PART 10 - INSPECTION, APPROVALS AND TESTS

10.1 Before requesting a final review of the installation from the Architect and/or Engineer, each Contractor shall thoroughly inspect their 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.

10.2 The Contractor shall provide as a part of this contract electrical inspection by the Bullitt County Electrical Inspector, licensed to provide such services. All costs incidental to the provision of electrical inspections shall be borne by the Contractor.

10.3 The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when they anticipate commencing work. Failure of the Inspection Agency to inspect the work at the appropriate time 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.

10.4 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 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.

10.5 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.

10.6 Before final acceptance, the Contractor shall furnish the original and three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates i.e. fire alarm) 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.

10.7 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 11 - CHANGES IN ELECTRICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 12 - CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 13 - SURVEYS, MEASUREMENTS AND GRADES

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

13.2 The Contractor shall base all measurements, both horizontal and vertical from established benchmarks. 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.

13.3 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, the Contractor shall notify the Engineer thru normal channels of job communication and shall not proceed with the work until the Contractor has received instructions from the Engineer.

13.4 All underground primary and secondary electrical lines will be surveyed by a licensed Kentucky Land Surveyor hired by the Owner. Lines shall be dimensioned including depth. Do not backfill prior to survey. Contractor is responsible for coordinating the times the Owner's surveyor will be needed on site. Provide at least 24 hours notice.

PART 14 - TEMPORARY USE OF EQUIPMENT

14.1 The existing permanent electrical equipment, may not be used for temporary services, unless an agreement between the Contractors involved, the Owner, and the Engineer is had. 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.

14.2 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 15 - TEMPORARY SERVICES

15.1 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.

15.2 All temporary services shall be removed by Contractor prior to acceptance of work.

PART 16 - RECORD DRAWINGS

16.1 Note: Also, refer to additional record drawing requirements within the general conditions and other sections of these specifications.

16.2 The Contractor shall insure that any deviations from the design are being recorded daily or 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 (10) 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.

PART 17 - MATERIALS AND WORKMANSHIP

17.1 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 they propose 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).

17.2 All conduit and/or conductors shall be concealed underground, within chase, in walls, 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 or footings.

17.3 All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer-approved testing agency, where such a standard has been established.

17.4 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.

17.5 All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

17.6 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.

PART 18 - QUALIFICATIONS OF WORKERS

18.1 All electrical contractors bidding this project must have been a licensed company for a minimum of three years to qualify to bid this project. Individual employee experience does not supersede this requirement.

18.2 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.

18.3 All electrical 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 relieved of their responsibilities in those areas. 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 satisfactory to them. Requests for removal of a worker shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

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

18.5 Special electrical systems, such as Fire Detection and Alarm Systems, Intercom or Sound Reinforcement Systems, Telecommunications or Data Systems, Lightning Protection Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by companies and workers normally engaged or employed in these respective trades.

PART 19 - CONDUCT OF WORKERS

19.1 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 permanent dismissal of that worker from the project. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

PART 20 - COOPERATION AND COORDINATION BETWEEN TRADES

20.1 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 the work, including Architectural, Mechanical and Structural Drawings, to the end that complete coordination between trades will be affected.

20.2 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.

20.3 This project will accompany other bid-packages on these schools that this contractor is responsible for coordinating with for all his work.

PART 21 - PROTECTION OF EQUIPMENT

21.1 The Contractor shall be entirely responsible for all material and equipment furnished in connection with the work and special care shall be taken to properly protect all parts thereof from damage and weather 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 their expense.

PART 22 - CONCRETE WORK

22.1 The Contractor shall be responsible for the provision of all concrete work required for the installation of any of their systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of the responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 4000 PSI minimum compression strength at 28 days curing slump 4" +/- 1", water to cement ratio of 0.50, and air content 4.5% +/- 1.0% 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 (7) days after placement. Refer to Section pertaining to Concrete.

22.2 All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than 18" in width shall be reinforced with minimum #5 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. Chamfer all vertical edges ¾” and tool horizontal edges with ¾” radius.

22.3 Special Note: All pads and concrete lighting standard bases shall be crowned slightly in center to avoid water ponding beneath equipment.

22.4 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 18" beyond base or overall dimensions of the equipment to allow walking and servicing space at locations requiring service access.

22.5 Exterior concrete pads shall be 4" minimum above grade and 6" thick slab on a compacted 4" dense grade rock base unless otherwise noted or required by utility company. Vertical surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius/chamfer on exposed edges, trowelled or rubbed smooth. Horizontal surface shall be broom finished. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage. Turn down edges 18” below grade. Refer to 22.2 for reinforcing.

PART 23 - RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

23.1 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 Contractor’s 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 24 - MAINTENANCE OF EXISTING UTILITIES AND LINES

24.1 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 Article 1. - General, this section.

24.2 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 shall ascertain and mark all utilities or lines that would be endangered by the excavation. Contractor to employ independent utility locator to mark all utilities. Refer to Division 2 Site Conditions. Contractor shall bear costs of repairing damaged utilities.

24.3 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.

24.4 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.

24.5 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.

24.6 Machine excavation shall not be permitted within ten (10) 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.

24.7 Protect all new or existing lines from damage by traffic, etc. during construction.

24.8 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 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.

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 their 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 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 - FINAL CONNECTIONS TO EQUIPMENT

27.1 The Contractor shall finally connect to electrical services, any terminal equipment, appliances, kitchen equipment, etc., provided under this and 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 Engineers prior to installation.

PART 28 - WELDING

28.1 The Contractor shall be responsible for quality of welding done by their 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 29 - ACCESSIBILITY

29.1 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 their work. Cooperate with the General Contractor and all other Contractors whose work is in the same space and advise each Contractor of their requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

29.2 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.

29.3 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.

29.3.1 Access Doors; in Ceilings or Walls:

29.3.2 In mechanical, electrical, or service spaces: 14 gauge aluminum brushed satin finish, 1" border.

29.3.3 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.

29.3.4 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 30 - ELECTRICAL CONNECTIONS

30.1 The Contractor shall furnish and install all power wiring complete from power source to disconnect 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 Mechanical Specifications, shop drawings and equipment schedules for additional information.

30.2 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.

PART 31 - MOTORS

31.1 Each motor shall be provided by the equipment supplier or manufacturer with conduit terminal box, adequate starting and internal thermal overload protective equipment as specified or required. The capacity 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. Also, see Mechanical Specifications for further requirements and scheduled sizes.

PART 32 - CUTTING AND PATCHING

32.1 Unless otherwise indicated or specified, each Contractor shall provide their own 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.

32.2 No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed.

PART 33 - SLEEVES AND PLATES

33.1 Each Contractor shall provide and locate all sleeves and inserts required for their 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 their 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.

33.2 Galvanized steel sleeves shall be provided for all electrical conduit passing thru concrete floor slabs and concrete, masonry, tile, and gypsum wall construction.

33.3 Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be sealed with an approved product, mechanical waterstop or other approved material and made completely water tight by a method approved by the Engineer and/or Architect.

33.4 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:

33.4.1 Terminate sleeves flush with walls, partitions, and ceiling.

33.4.2 In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.

33.4.3 In all areas where pipes are exposed, extend sleeves ½ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

33.5 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.

33.6 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 34 - WEATHERPROOFING

34.1 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.

34.2 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 35 - OPERATING INSTRUCTIONS

35.1 Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment until systems are operating without error, or as otherwise specified. During this period, instruct the Owner's 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 with copy to the Owner and Architect that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

35.2 Each Contractor shall furnish three complete bound sets of O & M manuals 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 form, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Each section shall be properly tabbed, indexed and labeled, with a table of contents.

35.3 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 36 - SCAFFOLDING, RIGGING AND HOISTING

36.1 Each Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

PART 37 - CLEANING

37.1 Each Contractor shall, at all times, keep the area of their work presentable to the public and clean of rubbish caused by their operations; and at the completion of the work, shall remove all rubbish, all 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 and/or Architect 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 their rubbish or debris.

37.2 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 38 - PAINTING

38.1 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 and exposed on exterior shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

PART 39 - INDEMNIFICATION

39.1 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 40 - HAZARDOUS MATERIALS

40.1 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 the work, ensure that their workers are aware of this potential and what they are to do in the event of suspicion. 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 hazardous.

40.2 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.

40.3 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.

40.4 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.

40.5 No asbestos containing material shall be installed on the project.

END OF SECTION 26 05 00

SECTION 26 05 01 - SCOPE OF THE ELECTRICAL WORK

PART 1 - GENERAL

1.1 Each Electrical Contractor's attention is directed to Section 260500 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

PART 2 - SCOPE OF THE ELECTRICAL WORK

2.1 The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, 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:

2.1.1 All conduits, cable trays, conductors, outlet boxes, fittings, etc.

2.1.2 All switchgear, panels, disconnect switches, fuses, transformers, contactors, etc.

2.1.3 All wiring devices and device plates.

2.1.4 All light fixtures and lamps.

2.1.5 Electrical connection to all electrically operated equipment furnished and/or installed by others, including kitchen equipment, gymnasium equipment, mechanical equipment, door hardware, etc.

2.1.6 Program/paging system, including equipment, wiring, terminal plates, service cables, etc., for the classroom system as described herein, as well as plates, wiring, terminations for the owner-installed digital telephone system.

2.1.7 Inspection of electrical system by an approved Electrical Inspector, in compliance with local and state requirements.

2.1.8 Grounding, per N.E.C. and the specified requirements.

2.1.9 All necessary coordination with electric utility company, telephone company, cable T.V. Co., etc., to ensure that work, connections, etc., that they are to provide is accomplished.

2.1.10 All necessary fees and cost for permits, inspections, work by utility companies, etc. Provision of electrical power, telephone, and cable television services into the building from the utility termination points outside.

2.1.11 Local sound reinforcement systems rough-in.

2.1.12 Data Voice Rough-in.

2.1.13 CCTV Security System Rough-in

2.1.14 Intercom System.

2.1.15 Fire Alarm System

2.1.16 Emergency standby systems.

2.1.17 Cabling, testing and devices for data/voice network.

2.1.18 Classroom Audio/Video Systems.

2.1.19 Intrusion Detection System.

2.1.20 Special Note:

2.1.20.1 A specialty sub-contractor (Electronic Systems Contractor) shall be utilized for paging-intercom system, security intrusion detection system and fire alarm system. 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. The Contractor is not permitted to install or work on these systems. Data/voice local sound work are part of a separate bid package.

END OF SECTION 26 05 01

SECTION 26 05 02 - SHOP DRAWINGS, LITERATURE, MANUALS, PART LISTS, AND SPECIAL TOOLS

PART 1 - SHOP DRAWINGS

1.1 Each Contractor shall submit to the Architect and/or Engineer, within thirty (30) days after the date of the Contract, shop drawings and/or manufacturer's descriptive literature on all equipment required for the fulfillment of the 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.

1.2 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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:

Power Equipment

- Switchgear and panelboards.
- Circuit breakers or fusible switches, per each type.
- Power and lighting contactors.
- Disconnect switches.
- Fuses, per each type required.
- Magnetic starters, if not submitted with unit equipment by supplier.
- Control components (relays, timers, selector switches, pilots, etc.)
- Building service grounding electrode components.
- TGB/TGMB telephone/data network grounding components

Raceways

- Cable tray and each type of cable tray fitting.
- Wireways and each type of wireway fitting.
- Surface raceways and fittings.
- J-hook assembly.
- Surface raceway (wiremold)

Devices

- Each type of wiring device and their coverplates.
- Floor boxes, each by type, with required accessories.
- Data/voice/video wallplates, each by type.
- Any special items not listed above.

Lighting

- 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.
- Lighting standards or poles.
- Photocells, time clocks or other lighting accessories.
- Occupancy/Vacancy control systems.

Systems

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. Refer to the specific system's specification for additional submittal requirements where required.

- Fire alarm system.
- Security system (Intrusion).

- Building paging/intercom audio system.
- Clock system.

Miscellaneous

- Control panel assemblies.
- Non-standard junction/pullboxes.
- Equipment Clearance Markings – Refer to 26 05 53 – Identifications

PART 2 - SPECIAL WRENCHES, TOOLS, AND KEYS

2.1 Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least six (6) (U.N.O.) of any such special wrench, keys, etc. shall be turned over to the Owner prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

PART 3 - FIRE ALARM SHOP DRAWINGS

3.1 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 submittal to the Kentucky Department of Housing, Buildings and Construction or other governing authority for their review and approval. System submitted by the contractor shall be delegated design, turn-key and abiding by all codes.

PART 4 - MAINTENANCE AND OPERATION MANUALS

4.1 Upon substantial completion of the project, the Electrical Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. These documents shall at least include:

4.1.1 Detailed operating instructions.

4.1.2 Detailed maintenance instructions including preventive maintenance schedules.

4.1.3 Addresses and phone numbers indicating where parts may be purchased.

4.1.4 Floor plan drawing that shows the location of all fire alarm devices and each device descriptive address. Provide two floor plans in addition to quantities specified above to be provided to the Owner.

4.1.5 Digital video documentation on DVD and USB thumb drive of owner training on specified systems throughout these documents.

- Interior Lighting Controls
- Storm Shelter Lighting and Ventilation Battery Inverter Systems
  - Provide 4 hours of video documented training. System specified on the drawings.

- Generator Connection Cabinet
- Emergency Standby Generator System
- Intercom System
- Intrusion Detection System
- Fire Alarm System

4.1.6 Maintenance and Operation manuals shall also be provided digitally on CD/DISC and USB Flash Drive.

END OF SECTION 26 05 02

SECTION 26 05 03 - CUTTING, PATCHING AND REPAIRING

PART 1 - GENERAL

1.1 Each Electrical Contractor shall be responsible for all openings, sleeves, trenches, etc. that they may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. Improperly located openings shall be reworked at the expense of the responsible Contractor.

1.2 Each Electrical 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 conduit, buss duct, 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 their work, or they shall pay other trades for doing this work when so directed by the Architect. Any damage caused to the buildings by the workers of the responsible Contractor must be corrected or rectified by them at their own expense.

1.3 Each Electrical Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out. Provide escutcheons around piping in finished spaces or within casework.

1.4 Each Electrical Contractor shall notify other trades in due time where they will require openings of chases in new concrete or masonry. Set all concrete inserts and sleeves for the work. Failing to do this, they shall cut openings for the work and patch same as required at their own expense.

1.5 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.

1.6 Cast iron 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 with an approved product between pipe and sleeve for waterproofing.

1.7 In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

1.8 Sleeves passing through exterior wall (none are permitted thru roof) 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. All roof penetrations shall be made inside mechanical equipment curbs.

1.9 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.

1.10 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.

1.11 Each Electrical 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.

1.12 All work improperly done or not done at all as required by the Electrical trades in this section will be performed by the General Contractor at the direction of the Contractor whose work is affected. The cost of this work shall be paid for by the Contractor responsible.

END OF SECTION 26 05 03

SECTION 26 05 04 - DEMOLITION

PART 1 – GENERAL:

1.1 Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division A Specification Sections to apply to work specified in this section.

PART 2 – DESCRIPTION OF WORK:

2.1 This section covers all demolition, restoration and salvage required to perform the electrical work indicated 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 their 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.

PART 3 – ELECTRICAL:

3.1 Where electrical fixtures, equipment or other materials are removed and/or relocated, all abandoned conduit and conductors shall be removed in exposed areas.

3.2 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.

3.3 All ballasts being removed, containing PCBs or not, shall be properly disposed of by the Contractor.

PART 4 – REPAIR:

4.1 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.

PART 5 – SALVAGE:

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

5.2 The following items being removed as shown on the drawings shall be salvaged from the existing building and offered over to the Owner for first right of refusal:

5.2.1 LED Outdoor Lighting Pole Lighting Standards

5.2.2 Emergency battery LED troffers (qty 15)
5.2.3 Normal LED troffers (qty 15)
5.2.4 LED Troffer lenses (remove from 15 fixtures)
5.2.5 Branch Panelboards (qty 3 and all 20a breakers)
5.2.6 All (3) phase breakers

5.3 If Owner does not wish to have, Contractor shall dispose of.

PART 6 - LAMP DISPOSAL

6.1 Contractor shall be responsible for the careful removal of all lamps and fluorescent tubes without breakage from existing lighting fixtures.

6.2 Lamps removed from fluorescent, metal halide, mercury vapor, and sodium fixtures that do not have green end caps 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/legally disposed of.

6.3 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. The Contractor shall properly/legally dispose of.

6.4 All lamps and tubes with green end caps as well as incandescent lamps shall be disposed of by the Contractor in their dumpster. Green end cap lamps and broken lamps shall not be placed in any box designated for recycled lamps.

END OF SECTION 26 05 04

SECTION 26 05 05 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

PART 1 - COORDINATION

1.1 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 their 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.

1.2 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.

1.3 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.

1.4 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.

1.5 In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s) and 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.

PART 2 - INTERFACING

2.1 Each Electrical Trade, Specialty Controls Trade, Mechanical Trade, and the General Trades, etc., shall insure that coordination is affected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

2.1.1 Connection of Telecommunications (voice, data) lines to Owner's new equipment, including cross connections to tie-in to phone switch, and punch down to new network switches.

2.1.2 Connection of Power lines to new utility service.

2.1.3 Connection of all controls to equipment.

2.1.4 Electrical power connections to electrically operated (or controlled) equipment.

2.1.5 Electrical provisions for all equipment provided by other trades or suppliers within this contract.

PART 3 - CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

3.1 Each Contractor shall make all electrical 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.

3.2 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 their 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.

3.3 Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

3.4 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.

3.5 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.

3.6 The Contractor shall be responsible for coordinating with the General and all other trades and bid package, as necessary, to determine any and all final connections that are to be made to equipment furnished by others.

END OF SECTION 26 05 05

SECTION 26 05 19 - CONDUCTORS, IDENTIFICATION, SPLICING DEVICES & CONNECTORS

PART 1 - GENERAL

1.1 This section of the Specifications covers all of the electrical power, lighting, and control power (line voltage) conductors, but does not include signal conductors which will be provided by the Contractor, as specified elsewhere.

1.2 **No more than 40% conduit fill is permitted for any conduit system, including video, intercom, data, power, or other signal circuits.**

1.3 No more than seven conductors shall be installed in conduit except for switch legs and travelers in multi-point switching arrangements.

1.4 Each branch circuit shall be provided with a dedicated neutral conductor and shall be considered current carrying.

1.5 If more than 3 phases are installed in a single raceway, an additional equipment grounding conductor shall be installed, and appropriate derating factors applied.

PART 2 - MATERIALS

2.1 CONDUCTORS

2.1.1 All conductors shall be 98% conductive annealed copper unless otherwise noted, UL listed and labeled.

2.1.2 Lighting and receptacle branch circuits shall be not less than No. 12 copper wire or of the sizes shown on the drawings with Type THW or THWN insulation. All feeder circuits shall be Type THW or THWN of the size as shown on the Contract Drawings.

2.1.3 Conductors No. l0 and smaller sizes of wire shall be solid. Conductors No. 8 and larger sizes shall be stranded. A 200 lb test nylon line shall be installed in all empty conduit and stubs for future use, as indicated. Conductors for fire alarm wiring and control wiring shall be stranded, and in compliance with NEC 760, routed in ¾" red conduits.

2.1.4 All wire on the project shall be new, in good condition, and shall be delivered in standard coils or reels.

2.1.5 The color of the wire shall be selected to conform with Section 210-5 of the latest edition of the National Electrical Code. Refer also to 16J-4, Color Coding.

2.1.6 All equipment grounding conductors #6 AWG or less shall have green color insulation. Those larger than #6 shall be green taped 4" at each termination, pull and junction boxes.

2.1.7 Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible.

2.1.8 Conductors 150V to ground and less and greater than 100' in length shall be increased at least one size to compensate for voltage drop. For higher voltages up to 600 volts, provide similar increase in wire size. All circuits shall be 3% maximum voltage drop.

2.1.9 Conductors for main ground from neutral bus, equipment grounding bus, building steel, grounding grid and main cold water pipe connection shall be bare copper, unless mechanical protector is required by code or AHS.

2.1.10 All conductors shall be identified by color code and by means of labels placed on conductors in junction boxes and at terminal points with Brady, Gardner, T & B or approved equivalent labels indicating source, circuit No. or terminal No.

2.1.11 No aluminum conductors shall be used.

2.1.12 Feeders serving life safety systems and panelboards and fire pumps are required to have fire protection per NEC 695, NEC 700 and as follows:

1. Encased in a minimum of 2” of concrete. Refer to 260533 for raceway requirements and riser for locations utilized.
2. Provide above ground in horizontal or vertical runs utilizing a 2-hour fire rated and FHIT listed system/assembly listed with UL2196.
    a. Assemblies include:
        i. RHW-2 conductors in Phenolic Conduit Systems meeting the above requirements.
3. Draka RHW-2 conductors Lifeline in XW Breathsaver conduit system installed per manufacturers requirements and FHIT system.
    a. 2 HR MC cable with Flame resistant low smoke zero halogen (colored as required) jacket with corrugated copper armor, silicon Ceramifiable rubber inner jacket and LSZH Ceramifiable silicon conductor insulation with annealed copper conductors.
4. Vitalink MC transit system installed per manufacturers requirements and FHIT system.

2.1.13 MC CABLE

2.1.13.1 MC Cable with copper conductors and copper ground shall be allowed for #10 awg and smaller wiring inside all rooms and spaces where concealed by accessible ceiling or concealed in wall. MC cable shall transition to EMT raceway at a junction box at the room or end of circuit and home run from there to the branch panel board. MC cable home runs will not be allowed. MC cable is not allowed where exposed, in mechanical or electrical rooms, and in wet/damp locations. Dedicated neutral conductors are still required.

2.2 SPLICING DEVICES & CONNECTORS

2.2.1 Splicing devices for use on No. 14 to No. 10 AWG conductors shall be pressure type such as T & B "STA-KON", Burndy, Reliable or approved equivalent. Wire nuts shall be spring pressure type, insulation 600V, 105 degree C insulation, up to #8 size. Greater than #6 Cu shall be a compression type connection, 600V insulation, cold shrink tubing, taped, for full insulation value.

2.2.2 Terminating pressure 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 No. 10 AWG or smaller conductors.

2.2.3 The use of split-bolt clamps is not permitted.

2.2.4 Large connectors (lugs) shall be compression, hydraulically set. Lugs furnished on equipment shall be per manufacturer's recommendations.

2.2.5 Fire pump connections shall be fine strand compression connections.

PART 3 - INSTALLATION

3.1 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 after all insulation and insulating bushings are in place.

3.2 The radius of bending of conductors shall be not less than eighteen (l8) times the outside diameter of the conductor insulation.

3.3 Conductors installed within environmental air plenums shall be per N.E.C., teflon-type insulation or approved equivalent.

3.4 Low voltage 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 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. Wiring shall be installed parallel/perpendicular to the building structure.

3.5 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 as required to ensure compliance.

3.6 All junction boxes shall be labeled with panel fed from and circuit number in black permanent marker.

PART 4 - COLOR CODING DISTRIBUTION VOLTAGE CONDUCTORS, 600 VOLT OR LESS

4.1 Conductors to be color coded as follows:

4.1.1 277/480 Volt Conductors
Phase A - Brown

Phase B - Orange
Phase C - Yellow
Neutral - Gray, or white with brown tracer

4.1.2 120/208 Volt Conductors
Phase A - Black
Phase B - Blue
Phase C - Red
Neutral - White

4.1.3 0-10V low-voltage dimming
0-10V (-) : 18AWG stranded copper Gray class 2 as required per NEC
0-10V (+) : 18AWG stranded copper Violet class 2 as required per NEC
Install separately from class 1 wiring.
Runs over 200’ require 16AWG Conductors.
Where installed with class 1, wires shall be installed as class 1 conductors.

4.1.4 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.

4.1.5 Conductors and low voltage cabling insulation jackets shall not be painted.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING

PART 1 - GENERAL

1.1 All metallic conduit, raceways, cable trays, 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.

1.2 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.

1.3 Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by bonding jumper connection to common ground.

1.4 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 or meter 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 shall be made electrically continuous. Refer to drawings.

PART 2 - MATERIALS

2.1 Ground wires and cables shall be of the AWG sizes shown on the Contract Drawings or shall be sized in accord with the prevailing codes. All ground wires and cables shall be copper.

2.2 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. Irreversible compression fitting shall be used where indicated or code required.

2.3 Other bonding clamps or fittings in above ground locations shall be as manufactured by O.A. Co., T & B, Burndy, or approved equivalent.

2.4 Ground electrode pipe systems shall be solid copper construction. Ground rods shall be 3/4" minimum diameter, 10’-0 long, copper. All ground electrode systems shall be installed in accord with manufacturer's recommendations, U.L. listings, National Electrical and National Electrical Safety Codes.

2.5 Concrete encased grounding electrodes shall consist of a minimum 20’-0” length of electrically continuous rebar bonded to the grounding electrode conductor.

PART 3 - INSTALLATION

3.1 All grounding conductors shall be protected from mechanical injury and shall be rigidly supported. Where ground conductors are run through 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.

3.2 Equipment grounding conductors shall be run to lighting fixtures, devices, receptacles, electric heaters, furnace, and other equipment. Equipment grounding conductors not exceeding No. 6 AWG in size shall be green colored Type "THWN". Those larger than No. 6 shall be green (same color everywhere) taped 4" at each termination, pull and junction boxes.

3.3 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.

3.4 Resistance to the grounding at the service entrance equipment shall be in accordance with the N.E.C. and shall not exceed five ohms.

3.5 All circuits shall have a separate grounding conductor, except as otherwise noted.

3.6 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.

3.7 Contractor shall obtain direction from the Engineer. 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 bus bar 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 continuous grounding electrode conductor routed back to the main facility ground bus. Coordinate with the Engineer.

3.8 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 #500MCM 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.

3.9 Grounding connections shall **never** be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans. Bonding is required.

3.10 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. Piping shall be bonded.

3.11 At all metallic boxes, bond the equipment grounding conductor to the box.

PART 4 - GROUND TESTING PROCEDURE

4.1 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.

4.2 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).

4.3 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.

4.3.1 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.

4.3.2 Drive a copperweld reference electrode probe (point C2) into earth between 300 and 500 feet away from C1 and connect to measurement instrument.

4.3.3 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.

4.3.4 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.

4.3.5 At completion of testing, remove reference electrode C2 and all temporary wiring and connections.

4.3.6 If actual measurements of grounding electrode indicate a resistance greater than five 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.

4.3.7 Provide to the Engineer the ground test results along with all other close-out documents.

END OF SECTION 26 05 26

SECTION 26 05 31 - CABINETS, OUTLET BOXES & PULL BOXES

PART 1 - GENERAL

1.1 This section of the specifications covers all electrical cabinets, outlet boxes and pull boxes.

1.2 Continuous runs of conduit shall have pull boxes at least each eighty-five (85) feet of run, or as near as possible to that limit.

PART 2 - MATERIALS & INSTALLATION

2.1 Cabinets, Outlet & Pull Boxes:

2.1.1 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. 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 panels, shall be provided with code gauge fronts with 1/4 turn fasteners. Fronts for panels shall be as specified under "Panelboards".

2.1.2 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. Position boxes so cover will be accessible upon completion of the project.

2.1.3 Special size concealed and surface outlet boxes for clocks, speakers, alarms, TV, etc., shall be provided by the manufacturer of the equipment.

2.1.4 Unless otherwise noted on the drawings or in the specifications, outlet boxes shall be installed at the following heights to center of box:

Wall Switches	3'-10"
Convenience Outlets	1'-6"
Telephones/Data	1'-6" or as noted on details
Panels	80" to top
Weatherproof Outlets	2'-2"
Disconnects	5'-0" max. to centerline
Fire Alarm Man. Stations	3'-10"
Fire Alarm Notification	7'-6" AFF or 6" below ceiling, whichever is lower
Digital Wall Clocks	8’-2” AFF or as noted on the plans

2.1.5 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 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 A-E before this change is made.

2.1.6 Do not install any receptacles above or within 12" of a sink.

2.2 Cabinets, 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, Pyle-National, Killark, or approved as equivalent.

2.2.1 NEMA 1 or 1A cabinets, outlet boxes or pull or junction boxes shall be as manufactured by Appleton, Steel City, T & B, or approved equivalent. They shall be sized per N.E.C., Article 370.

2.2.2 Outlet boxes for switches, receptacles, telephone, etc., concealed in walls shall be galvanized steel, 4" X 4" X 2-1/8" with plaster cover for one (1) or two (2) devices, as required to be flush with face of finished wall. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or other masonry, 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 ensure that the outlet boxes are installed straight and snugly in the walls. Receptacles shall be set vertically in walls, without over cuts and shall be secured against shifting during concrete slushing.**

2.2.3 Exterior outlets shall be weather proof with gasketed metal in-use covers and baked on grey enamel finish, per ANSI 61.

2.2.4 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.**

2.2.5 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.

2.2.6 Outlets for use on this project 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.

2.2.7 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.

2.2.8 Provide voltage dividers for mix use backboxes with line and low voltage. Provide separate stub-outs.

PART 3 - SPECIAL NOTICE

3.1 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.

3.2 All junction box covers shall be labeled with panel fed from and circuit number in black permanent marker. Where box is exposed in finished area, inside cover of box shall be labeled.

3.3 Fire alarm junction boxes shall be factory red. Where in exposed areas, standard box shall be painted to match adjacent surfaces.

END OF SECTION 26 05 31

SECTION 26 05 33 - RACEWAYS & FITTINGS

PART 1 - GENERAL

1.1 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.

1.2 This section specifies basic materials and methods and is a part of each Division 26 Section that implies or refers to electrical raceways specified therein.

1.3 The types of raceways specified in this section include the following:

1.3.1 Steel electrical metallic tubing. (E.M.T.)
1.3.2 Intermediate metal conduit (I.M.C.).
1.3.3 Galvanized rigid steel conduit (G.R.S.)
1.3.4 Flexible metal conduit
1.3.5 Liquid - tight flexible metal conduit.
1.3.6 Rigid nonmetallic conduit (PVC).
1.3.7 Surface metal raceways.
1.3.8 Cable tray or cable trough.
1.3.9 Duct banks, and their construction.
1.3.10 MC Cable

1.4 For each piece of cord-connected or flexible conduit connected items of equipment in the kitchen, provide a "Kellems" or equivalent strain relief grip at each end of connector, to prevent pullout if equipment is rolled or shoved by cleaning personnel.

1.5 Refer to the Architect's details for fire-rated grids and gypsum board expanses that protect certain areas of the steel construction of the building. This rated partition shall not be penetrated by electrical or mechanical work unless absolutely necessary and then equivalent firestopping methods to restore the rating of the plane shall be provided.

1.6 All raceways, as listed above and otherwise specified herein shall be provided in compliance with latest editions of all applicable U.L., NEMA, N.E.C. and A.N.S.I. 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.

1.7 Conduit and raceways, as well as supporting inserts in contact with or enclosed in concrete shall comply with the latest edition of all A.C.I. standards and the equipment manufacturer's recommendations for such work.

1.8 P.V.C. 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.

1.9 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.

1.10 Minimum size of conduit shall be 3/4" trade size. 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.

1.11 The installer of raceway systems shall avoid the use of dissimilar metals within raceway installations that would result in galvanic-action corrosion.

PART 2 - MATERIALS

2.1 STEEL ELECTRICAL METALLIC TUBING

2.1.1 Electrical metallic tubing, (E.M.T.) of corrosion-resistant steel construction shall be permitted for concealed installation in dry interior locations. Electrical metallic tubing shall not be installed underground, in concrete slabs or where exposed to physical damage. Electrical metallic tubing 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.

2.2 GALVANIZED RIGID STEEL CONDUIT

2.2.1 Galvanized rigid steel (GRS) conduit shall be used where subject to physical damage for exposed work in electrical, mechanical spaces or fire pump 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 P.V.C. conduits (except for primary utility duct banks), or where turning out of concrete encased duct banks, and at other locations as specifically called out on the drawings. LOCATIONS WHERE ELLS ARE EXPOSED ABOVE GROUND OR STUB-OUTS, CONDUIT SYSTEM SHALL TRANSFER TO BONDABLE TYPE VIA BONDING WITH A LOCKNUT OR OTHER APPROVED METHODS.

2.2.2 Galvanized rigid steel (GRS) conduit shall be used for all building interior power wiring or cables of over 600 Volts.

2.3 INTERMEDIATE METAL CONDUIT

2.3.1 Unless otherwise indicated on the drawings, intermediate metal conduit (I.M.C.) may be used in any location in place of galvanized rigid steel conduit, as permitted by codes, and as approved by the Engineer.

2.4 FLEXIBLE METAL CONDUIT

2.4.1 Flexible 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 clamp-on,

insulated throat 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. Maximum length shall not exceed 6' for light fixture and 3' for other connections. May not be used for data or low-voltage access control unless approved by BCPS or engineer.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

2.5.1 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.

2.6 RIGID NON-METALLIC CONDUIT

2.6.1 Rigid non metallic conduit shall be constructed of P.V.C, nominally schedule 40 weight, except where encased in concrete, where it may be "EB" type. 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.

2.6.2 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 nonmetallic 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. Where used underground, provide continuous marker tape with metallic tracer above line as required.

2.6.3 **When approved by Engineer and required for underground connections to devices, equipment or floorboxes inside the building envelope**, rigid non metallic conduit may be placed underground, minimum bury 24” schedule 80 PVC. Where ell is made upward thru a slab on grade, the turning ell and the riser shall be rigid steel conduit to a height of 6" above the concrete slab or to debice/box termination. Transition may then be made to E.M.T or other approved conduit for remainder of run if run continues.

2.6.3.1 Where underground raceway will contain any low voltage cabling, raceway serving low voltage portion shall be encased in 6” of concrete, below slab, minimum bury 24”.

2.6.3.2 Where stub up penetrates the vapor barrier, contractor shall inform and work with GC to ensure vapor barrier is sealed around penetration.

2.6.3.3 Photo proof of depth is required to be submitted to owner/engineer before covering this underground raceway inside the building.

2.6.4 Flexible nonmetallic conduit shall not be used.

2.6.5 Provide equipment grounding conductors of copper, sized as required by codes, in all circuits installed in rigid nonmetallic raceways.

2.7 SURFACE METAL RACEWAYS

2.7.1 Surface metal raceways shall only be provided where indicated on the drawings.

2.7.2 Surface metal raceways and fittings shall be constructed of code gauge corrosion-resistant galvanized steel and finished in an ivory color. Finishes shall be suitable for field painting, prepared by the installing contractor as necessary. Surface metal raceways shall be painted to match wall color.

2.7.3 Surface metal raceways and all components and fittings shall be furnished by a single manufacturer, wherever practical. All trim and cover fittings, flush feed boxes, splices, outlet fittings, etc, necessary for a complete installation shall be provided by the installing contractor - bends are not permitted. These raceways shall be rigidly mounted with approved fasteners on not to exceed 30" centers in a run, 6" from ends and on either side of a corner. Refer to plans for notations on exact types of these raceways and outlet configurations.

2.8 CABLE TRAY

2.8.1 Refer to drawings for specification and requirements.

2.9 DUCT BANKS

2.9.1 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.

2.9.2 All concrete used in duct bank construction shall be as specified in accord with latest A.C.I. standards. Testing of concrete shall be coordinated with the Contractor, as directed by the engineer. Place concrete against undisturbed earth or provide forming as needed. Float surface of concrete to a consistent uniform finish.

2.9.3 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. Provide marker tape with metal tracer above all duct banks as required.

2.9.4 Each corner of duct bank shall receive 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.

2.9.5 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.

2.9.6 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 (rated for encased burial), or similar ducts exit concrete envelope, except where duct bank ties into a manhole wall. Provide bell ends at such terminations and dowel 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.

2.9.7 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.

2.10 FIRE PROTECTED RACEWAY AND CONDUCTOR SYSTEMS

2.10.1 Refer to 26 05 19 – Conductors, Identification, Splicing, Devices and Connectors for further requirements on Fire Protected Raceway and Conductor Systems. Refer to riser for system usage type at locations required. Concrete encasement shall be constructed utilizing the duct bank requirements.

2.10.2 Other Fire Protected Raceway and Conductor Systems make use of Rigid, Non Metalic, Phenolic raceways or MC cable conductor assemblies listed as Fire Protected raceways or cables and conductors. Install per manufacturers recommendations and as required to meet NEC 695 and NEC 700.

2.11 MC CABLE

2.11.1 Limited use of MC cable is allowed. Refer to 26 05 19 – Conductors, Identification, Splicing Devices, etc. for requirements.

2.12 RACEWAY COLORS

2.12.1 Interior raceways shall have a factory finish color as specified below:

2.12.1.1	120/208V System Voltage:	Uncolored
2.12.1.2	277/480V System Voltage:	Orange
2.12.1.3	120/208V System Voltage EMERGENCY:	Yellow
2.12.1.4	277/480V System Voltage EMERGENCY:	Green
2.12.1.5	LV Communications and Stubouts:	Blue
2.12.1.6	Fire Alarm:	Red

2.12.2 Exposed raceways in painted interior areas shall be similarly painted to adjacent surfaces.

2.13 RACEWAY FITTINGS

2.13.1 Fixture whips shall be 3/8" 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 whip shall be #12, with #12 ground bonded to outlet at source end.

2.13.2 Conduit bodies and / or “LB’s”, shall be of gray iron or malleable iron. 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.

2.13.3 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.

2.13.4 Expansion fittings shall be provided at all locations where conduits or other raceways cross over expansion joints. Provide copper ground bonding jumpers across expansion fittings.

2.13.5 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.

2.13.6 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 No. 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.

2.13.7 Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.

2.13.8 Fittings for E.M.T. conduit shall be of steel, compression type. Fittings for sizes larger than 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.

2.13.9 Indentation or die-cast fittings shall <u>not</u> be permitted in any raceway system.

2.13.10 Compression type fittings shall be utilized for EMT conduit installed in damp or dusty locations, or where otherwise indicated.

2.13.11 All conduit fittings shall be securely tightened. All threaded fittings shall engage seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.

2.14 SUPPORTS AND HANGERS

2.14.1 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 U.L. 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.

2.14.2 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.

2.14.3 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.

2.14.4 The installing contractor shall provide all necessary supports and braces for raceways, in a rigid and safe installation, complying with all applicable codes.

2.14.5 Individual raceways run 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.

2.14.6 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 clamps, flange clamps, beam clamps, "minerallacs", etc.

2.14.7 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.

2.14.8 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.

2.14.9 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.

2.14.10 Welding directly on conduit or fittings is not permitted.

2.14.11 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.

2.14.12 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.

2.14.13 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.

2.15 FIRESTOPPING MATERIALS

2.15.1 All conduits, and cables penetrating fire rated floors and walls must be firestopped. Firestopping assembly must be UL listed. All corridor walls, storage room walls and mechanical room walls are to be firestopped (whether rated or not). The mechanical mezzanine floor slab shall also be firestopped (whether rated or not). Refer to the Architectural Drawings for rating of fire walls.

2.15.2 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.)

2.15.3 3M fire protection products are listed below. Equivalent products by Hilti or others may be submitted if they are UL listed

2.15.4 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. Contact the Engineer prior to conducting this training session.

2.15.5 Firestopping materials to include but not limited to the following:

2.15.5.1 3M fire barrier FS-195 wrap/strip.
2.15.5.2 3M fire barrier CP 25 caulk.
2.15.5.3 3M fire barrier MP moldable putty.
2.15.5.4 3M fire barrier RC-1 restricting collar with steel hose clamp.
2.15.5.5 3M fire barrier damming materials.
2.15.5.6 3M fire barrier CS-195 composite sheet.
2.15.5.7 3M fire barrier fire dam 150 caulk.
2.15.5.8 Steel sleeves.
2.15.5.9 HILTI – speed sleeves.

PART 3 - INSTALLATION

3.1 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 within the building construction or run above ceilings. Size of all conduit shall conform to Table No. 1, Chapter 9, of the National Electrical Code, unless otherwise shown on the Contract Drawings.

3.2 No conduit shall be installed in or below poured concrete slabs, foundation walls or footings. Conduit shall be held at least 6" from flues or hot water pipes. Feeder conduits may be installed below concrete slab when approved by Engineer.

3.3 All exposed conduit in mechanical spaces, conduit above corridor ceilings, above gymnasium, library or other large room ceilings shall be installed on strut system racks 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. Conduits randomly routed will not be accepted.

3.4 Groups of branch circuit conduits shall be run above corridor ceilings where possible and shall not be routed over classrooms. The conduits from wall outlets in classrooms shall be turned out in the zone between the structure and the room ceiling directly into junction boxes (fastened to the masonry walls, with a minimum of bends. These branch power, lighting and systems conduits shall then be routed along the walls (or structure, in the case of lighting conduits) to emerge thru the corridor walls at the elevations necessary to route with minimal offset to the racked conduit/junction box system mounted on the bottom of the corridor structure. If in doubt about any particular installation, contact the Engineer for clarification prior to proceeding with rough-in work.

3.5 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 degree bends. Conduits must be installed within the building envelope for interior runs.

3.6 Junction boxes shall be installed so that conduit runs will not exceed 85', or as shown on the Contract Drawings. Sizes of junction boxes shall be in accord with Article 370 of the N.E.C.

3.7 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".

3.8 All underground or underfloor conduits shall be swabbed free of all moisture and debris before conductors are pulled.

3.9 At least two 1 inch and three 3/4 inch 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.

3.10 Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the N.E.C., and NECA "Standard of Installation", complying with recognized industry practices.

3.11 Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components. Do not run conduit within metal deck flutes or attached to roof deck.

3.12 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.

3.13 Complete installation of electrical raceways before starting installation of cables or wires within raceways.

3.14 All underground conduits shall be buried to minimum depth of 36" 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 42" to top below finished grade, unless otherwise noted on plans.

3.15 No more than seven conductors shall be installed in conduit without special permission of Engineer, except where switch legs and travelers for lighting controls will be the exceeding conductors or in the case of fire alarm wiring.

3.16 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.

PART 4 - SPECIALTIES

4.1 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.

4.2 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 N.E.C. and other applicable codes.

4.3 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.

4.4 Pulling lines shall be left in all open conduit systems and shall be non-metallic, left securely tied off at each end.

4.5 Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

4.6 All metal outlet boxes shall be grounded with pigtail to the equipment grounding conductor.

4.7 All fire alarm raceways shall be factory red rigid metalic. Painted red conduit will not be accepted.

END OF SECTION 26 05 33

SECTION 26 05 44 – EXCAVATION, TRENCHING, BACKFILLING AND GRADING

PART 1 - GENERAL

1.1 Each Contractor's attention is directed to Section 260500, General Provisions, Electrical, the Earthwork section and all other contract documents as they may apply to their work.

1.2 Each Contractor shall include all excavating, filling, grading, and related items required to complete the work as shown on the drawings and specified herein.

1.3 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 T.V. services shall, in all cases, be placed in a separate trench with minimum two feet separation from electrical power lines.

1.4 Depths of bury shall be:

42" minimum to top of primary ducts, unless otherwise noted.
36" minimum to top of secondary ducts, unless otherwise noted.
36" minimum to top of branch exterior circuits, unless otherwise noted.

PART 2 - SUBSURFACE DATA

2.1 Refer to Divisions 0, 1 and 2 for requirements of rock excavation.

PART 3 - BENCH MARKS AND MONUMENTS

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

PART 4 - EXCAVATION

4.1 Each Contractor shall accept the site as they find it and remove all trash, rubbish, and material from the site prior to starting excavation for his work.

4.2 Excavate trenches to sufficient width and depth for proper installation of the work and where required, grade the bottom of the trench to be consistent with uniform slope.

4.3 Keep trenches free from water while construction therein is in progress. Under no circumstances lay conduit or cable in water. Dewatering trenches, which is required during construction shall be accomplished at the Contractor's expense.

4.4 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.

PART 5 - BACKFILL

5.1 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 at this point. 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 testing is 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 (debris and rock free) tamped at 6" intervals. Water settling of backfill is permitted only as an aid to mechanical compacting.

5.2 Backfill for lawn areas shall be accomplished with clean debris free earth and the backfill compacted to 90% 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.

5.3 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.

5.4 The backfill below paved areas shall be 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.

5.5 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 top soil.

END OF SECTION 26 05 44

SECTION 26 05 53 - IDENTIFICATIONS

PART 1 - GENERAL

1.1 Equipment, disconnect switches, safety switches, motor starters, pushbutton stations, special device plates, VFD's 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. Refer to drawings for detailed requirements of lamacoid labels and equipment required for.

1.2 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 card holders in each panel.

1.3 Branch circuit panelboards and switch gear 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. Panelboard and switchgear 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. **Label shall also indicate available fault current and date this was calculated based on engineered study included in shop drawings.** Refer to drawings for detail.

1.4 Where branch circuit panelboards and switchgear are connected to an emergency source, the lamacoid plate shall be red, and the word "emergency" shall be incorporated into the legend. Also provide similar plates and legends for automatic transfer switches, as appropriate. Refer to drawings for detail.

1.5 Lamacoid plates shall be located at center of top of trim for branch circuit panels, switch gear, and centered at side for branch circuit switches. Fasten with self-tapping stainless steel screws or other approved method.

1.6 Properly size lamacoid plates to properly fit on device it is being applied to. Do not allow edges to extend beyond flat surface.

1.7 All junction box covers shall be labeled with panel fed from and circuit number in black permanent marker.

1.8 Low voltage cabling provided as part of this contract shall be labeled at each end in a way that is clear to the owner what the cable serves. Consult with BCPS Technology Department for clarification before labeling to provide a coherent scheme.

1.9 All markings shall be done in a manner that presents a neat, professional appearance.

1.10 The drop id identifies the cable drop location. This field may be up to six characters in length. This identification shall identify a room number and wiring closet location. Note: It is imperative that

the final version of the building room numbering system be utilized in all cable identifications. Verify room numbering system with the Architect or Owner.

1.11 Example of a Label "**121aM"**

1.11.1 "121" in this example is the room number/door number. Label these cables based on the final number scheme of the building.

1.11.2 "a" indicates the device type. See below for examples.

c = card reader
s = door strike
a = aiphone
o = ada door operator
m = motion detector (security)
g = glass break detector (security)
d = door contact (security)
e = emergency pull station
x = confirm with owner if device is not listed here.

1.11.3 The "D1" is the drop designator and number, "V" for voice, "D" for data. The letter should be upper case.

1.11.4 The "M" is the termination location, "M" for MDF," A" for IDF A, "B" for IDF B, or if serving another device in another room the room number. The letter should be upper case.

1.11.5 Place a permanent label one inch behind the termination on both ends of the cable. Also put a label above each and every drop on patch panels in the distribution frames.

1.11.6 Each subcontractor is responsible for labeling his system(s) or cabling plants per these requirements.

1.12 Coverplates of all devices shall be labeled with clear adhesive tape labels indicated panel and circuit served from with black lettering.

1.13 All powered equipment shall be provided with clear adhesive tape labels indicated panel and circuit served from with black lettering.

1.14 Equipment Clearance Marking

1.14.1 Electrical switchboards and panelboards location in electrical, mechanical or storage room spaces shall be provided with 2" wide, 35mil floor marking tape consisting of large yellow and black diagonal stripes stuck on with a reinforced, rubber based adhesive.

1.14.1.1 Material Shall be SafetyTac Hazard or Brady equal.

1.14.2 Area shall be provided with a 12x12 self adhesive circle label indicating “ELECTRICAL PANEL – DO NOT BLOCK”

1.14.2.1 Label shall be Creative Safety Supply Electrical Panel - Do Not Block (Circle) or Brady equal.

1.14.3 Clearance marking spec sheets shall be submitted with a scaled, dimensioned floor plan indicating proposed tape and sign locations for review by the owner, architect, and engineer for prior to installation.

END OF SECTION 26 05 53

SECTION 26 24 00 - ELECTRICAL DISTRIBUTION EQUIPMENT

PART 1 - MAIN SWITCHBOARD - CIRCUIT BREAKER

1.1 Switchboard shall be dead front, totally enclosed, free standing type consisting of sections housing the equipment as indicated. The structure height shall be 92" high including the base channels. The structure shall be constructed of formed steel channels and angles, 12 gauge minimum to support cover plates, bussing, distribution equipment and other devices to be installed therein. Neutral and ground shall be separate buses. Removable cover plates shall be provided on all sides and top with opening for conduit in bottom. Cover plates and trim shall have formed edges so that no sheared surfaces are exposed. Housing shall be given a rust inhibiting treatment inside and out and finished in blue gray baked enamel. Connection will be made by entering the switchboard as indicated on the drawings.

1.2 All bussing shall be solid copper. The temperature rise above ambient of the bus bars shall not exceed 65 degrees C. Heat rise test shall be conducted in accordance with U.L. Standard UL-67. All joints are to be rigidly bolted to insure maximum conductivity. All bus bars shall extend full length of equipment to permit future additions.

1.3 The main bus shall be adequately braced to withstand short circuits of 100,000 asymmetric RMS amperes. The line side of branch units shall be bussed with copper connectors unless otherwise indicated or required. All units shall have lockout provisions.

1.4 Main section shall house a 100% rated, solid-state, electronic trip circuit breaker. Provide incoming section and/or space in main section for equipment required by utility company. Mains rated 800 amps at 277/480V shall be provided with GFI protection.

1.5 Distribution section shall consist of the number of circuit breakers of sizes as indicated. Units shall be mounted in group type construction and supplied as indicated.

1.6 Gear shall be provided with arc reduction monitoring switch as required by 2014 NEC.

1.7 **Switchboard shall be provided with phase voltage unbalance and phase loss functionality to trip main breaker in either of these two events.**

1.7.1 Switchboard shall be provided with current transformers and pilot lights to indicate if each phase upstream of the main is energized or not.

1.8 Switchboard shall be provided with a multi-function main meter with pulse output and BAS integration into BAS system. Coordinate with temperature controls contractor.

1.9 **Switchboard shall be Square "D", Siemens, GE, or approved equivalent. Service entrance labeled and listed by U.L.**

PART 2 – DISTRIBUTION PANELBOARDS (where indicated or specified as i-line)

2.1 Panelboard assembly shall be enclosed in a steel cabinet at least 18” above the floor. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets to be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. End walls shall be removable. Fronts shall be of code gauge steel, with gray baked enamel finish electrodeposited over cleaned, phosphatized steel.

2.2 The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Bus structure shall be copper and shall be full height of panel.

2.3 Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C. rise above ambient. Heat rise tests shall be conducted in accordance with Underwriters Laboratories Standard UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All panelboards unless otherwise noted shall have space to accept forty-two 20 amp one pole circuit breakers.

2.4 Circuit breakers shall be equipped with individually insulated, braced, and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF." Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. All panelboards shall be capable of accepting 225 amp 3 pole branch breakers as a minimum unless otherwise noted.

2.5 Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on schedules on the plans or as determined by verification with local utility company. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard, structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

2.6 Distribution panelboards shall be Square "D", Siemens, GE or approved equivalent.

PART 3 - BRANCH PANELBOARDS

3.1 This section covers lighting and power panelboards (refer to schedule and notes on Contract Drawings and One-Line Diagram, of the Contract Drawings).

3.2 All panelboards shall be of the circuit breaker type and shall be of one manufacturer.

3.3 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.

3.4 The panelboards shall be enclosed in code gauge, galvanized steel cabinets with smooth finished double 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.

3.5 Each door shall have a directory card inside, covered with a plastic shield, filled in typewritten with circuit numbers and description indicated**. Room numbers shall be coordinated with final/actual room numbers as selected by Owner -- not numbers on Contract Documents**.

3.6 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.

3.7 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 on surface mounted panels. Covers shall over hang box 1” on all sides for flush mounted panelboards.

3.8 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.

3.9 Circuit breakers shall be molded-case construction, per U.L. 489, Federal Specifications W-C-375B/GEN MCCB, NEMA AB1. 208V circuit breakers shall be a minimum of 10,000 A.I.C. RMS symmetrical rating. 480V circuit breakers shall be a minimum of 14,000 A.I.C. RMS symmetrical rating unless otherwise indicated on the Contract Drawings or required by fault current capacity. Verify incoming fault capacity with utility company and submit coordination/fault current study for all breakers on this project to the engineer. Distribution panels ("DP") shall have 42K A.I.C. or 30K A.I.C. breakers as noted.

3.10 All main bus and connections thereto in branch panelboards shall be copper. All bus bars shall extend full length of panelboards.

3.11 All circuit breakers used to switch lights shall be SWD (switching duty) rated.

3.12 All panelboards shall have full size uninsulated copper ground busses, insulated full neutral busses. All "SS" panels indicated to have surge protection added outboard shall have 200% rated neutrals.

3.13 Panels shall be Square "D", Siemens, GE, or approved equivalent.

PART 4 - INSTALLATION

4.1 Panelboards with circuit breakers installed before the building has been finished and cleaned shall be masked.

4.2 All dust and debris shall be removed from the panels before they are energized and placed in service. All wires shall be properly formed - no splices are permitted in gutters.

4.3 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 A/E at that time. Provide description of location(s) and load, i.e., "Room 101 - lighting."

4.4 Painted caution yellow lines on floor shall be provided for working space in mechanical/electrical rooms in front of switchboards and panelboards in accordance with the NEC.

PART 5 - SAFETY SWITCHES

5.1 Provide heavy duty safety switches as a final disconnecting means as required by NEC and as indicated on the Contract Drawings.

5.2 All safety switches shall be NEMA Type 1 or NEMA 3R and Heavy Duty Type HD and UL listed. Provide uninsulated ground bus in all switches and additional insulated neutral bus if required by circuit.

5.3 All safety switches shall have switch blades that are fully visible in the "OFF" (open) position with the door open.

5.4 All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.

5.5 Switch mechanism shall be quick-make, quick-break, load 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. NEMA 3R 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.

5.6 Switches shall be as manufactured by Square D., G.E., Siemens, Cutler Hammer, or approved equivalent.

PART 6 - FUSES

6.1 Upon completion of the building, the Contractor shall provide the owner with spare fuses as shown below. All fuses shall be Busman or Little Fuse.

6.1.1 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares.

6.1.2 Busman spare fuse cabinets - Catalog No. SFC - shall be provided to store the above spares.

6.2 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 ensure retention of selective coordination, as designed.

6.3 Circuits 601 to 6000 amperes shall be protected by current limiting Busman 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 R.M.S. symmetrical. The fuses shall be UL Class L.

6.4 Circuits 0 to 600 amperes shall be protected by current limiting Busman 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 284 degrees F 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 r.m.s. symmetrical. The fuses shall be UL Class RK1.

6.5 Motor Circuits - All individual motor circuits rated 480 amperes or less shall be protected by Busman 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 BUSMAN 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.

6.6 Circuit breaker panels shall be protected by Busman 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.

PART 7 - CONTACTORS

7.1 General: Contactors shall be continuously rated at the specified amperes per pole for all types of ballast, resistance, and motor load. Contactors shall have totally enclosed, double-break silver-cadmium-oxide power contacts. Auxiliary arcing contacts will not be acceptable. Contact inspection and replacement shall be possible without disturbing line or load wiring. Contactors shall have straight-through wiring with all

terminals clearly marked. Contactors shall have a gasketed NEMA Type 1 (NEMA 12 for electrically-held) enclosure, unless otherwise noted or required.

7.2 Contactors shall be approved per UL 508 and/or CSA and be designed in accordance with NEMA Standards. They shall be industrial-duty rated for applications to 600 volts maximum. I.E.C.-style contactors are not acceptable.

7.3 Contactors shall have provisions for factory or field addition of:

7.3.1 Four N.O. or N.C. auxiliary contacts rated 6 amperes continuous at 600 volts.

7.3.2 Single or double circuit, N.O. or N.C., 30 or 60 amperes 600 volt power-pole adder.

7.3.3 Control-circuit fuse holder, one or two fuses.

7.3.4 0.2-60 second adjustable interval timer attachment, if so, indicated on plans.

7.3.5 Transient-suppression module for coil control circuit. Coil control to be 120 volts. Provide circuit or step-down transformer if required.

7.4 Electrically Held Lighting Contactors: Contactor coils shall be continuously rated and encapsulated, 120 volt rated. Enclosures shall be NEMA 12, to minimize noise transmission.

7.5 Mechanically Held Lighting Contactors: Coil-clearing contacts shall be supplied so that the contactor coils shall be energized only during the instance of operation. Both latch and unlatch coils shall be encapsulated. Coils shall be rated for 120 volt operation.

7.6 Lighting contactors shall be Square D Class 8903 or equivalent by G.E., I.T.E./Siemens, or Allen-Bradley.

PART 8 - PANELBOARD SCHEDULES

Refer to the drawings.

PART 9 - DISTRIBUTION TRANSFORMERS

9.1 Not used.

PART 10 – POWER SYSTEM STUDIES:

10.1 GENERAL

10.1.1 Provide power system studies as specified in this section. The studies shall be performed with the aid of a computer program and shall be in accordance with the latest applicable IEEE and ANSI standards. For computer software, use the most recent version of SKM power tools for windows or approved equal.

10.1.2 Provide reports for all studies. Reports shall be submitted as shop drawings to the engineer prior to ordering equipment. Any equipment submitted prior to submission of the reports will not be reviewed. Note: If the final studies (based on actual project conditions) cannot be completed in time to meet project schedule requirements, then preliminary studies may be submitted based on worst-case project conditions (estimated wire lengths, infinite-buss transformer calculations, etc.). Final studies are still required to be completed and submitted after the exact project conditions are determined and prior to substantial completion.

10.1.3 Reports shall include a detailed description, purpose, basis, and scope of the study. Reports shall include single line diagram. Protective device time versus current coordination curves, circuit breaker and fuse selection with commentary regarding any component shall be provided for each section.

10.1.4 Selective coordinate is required for the EMERGENCY (article 700) emergency system. Provide all equipment as required to selectively coordinate.

10.1.5 Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays/breakers shall be provided.

10.1.6 The equipment manufacturer shall provide the services of a qualified field engineer and necessary tools and equipment to test and calibrate the protective relays, ground fault relays and circuit breaker trip devices as recommended by the studies. Field settings of devices, adjustments, upgrading and modifications to the new equipment to accomplish conformance with the accepted studies shall be provided out by the Contractor. The Contractor shall be responsible for modifying settings on existing equipment only at the nearest existing over-current protection device which serves new equipment. All settings shall be adjusted per the studies prior to substantial completion.

10.1.7 Equipment shall not be energized until all breakers or protective relays are set either to the recommended values indicated by the studies or to minimum trip settings.

10.1.8 All equipment labels shall be affixed prior to final punch or final electrical inspections.

10.2 FAULT CURRENT STUDY

10.2.1 Provide a complete fault current study for equipment on this project. Study shall include all power distribution equipment on the project and shall extend to the main lugs or breaker of the furthest device downstream. This study shall also include all applicable areas required by code to evaluate which include but are not limited to Industrial Control Panels, Motor Controllers and VFD’s, Air Conditioning and Refrigeration Equipment, Elevator Control and Emergency System transfer equipment.

10.2.2 Service equipment shall be field-marked with dated maximum available fault current at the equipment. Apply an engraved lamacoid label similar to equipment label detailed on drawings.

10.3 ARC FLASH STUDY

10.3.1 Provide a complete arc flash analysis for equipment on this project. Study shall include all power distribution equipment on the project and shall extend to the main lugs or breaker of the furthest device downstream (including fused disconnects and wire troughs which are overcurrent devices)

10.3.2 Provide all arc flash labels, warning signage, etc. as recommended by NFPA 70E. Labels shall include, at a minimum, an arc flash hazard warning, the incident energy at that location, the arc flash boundary, the level of PPE required, safe approach distances, safe working distances, and any other information recommended or required per NFPA 70E and the NEC.

10.3.3 Where an overcurrent device is provided with arc flash reduction provisions, an additional complete arc flash label shall be provided which indicates the arc flash hazard, PPE requirements, incident energy, etc. when the arc flash reduction provisions are implemented. The label shall also indicate the location and type of the arc flash reduction provisions for each device affected.

10.4 QUALIFICATIONS

10.4.1 A professional engineer directly employed by the electrical distribution equipment manufacturer shall perform the studies and prepare a complete and detailed report.

10.4.2 The studies shall be performed, stamped, and signed by a registered professional electrical engineer.

10.4.3 A minimum of ten (10) years experience in power system analysis is required for the individual in charge of the studies.

10.4.4 The manufacturer performing the studies should demonstrate capability and experience to provide assistance during start up as required.

END OF SECTION 26 24 00

SECTION 26 27 26 - WIRING DEVICES AND PLATES

PART 1 -GENERAL

1.1 This section of the specifications covers all wiring devices and cover plates, standard, weatherproof and dust-tight.

1.2 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 via the appropriate addenda. Submit cutsheets and/or samples of each type ten (10) 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.

PART 2 -MATERIALS

TYPE	RATING	CONFIGURATION	COLOR	VENDOR - CAT. #
RECEPTACLE - DUPLEX SPECIFICATION GRADE	125V, 20A	NEMA 5-20R	*	HUBBELL 5362TR, LEVITON 5362SG P&S TR63 COOPER AHTR5362
RECEPTACLE – EMERGENCY (IF FED FROM EMERGENCY PANEL)	125V, 20A	NEMA 5-20R	RED	HUBBELL 5362TR, LEVITON 5362SG P&S TR63 COOPER AHTR5362
RECEPTACLE - DUPLEX G.F.I.	125V, 20A	NEMA 5-20R	*	HUBBELL GF5362SG LEVITON G5362-T P&S EQUAL COOPER EQUAL
RECEPTACLE – SINGLE	125V, 20A	NEMA 5-20R	*	HUBBELL 5361TR LEVITON EQUAL P&S EQUAL COOPER EQUAL
RECEPTACLE – SINGLE WITH CLOCK HANGER TAB, STAINLESS STEEL PLATE	125V, 15A	NEMA 5-15R	METAL	HUBBELL 5235 LEVITON 658-BR ARROW –HART 5760

RECEPTACLE, DUPLEX ISOLATED GROUND (WITH ORANGE LEGEND PLATE)	125V, 20A	NEMA 5-20R	ORANGE	HUBBELL IG-5352 GE 5362-IG LEVITON 5362-IG
RECEPTACLE, SINGLE TWISTLOCK	250V, 30A	NEMA 126-30R	BLACK	HUBBELL 2610A
RECEPTACLE, SINGLE	250V, 20A	NEMA 10-20R	BLACK	HUBBELL 6810 GE 4124 LEVITON 5032
RECEPTACLE, SINGLE	250V, 50A	NEMA 6-50R	BLACK	HUBBELL 9367 GE 4141 LEVITON 5374
SWITCH, SINGLE POLE	120/277V, 20A	SPST	*	HUBBELL 1221 GE 5951 LEVITON 1221
SWITCH, THREE-WAY	120/277V, 20A	3-WAY	*	HUBBELL 1223 GE 5953 LEVITON 5953
SWITCH, FOUR-WAY	120/277V, 20A	4-WAY	*	HUBBELL 1224 GE 5954 LEVITON 5954
SWITCH, KEYED	120/277V, 20A	SPST	N/A	HUBBELL 1221-L GE 5951-L LEVITON 1221-L
SWITCH, KEYED	120/277V, 20A	3-WAY	N/A	HUBBELL 1223-L GE 5953-L LEVITON 1223-L
SWITCH, KEYED	120/277V, 20A	4-WAY	N/A	HUBBELL 1224-L GE 5954-L LEVITON 1224-L

NOTE:

SWITCH, KEYED TO EACH BE FURNISHED WITH ONE HUBBELL #1209 KEY. TURN OVER TO OWNER AT CLOSE OF PROJECT AND OBTAIN RECEIPT FOR VERIFICATION THAT KEYS HAVE BEEN DELIVERED.

SWITCH, MOMENTARY, 3-POSITION, CENTER OFF SWITCH	120/277V, 20A (VERIFY VOLTAGE USED)	SPDT	*	HUBBELL 1557 GE EQUIVALENT LEVITON EQUIVALENT
SWITCH, PILOT (TOGGLE LIT IN ON POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPDT OR AS NOTED	CLEAR "LEXAN"	HUBBELL 1221-PL GE EQUIVALENT LEVITON EQUIVALENT
SWITCH, ILLUMINATED (TOGGLE LIT IN OFF POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPST OR AS NOTED	CLEAR "LEXAN"	HUBBELL 1221-IL GE EQUIVALENT LEVITON EQUIVALENT
TIMER SWITCH	120V	SPST, 15 MINUTE	*	NUTONE VS63 GE EQUIVALENT LEVITON EQUIVALENT

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. ALL 120V RECEPTACLES SHALL BE TAMPER RESISTANT TYPE

* SEE ARTICLE 3, COLOR.

2.1 Small Motor Control Switches: For small motor loads of 3/4 HP or less, single phase, 120 or 277 volts, provide snap-type, H.P. rated motor starter switch without thermal overloads. Hubbell 3031 IA or equivalent Square D or G.E. Provide lockout-type trim plate for each device. 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. All such disconnects shall be mounted next to the motor above ceilings or exposed in mechanical spaces, located in readily accessible areas.

PART 3 -COLOR

3.1 Color of devices shall be grey, except for outlets on computer panels, which shall be blue. Outlets connected to emergency circuits shall be red. 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.

PART 4 - MANUAL DIMMERS

4.1 Manual dimmers for LED fixtures shall be matched to the type load intended to be controlled.

4.2 Power rating shall be verified by examining the plans and suitable for the load, but in no case less than 125% of the circuit load. Furnish dimmers in nominal power ranges of 600W, 1000W and 1500 watts.

4.3 Manual dimmers shall be provided with all solid state components, complete with choke coil and/or other R.F.I. suppression devices.

4.4 Manual dimmers shall be suitable for mounting in single gang outlet box, ganging together in multi-section boxes where indicated, without derating being necessary.

4.5 Manual dimmers shall be of the sliding-type, with detent stop at off position, full range control 0-100%. Lutron Company "Nova" Series or equivalent Lithonia, Cooper, or Lightolier. Provide with grey trim.

PART 5 - PLATES AND COVERS

5.1 Unless otherwise specified or noted, all wiring device plates and covers shall unbreakable nylon.

5.2 All kitchen or food service area plates shall be 302/304 stainless steel, with foam gasket behind to help prevent water infiltration.

5.3 Any switch plate covers accessible in public areas, corridors, lobbies, media center, cafeteria(s), atrium, and gymnasium shall be 302/304 stainless steel.

5.4 Cover plates shall be of one manufacture insofar as possible.

5.5 Weatherproof, while in use, plates for G.F.C.I. receptacles shall be cast aluminum, self-closing, gasketed, suitable for standard box mounting, U.L. listed for wet location use, cover closed. Vertical mounting - Hubbell CWP26V (die-cast zinc) or equivalent Tay-Mac or Ideal.

5.6 Weatherproof switch plates for toggle-handle switches shall be cast aluminum, sealed, for standard outlet boxes, with thru - the cover toggle operation. Hubbell, equivalent G.E., or Leviton.

5.7 Cover plates for telephone wall outlets shall be as required to meet telephone supplier's requirements. Color to match other plates on project. Furnish with wall-mounting studs if mounted at 48" or higher. Refer to this Section for further requirements.

5.8 Cover plates for computer outlets with multiple cable feeds shall be multi-gang, thermoplastic, modular, for snap-in terminators as specified in separate bid package documents.

5.9 Blank cover plates for rough-in only boxes for future or other vendor use are to be 302/304 Stainless Steel blank covers when other device is not installed by time of temporary certificate of occupancy.

PART 6 - INSTALLATION

6.1 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.

6.2 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. Any device showing paint or dirt shall be replaced.

6.3 Provide G.F.C.I. duplex feed-thru style receptacles where indicated or required by the National Electrical Code, whether specifically called out or not. When a G.F.C.I. receptacle is on a circuit with other non-G.F.C.I. 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 "G.F.C.I. protected" label on each downstream outlet.

6.4 Where surge suppression outlets are provided, they shall be ANSI Category "A" style. They shall be installed as dedicated-circuit outlets or where with multiple outlets on a circuit, they shall be placed at the homerun point of that circuit and feed-thru wired to protect the downstream outlets on that circuit.

6.5 All receptacles shall be installed with ground prong at top position.

6.6 All outlet boxes, in final positions shall be properly fitted, tight to wall, per N.E.C. No jumbo plates shall be used. All receptacles/grounds shall be "pig-tail" bonded to the outlet box (except for isolated grounds).

END OF SECTION 26 27 26

SECTION 262913 –MOTOR STARTERS

PART 1 – GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 This section is an Electrical Division Basic Materials and Methods section and is part of each Division 26 section making reference to motor starters specified herein. Refer to Mechanical Division for further requirements.

PART 2 - DESCRIPTION OF WORK:

2.1 Extent of motor starter work is indicated by drawings and schedules.

2.2 Types of motor starters in this section include the following: Manual. Full voltage, non-reversing.

PART 3 - QUALITY ASSURANCE:

3.1 Manufacturers: Firms regularly engaged in manufacturer of motor starters, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

3.2 Installer: Qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

3.3 NEC Compliance: Comply with NEC as applicable to wiring methods, construction, and installation of motor starters.

3.4 UL Compliance and Labeling: Comply with applicable requirements of UL 508, "Electrical Industrial Control Equipment", pertaining to electrical motor starters. Provide units which have been UL listed and labeled.

3.5 NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to motor controllers/starters and enclosures.

PART 4 - SUBMITTALS:

4.1 Product Data: Submit manufacturer's data on motor starters.

4.2 Shop Drawings: Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts and spatial relationship to associated motors, and connections to electrical power panels and feeders.

4.3 Maintenance Data: Submit maintenance instructions for motor and drive replacement, and spare parts lists. Include this data in maintenance manuals.

4.4 Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units of each. Fuses shall be of a type available from at least two manufacturers.

4.5 Maintenance Stock overloads: for each type and rating required, furnish additional overloads, amounting to one unit for each nine installed, but not less than three units of each.

PART 5 - ACCEPTABLE MANUFACTURERS:

5.1 Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter): Furnas Electric Co., Allen Bradley Co., Square D. Co.

PART 6 - MOTOR STARTERS:

6.1 General: Except as otherwise indicated, provide motor starters and ancillary components; of types, sizes, ratings, and electrical characteristics indicated, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installations. Where more than one type of equipment meets indicated requirements, selection is Installer's option. Provide phase loss and low voltage protection relay in the control circuit of all motors 7-1/2 HP and larger. Starters shall be a minimum of size 1 with solid state overloads, phase failure and low voltage protection, control transformers, hand-off-auto selector, and red and green pilot light. Provide fixed (.6-10 second) time delay electronic relay in control circuit of all motors, 7-1/2 HP and larger, connected to the essential electrical system. This includes starters for motor control centers also.

6.2 Control transformers shall be individually fused from the line side with two cartridge fuses and one fuse on the secondary. Size transformers for holding coil circuit current and all other connected loads.

6.3 AC Fractional HP Manual Starters: Provide manual single phase or three phase fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with thermal overload relay for protection of 120 volt or 208V AC motors of 2 HP and less. Provide starters with quick-make, quick-break trip free toggle mechanisms. Mount starter in NEMA Type 1 general purpose enclosure for indoor applications, NEMA Type 3 enclosure for outdoor applications. Enclosure shall be provided with a permanently installed lockable hasp.

6.4 A.C. Full Voltages: Provide full voltage alternating current magnetic starters, consisting of contactors and solid state overloads mounted in common enclosures; of type, size, ratings and NEMA sizes indicated. Control voltage to be 120V with a minimum of 2 sets of auxiliary contact, (one - N.O. and one N.C.) or as required for controls specified. Provide other control components such as H.O.A. switches, pushbuttons, pilot lights.

PART 7 - INSTALLATION OF MOTOR STARTERS:

7.1 Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

7.2 Install fuses in fusible disconnects, if any.

7.3 Install overloads, sized to provide protection in accordance with the manufacturer’s recommendations and the N.E.C. in overload relays.

PART 8 - ADJUST AND CLEAN:

8.1 Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

8.2 Touch-up scratched or marred surfaces to match original finish.

PART 9 – FIELD QUALITY CONTROL:

9.1 Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 26 29 13

SECTION 26 43 13 - SURGE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 This section describes the materials and installation requirements for Surge Protective Devices (SPDs), formerly TVSS, for the protection of AC electrical circuits.

1.2 Each Contractor's attention is directed to Section 260500, General Provisions-Electrical and all other contract documents as they may apply to their work.

PART 2 – SCOPE OF THE WORK

2.1 The Contractor shall provide the necessary labor, materials, wiring and services necessary to provide the complete electrical surge protection systems as specified herein. This work shall include, but is not necessarily limited to:

2.2 Provision of Surge Suppression Units at certain points in the power distribution network and on telephone and television service lines.

2.3 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.

PART 3 – QUALITY ASSURANCE

3.1 STANDARDS – Most Recent Edition of the following:

3.1.1 Underwriters Laboratories: UL1449, 3RD Edition

3.1.2 ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002

3.1.3 National Electrical Code: Article 285

3.2 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.

3.3 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.

3.4 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.

PART 4 – SUBMITTALS

4.1 Product Data: Submit manufacturer's data 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:

4.1.1 Short Circuit Current Rating (SCCR).

4.1.2 Voltage Protection Ratings (VPRs) for all modes.

4.1.3 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.

4.1.4 I-nominal rating (I-n).

4.1.5 Type 1 or Type 2 Device Listing.

4.1.6 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.

4.1.7 kA rating per phase.

4.1.8 kA rating per mode.

4.2 Submittals shall also include the following:

4.2.1 Line drawings detailing dimensions and weight of enclosure.

4.2.2 Listing and rating of all modes of protection in each type of SPD required.

4.2.3 Breaker sizes used for SPD service disconnects.

4.2.4 Wiring diagram showing all manufacturer installed wiring including wire size, type, routing, and exact length of conductors.

4.2.5 Listing of equipment where each type of SPD is installed.

4.3 Maintenance Data: Submit maintenance instructions for surge suppression system. Include this data in Operation and Maintenance manuals.

PART 5 – ACCEPTABLE MANUFACTURERS

5.1 Available Manufacturers: Subject to compliance with requirements, the manufacturer providing panelboards and/or switchgear on this project shall also provide SPD’s.

PART 6 – BUILDING ELECTRICAL SERVICE SURGE PROTECTION DEVICES

6.1 GENERAL

6.1.1 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.

6.1.2 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.

6.1.3 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.

6.1.4 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.

6.1.5 Each MOV shall be individually fuse-protected to avoid cascading faults. This shall be certified by Manufacturers letter of compliance.

6.1.6 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.

6.1.7 SPD shall provide surge current paths for all modes of protection: L-N, L-G, and N-G for Wye systems; L-L, L-G in Delta, and impedance grounded Wye systems.

6.1.8 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.

6.1.9 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

6.1.10 SPD enclosures shall be surface-mounted in mechanical spaces, flush-mounted for units in finished areas, or as noted. Provide in a NEMA 1 gasketed or NEMA 12 enclosure with hinged front panel. Where devices are indicated on drawings to be recessed, provide with flush enclosure for recessed mounting.

6.1.11 SPD shall be installed above or below equipment being protected to minimize lead length.

6.1.12 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.

6.2 MAIN SERVICE SWITCHBOARD SURGE SUPPRESSION

6.2.1 Main service entrance switchboard units shall be installed as indicated on the contract documents and shall be as manufactured by distribution equipment manufacturer, 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 480,000 amperes; Line to Ground 480,000 amperes; Line to Line 480,000 amperes; and Neutral to Ground 480,000 amperes. 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.

6.2.2 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.

6.2.3 Provide integral fused disconnecting means for each surge protection device. Integral disconnect shall be able to withstand the single surge rating of the SPD.

6.2.4 Provide 100A circuit breaker in switchboard being protected for unit disconnecting means. Utilize #1/0 AWG wire for connection to switchboard. Maximum wire length is three feet.

6.2.5 SPD shall be installed with external main disconnect operator.

6.3 PANELBOARD SURGE SUPPRESSION

6.3.1 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. All MOV's shall be individually fused.

6.3.2 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.

6.3.3 SPD shall be UL labeled as Type 1 or Type 2.

PART 7 - EXECUTION

7.1 Installation of Surge Protection Systems:

7.1.1 Install surge protection systems 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.

7.1.2 Coordinate with other work, including electrical wiring work as necessary to interface installation of units.

7.1.3 Install conductors with direct, shortest possible phase, neutral and ground paths from all in/out connections, avoiding sharp bends and narrow loops.

7.1.4 Install surge suppression units as close as practical to equipment they are protecting. Install appropriate units at main electrical service entrance equipment and secondary branch panelboards as indicated.

7.1.5 Suppressors shall be installed such that conductor lengths are no more than three feet to panel connections.

7.1.6 Refer to the drawings for installation of individual surge suppression devices to protect branch circuits. Also see Section 262726 for (receptacle type) device requirements. All receptacle type surge suppression units shall be wired as feed-thru type, to protect all downstream outlets on that branch circuit unless otherwise indicated.

7.1.7 Where devices are indicated on drawings to be recessed, provide with flush enclosure for recessed mounting.

PART 8 – WARRANTIES

8.1 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.

END OF SECTION 26 43 13

SECTION 26 51 13 - INTERIOR LIGHTING

PART 1 – GENERAL:

1.1 RELATED DOCUMENTS

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

1.1.2 The Contractor is directed to examine each and every section of these specifications including Section 260500, 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.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Interior Luminaires
1.2.1.2 Building Mounted Exterior Luminaires
1.2.1.3 Exit Signs
1.2.1.4 Lamps, Ballasts, and Drivers
1.2.1.5 Luminaire Supports and Accessories

1.3 DESCRIPTION OF WORK

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.3.4 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.

1.3.5 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.

1.3.6 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.

1.3.7 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.

1.3.8 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.

1.3.9 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.

1.3.10 Pre-manufactured flexible wiring systems are not permitted for this project.

1.3.11 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.

1.5.1 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 265114 EXTERIOR LIGHTING.

1.6 ACRONYMS AND DEFINITIONS

1.6.1 CCT: Correlated color temperature

1.6.2 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)

1.6.3 CU: Coefficient of utilization

1.6.4 IECC: International Energy Conservation Code

1.6.5 LER: Luminaire efficacy rating, which is calculated according to NEMA LE 5.

1.6.6 Lumen: Delivered output of luminaire.

1.6.7 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.

1.6.8 NRTL: Nationally Recognized Testing Laboratory

1.6.9 SPD: Surge Protection Device

1.6.10 RCR: Room cavity ratio.

1.6.11 UL: Underwriters Laboratory

1.6.12 Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.6.13 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

1.7.1 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.

1.7.2 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

1.8.1 Submittal data shall be in accordance with Division 01 SUBMITTAL Specification Section, IECC and as specified herein.

1.8.2 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.)

1.8.3 Data, drawings, and reports shall employ the terminology, classifications and methods prescribed by IESNA HB-10, as applicable, for the lighting system specified.

1.8.4 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.

1.8.5 Product data lacking sufficient detail to indicate compliance with contract documents will be rejected.

1.8.6 Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1.8.6.1 Physical description of lighting fixture including dimensions.
1.8.6.2 Emergency lighting units including battery and charger.
1.8.6.3 All available finishes and colors for each luminaire type shall be submitted to the Architect for selection during review.
1.8.6.4 Life, output (lumens, CCT, and CRI), and energy-efficiency data for light fixtures.
1.8.6.5 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.
1.8.6.6 Distribution data according to IESNA classification type as defined in IESNA HB-10.
1.8.6.7 Amount of shielding on luminaires.

1.9 QUALITY ASSURANCE

1.9.1 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.

1.9.2 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.

1.9.3 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.

1.9.4 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.

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 WARRANTY

1.12.1 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.

1.12.2 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.

1.12.3 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.

1.12.4 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

2.1.1 In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products the manufacturers specified.

2.1.2 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 paragraph EQUAL MANUFACTURERS for additional requirements.

2.1.3 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.

2.1.4 All luminaires shall be DLC (Design Lights Consortium) Certified.

2.1.5 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 luminance's, 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

2.2.1 Comply with the requirements specified in the Articles below and the Light Fixture Schedule.

2.2.2 Complete luminaires shall be in accordance with NFPA 70, NEMA, and UL 1598 listed and labeled.

2.2.3 Provide luminaires complete with lamps of number, type, and wattage indicated.

2.2.4 Ballasts, drivers, or transformers, unless otherwise specified, 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.

2.2.5 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.

2.2.6 Recessed fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

2.2.7 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.

2.2.8 Provide in-line fuse-holders with fuses sized per manufacturer's recommendation for each fixture.

2.2.9 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.

2.2.10 Provide all luminaires with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor and ground accordingly upon installation.

2.2.11 All luminaires shall be provided with a ground wire and grounded accordingly upon installation.

2.2.12 All luminaires supplied for recessing in suspended ceilings shall be supplied with pre-wired junction boxes, unless otherwise specified.

2.2.13 Provide "maximum wattage label" on all light fixture based on the specified maximum wattage indicated on the light fixture schedule.

2.2.14 Metal parts: Free of burrs, sharp corners, and sharp edges.

2.2.15 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.

2.2.16 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.

2.2.17 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.

2.2.18 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.

2.2.19 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.

2.2.20 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.

2.2.21 Ballasts, drivers, or transformers, unless otherwise specified, 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.

2.2.22 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.

2.2.23 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.

2.2.24 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.

2.2.25 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.

2.2.26 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.

2.2.27 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.

2.2.28 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.

2.2.29 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.

2.2.30 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.

2.2.31 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.

2.2.32 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.

2.2.33 Product procurement and coordination: Contractor shall:

2.2.33.1 Order products according to application
2.2.33.2 Confirm the proper and complete catalog number with distributor and agent.
2.2.33.3 Ensure wiring, driver, etc meets the specifications and proper requirements.
2.2.33.4 Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.

2.2.34 Each light fixture shall be packaged with complete instructions and illustrations on how to install.

2.2.35 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

2.3.1 Alzak cones, reflectors, baffles, and louvers shall be warranted against discoloration.

2.3.2 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.

2.3.3 All trims, reflectors and canopies shall fit snugly and securely to the ceiling or wall so that no light leak occurs.

2.3.4 Trims shall be self-flanged and white, unless otherwise specified.

2.3.5 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:

2.4.1 LED drivers shall comply with NEMA SSL 1, NFPA 70, and UL 8750 unless otherwise specified.

2.4.2 All LED luminaires shall use drivers integral to luminaires or as otherwise required by the luminaire manufacturer.

2.4.3 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.

2.4.4 LED driver shall withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.

2.4.5 LED driver shall tolerate ±10 percent supply voltage fluctuation with no adverse effects to driver or LEDs.

2.4.6 LED driver forward voltage (Vf) shall be matched to LED board.

2.4.7 LED driver shall exhibit no visible change in light output with a variation of ±10 percent line voltage input.

2.4.8 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.

2.4.8.1 Refer to SECTION 26 05 19 - CONDUCTORS, IDENTIFICATION, SPLICING DEVICES & CONNECTORS for minimum requirements for dimming cabling. Dimming conductors to be supported via j-hooks every 4’-0”.

2.4.9 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.

2.4.10 Power factor shall be 0.95 (minimum).

2.4.11 Class A Sound Rating.

2.4.12 Current crest Factor of 1.5 or less.

2.4.13 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.

2.4.14 All LED luminaires shall be fused on the primary side of the driver as recommended by the respective luminaire manufacturers.

2.4.15 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:

2.5.1 LED modules shall be manufactured by Cree, GE, Philips, Osram, Niche, or Xicato.

2.5.2 LED lamps shall comply with ANSI C78.1.

2.5.3 Chromacity of LED lamps shall comply with ANSI C78.377A and NEMA SSL-3.

2.5.4 Light emitting diodes shall be tested under IES LM-80 standards.

2.5.5 Color Rendering Index (CRI) shall be 84 (minimum).

2.5.6 Color temperature of 3,500K, or as indicated on light fixture schedule.

2.5.7 Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).

2.5.8 Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

2.5.9 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.

2.5.10 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

2.6.1 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.

2.6.2 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

2.7.1 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.
2.7.2 Provide with tool-less hinged junction box access cover and thermal protection.

2.7.3 Provide telescoping channel bar hangers that adjust vertically and horizontally.

2.7 EXIT SIGNS

2.7.1 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.

2.7.2 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.

2.7.3 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.

2.8 LUMINAIRE SUPPORT HANGERS AND COMPONENTS

2.8.1 Wires: ASTM A641/A641M, Class 3, soft temper, galvanized regular coating, 0.1055 inches in diameter (12 gage).

2.8.2 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.

2.8.3 Rod Hangers: Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.9 FUSING: All luminaires shall be fused.

2.10 EQUIPMENT IDENTIFICATION

2.10.1 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.

2.10.2 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 _____":

2.10.2.1 LED or lamp type, and nominal wattage
2.10.2.2 Driver or ballast type
2.10.2.3 Correlated color temperature (CCT) and color rendering index (CRI)
2.10.2.4 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.

2.11 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

3.1.1 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.
3.1.2 Install luminaires in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", and NEMA standards.

3.1.3 Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.4 Installed luminaires shall be provided with protective covering by Contractor until such time as the space(s) is cleaned and ready for occupancy.

3.1.5 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.

3.1.6 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.

3.1.7 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.

3.1.8 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:

3.1.8.1 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).

3.1.8.2 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.

3.1.8.3 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.

3.1.9 Lighting Fixture Supports:

3.1.9.1 Shall provide support for all of the fixtures.

3.1.9.2 Shall maintain the fixture positions after cleaning and relamping.

3.1.9.3 Shall support the luminaires without causing the ceiling or partition to deflect

3.1.9.4 For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system.

3.1.10 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.

3.1.11 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.

3.1.12 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.

3.1.13 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.

3.1.14 Rigidly align continuous rows of light fixtures for true in-line appearance.

3.1.15 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.

3.1.16 Light fixture whips shall be supported from the building structure. Do not clip to lay-in ceiling support wires.

3.1.17 Exterior Fixtures:

3.1.17.1 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.

3.1.17.2 Provide exterior rated waterproof junction boxes for all fixtures and splices.

3.1.17.3 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.

3.1.17.4 Lubricate all threaded parts with a high temperature waterproof anti-seize lubricant, including lamp bases and sockets, to prevent seizing and corrosion.

3.1.17.5 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.

3.1.17.6 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.

3.1.18 Transformers (applies to all transformers including (but not limited to) low voltage, neon, remote ballast, LED power supplies, exterior locations):

3.1.18.1 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).

3.1.18.2 Transformers should be mounted as close to the load/feed lamp holders as practical to keep the secondary feeds as short as possible.

3.1.18.3 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.

3.1.18.4 Electrical Contractor to label front of transformer with load name and load location. For example: "Large Display Case @ Entry to Main Dining Room."

3.1.19 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.

3.1.20 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.

3.1.21 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.

3.1.22 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.

3.1.23 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.

3.1.24 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

3.2.1 Bond luminaires and metal accessories to the grounding system per National Electrical Code.

3.2.2 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

3.3.1 Light fixtures served from multiple power sources, such as emergency fixtures fed from emergency transfer relay, shall have the following label affixed to it:

"DANGER - ELECTRICAL SHOCK HAZARD - LIGHT FIXTURE HAS MULTIPLE POWER SOURCES"

3.4 CLEANING

3.4.1 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.

3.4.2 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.

3.4.3 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

3.5.1 The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

3.5.2 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.

3.5.3 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.

3.5.4 All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

3.5.5 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.

3.5.6 Control station with scene selection determination shall be coordinated with the owner and engineer for final programing.

3.5.6.1 **4 hour Training of usage of system is to be included with scene reprogramming based on this session. The owner is also to be taught how to reprogram scenes themselves and this information documented via digital video documentation and delivered with the close out documents.**

3.6 OPERATION AND MAINTENANCE DATA

3.6.1 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.

3.6.2 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.

3.6.3 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:

3.6.3.1 Vendor and local representative's contact information
3.6.3.2 Tools required
3.6.3.3 Types of cleaners to be used
3.6.3.4 Replacement parts identification lists
3.6.3.5 Equipment product data (high-quality reproducible copies)
3.6.3.6 Warranty documentation

3.7 FIELD QUALITY CONTROL:

3.7.1 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.

3.7.2 Dimming Drivers. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

3.7.3 Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

3.7.4 Inspect each light fixture for damage. Replace damaged light fixtures at no cost to the Owner.

3.7.5 Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 13

SECTION 26 51 14 – EXTERIOR LIGHTING

PART 1 – GENERAL:

1.1 RELATED DOCUMENTS

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

1.1.2 The Contractor is directed to examine each and every section of these specifications including Section 260500, 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.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Exterior Luminaires
1.2.1.2 Lamps, Ballasts, and Drivers
1.2.1.3 Luminaire Poles, Supports and Accessories

1.3 DESCRIPTION OF WORK

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.3.4 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.

1.3.5 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.

1.3.6 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.

1.3.7 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.

1.3.8 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.

1.3.9 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.

1.3.10 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.

1.5.1 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 260500 INTERIOR LIGHTING.

1.5.2 American Association Of State Highway And Transportation Officials (AASHTO)

1.5.2.1 AASHTO LTS-5 (2009; Errata 2009; Amendment 1 2010; Amendment 2 2011) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

1.5.3 American National Standards Institute (ANSI):

1.5.3.1 ANSI C62.41 - Recommended Practice in Low Power Circuits
1.5.3.2 ANSI C78 Series - Physical and Electrical Characteristics of High-Intensity Discharge Lamps

1.5.3.3 ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
1.5.3.4 ANSI C81 Series - Electric Lamp Bases and Holders
1.5.3.5 ANSI C82.4 - Specifications for High Intensity Discharge Lamp Ballasts (Multiple Supply Type)
1.5.3.6 ANSI C82.11 - Performance Requirements for High Frequency Ballasts
1.5.3.7 ANSI C82.77 - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
1.5.3.8 ANSI C136.21 (2004; R 2009) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
1.5.3.9 ANSI C136.3 (2005; R 2009) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments
1.5.3.10 ANSI E1.20 - Remote Device Management Over DMX512 Networks
1.5.3.11 ANSI/IES RP-16-10 - Nomenclature and Definitions for Illuminating Engineering

1.5.4 ASTM International (ASTM)

1.5.4.1 ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
1.5.4.2 ASTM B108/B108M - Standard Specification for Aluminum-Alloy Permanent Mold Castings
1.5.4.3 ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus

1.6 ACRONYMS AND DEFINITIONS

1.6.1 CCT: Correlated color temperature

1.6.2 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)

1.6.3 CU: Coefficient of Utilization

1.6.4 IECC: International Energy Conservation Code

1.6.5 LER: Luminaire efficacy rating, which is calculated according to NEMA LE 5.

1.6.6 Lumen: Delivered output of luminaire.

1.6.7 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.

1.6.8 NRTL: Nationally Recognized Testing Laboratory

1.6.9 SPD: Surge Protection Device

1.6.10 RCR: Room Cavity Ratio

1.6.11 UL: Underwriters Laboratory

1.6.12 Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.6.13 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

1.7.1 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.

1.7.2 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

1.8.1 Submittal data shall be in accordance with Division 01 Submittal Specification Section, IECC and as specified herein.

1.8.2 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.)

1.8.3 Data, drawings, and reports shall employ the terminology, classifications and methods prescribed by IESNA HB-10, as applicable, for the lighting system specified.

1.8.4 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.

1.8.5 Product data lacking sufficient detail to indicate compliance with contract documents will be rejected.

1.8.6 Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1.8.6.1 Physical description of lighting fixture including dimensions.
1.8.6.2 Emergency lighting units including battery and charger.
1.8.6.3 All available finishes and colors for each luminaire type shall be submitted to the Architect for selection during review.
1.8.6.4 Life, output (lumens, CCT, and CRI), and energy-efficiency data for light fixtures.

1.8.6.5 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.

1.8.6.6 Dimensions, effective projected area (EPA), accessories, installation details and construction details.

1.8.6.7 Poles: Include dimensions, wind load determined in accordance with AASHTO, pole deflection, pole class, and other applicable information.

1.8.6.8 Distribution data according to IESNA classification type as defined in IESNA HB-10.

1.8.6.9 Amount of shielding on luminaires.

1.9 QUALITY ASSURANCE

1.9.1 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.

1.9.2 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.

1.9.3 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.

1.9.4 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.

1.10 COORDINATION: Coordinate layout and installation of lighting fixtures with all other construction including geothermal well field, sanitary, storm and domestic water.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING

1.11.1 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.

1.11.2 Luminaire Poles: Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.12 EXTRA MATERIALS

1.12.1 Furnish the following extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing content:

1.12.1.1 LED Drivers: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.

1.12.1.2 LED Lamps/Boards: One (1) for every fifty (50) of each type and rating installed. Furnish at least five (5) of each type.

1.13 WARRANTY

1.13.1 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.

1.13.2 All luminaries, finishes, poles and all of its component parts, 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.

1.13.3 Provide a written five warranty for material, fixture finish, and workmanship.

1.13.4 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.

1.13.5 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

2.1.1 In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products the manufacturers specified.

2.1.2 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.

2.1.3 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.

2.1.4 All luminaires shall be DLC (Design Lights Consortium) Certified.

2.1.5 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

2.2.1 Comply with the requirements specified in the Articles below and the Light Fixture Schedule.

2.2.2 Complete luminaires shall be in accordance with NFPA 70, NEMA, and UL 1598 listed and labeled.

2.2.3 Provide luminaires complete with lamps of number, type, and wattage indicated.

2.2.4 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.

2.2.5 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.

2.2.6 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.

2.2.7 Provide in-line fuse-holders with fuses sized per manufacturer's recommendation for each fixture.

2.2.8 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.

2.2.9 Provide all luminaires with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor and ground accordingly upon installation.

2.2.10 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.

2.2.11 All light fixtures shall be completely wired at the factory in accordance with applicable codes and UL.

2.2.12 Provide “maximum wattage label” on all light fixture based on the specified maximum wattage indicated on the light fixture schedule.

2.2.13 Metal parts: Free of burrs, sharp corners, and sharp edges.

2.2.14 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.

2.2.15 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.

2.2.16 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.

2.2.17 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.

2.2.18 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.

2.2.19 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.

2.2.20 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.

2.2.21 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.

2.2.22 Product procurement and coordination: Contractor shall:

2.2.22.1 Order products according to application
2.2.22.2 Confirm the proper and complete catalog number with distributor and agent.
2.2.22.3 Ensure wiring, driver, etc meets the specifications and proper requirements.
2.2.22.4 Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.

2.2.23 Each light fixture shall be packaged with complete instructions and illustrations on how to install.

2.2.24 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

2.3.1 Alzak cones, reflectors, baffles, and louvers shall be warranted against discoloration.

2.3.2 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:

2.4.1 LED drivers shall comply with NEMA SSL 1, NFPA 70, and UL 8750 unless otherwise specified.

2.4.2 All LED luminaires shall use drivers integral to luminaires or as otherwise required by the luminaire manufacturer.

2.4.3 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.

2.4.4 LED driver shall withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.

2.4.5 Operating temperature rating shall be between -40°F and 120°F.

2.4.6 Provide with integral 10kV surge suppression protection minimum. Surge protection shall be tested in accordance with IEEE/ANSI C62.41.2.

2.4.7 LED driver shall tolerate ±10 percent supply voltage fluctuation with no adverse effects to driver or LEDs.

2.4.8 LED driver forward voltage (Vf) shall be matched to LED board.

2.4.9 LED driver shall exhibit no visible change in light output with a variation of ±10 percent line voltage input.

2.4.10 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.

2.4.11 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.

2.4.12 Power factor shall be 0.95 (minimum).

2.4.13 Class A Sound Rating.

2.4.14 Current crest Factor of 1.5 or less.

2.4.15 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.

2.4.16 All LED luminaires shall be fused on the primary side of the driver as recommended by the respective luminaire manufacturers.

2.4.17 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:

2.5.1 LED modules shall be manufactured by Cree, GE, Philips, Osram, Niche, or Xicato.

2.5.2 LED lamps shall comply with ANSI C78.1.

2.5.3 Chromacity of LED lamps shall comply with ANSI C78.377A and NEMA SSL-3.

2.5.4 Light emitting diodes shall be tested under IES LM-80 standards.

2.5.5 Color Rendering Index (CRI) shall be 84 (minimum).

2.5.6 Color temperature of 4,000K, or as indicated on light fixture schedule.

2.5.7 Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).

2.5.8 Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

2.5.9 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 POLES

2.6.1 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.

2.6.2 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.

2.6.3 Aluminum Poles: 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.

2.7 BRACKETS AND SUPPORTS

2.7.1 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.

2.8 POLE FOUNDATIONS

2.8.1 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.

2.9 FUSING: All luminaires shall be fused. Fuse pole mounted fixtures at handhole.

2.10 EQUIPMENT IDENTIFICATION

2.10.1 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.

2.10.2 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 _____":

2.10.2.1 LED or lamp type, and nominal wattage
2.10.2.2 Driver or ballast type
2.10.2.3 Correlated color temperature (CCT) and color rendering index (CRI)
2.10.2.4 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.

2.11 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

3.1.1 Install luminaires in accordance with luminaire manufacturer’s written instructions, applicable requirements of NEC, NECA’s “Standard of Installation”, and NEMA standards.

3.1.2 Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.3 Do not scale plans for exact location of lighting fixtures.

3.1.4 Set luminaires plumb, square, and level in alignment with adjacent luminaires, and secure in accordance with manufacturers' directions and approved drawings.

3.1.5 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

3.1.6 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.

3.1.7 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.

3.1.8 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.

3.1.9 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.

3.1.10 Lubricate all threaded parts with a high temperature waterproof anti-seize lubricant, including lamp bases and sockets, to prevent seizing and corrosion.

3.2 GROUNDING

3.2.1 Bond luminaires and metal accessories to the grounding system per National Electrical Code.

3.2.2 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.

3.2.3 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.

3.3 IDENTIFICATION

3.3.1 Light fixtures served from multiple power sources, such as emergency fixtures fed from emergency transfer relay, shall have the following label affixed to it:

"DANGER - ELECTRICAL SHOCK HAZARD - LIGHT FIXTURE HAS MULTIPLE POWER SOURCES"

3.4 CLEANING

3.4.1 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.

3.4.2 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.

3.4.3 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.

3.5 TESTING AND ADJUSTMENT

3.5.1 The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.

3.5.2 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.

3.5.3 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.

3.5.4 All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

3.5.5 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

3.6.1 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.

3.6.2 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.

3.6.3 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:

3.6.3.1 Vendor and local representative's contact information
3.6.3.2 Tools required
3.6.3.3 Types of cleaners to be used
3.6.3.4 Replacement parts identification lists
3.6.3.5 Equipment product data (high-quality reproducible copies)
3.6.3.6 Warranty documentation

3.7 FIELD QUALITY CONTROL

3.7.1 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.

3.7.2 Dimming Drivers and ballasts. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

3.7.3 Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

3.7.4 Inspect each luminaire for damage. Replace damaged luminaires at no cost to the Owner.

3.7.5 Fixtures showing dirt, dust or fingerprints shall be restored to like new condition or shall be replaced at no cost.

3.7.6 Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 14

SECTION 265995 – COMMISSIONING OF ELECTRICAL

PART 1 – GENERAL:

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section includes commissioning process requirements for ELECTRICAL systems, assemblies, and equipment.

1.2.2 Related Sections: Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.2.3 Contractor shall include all time and labor for SUPPORT of a third-party CxA agent hired direct by owner outside this contract to perform commissioning responsibilities

1.2.4 The scope of work includes commissioning support for the lighting control system and EPSS emergency generator and ats systems.

1.3 DEFINITIONS

1.3.1 Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

1.3.2 CxA: Commissioning Authority. Must have minimum five years experience and have performed similar duties to those included in this project on at least three projects of equal size and scope.

1.3.3 Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 CONTRACTOR'S RESPONSIBILITIES

1.4.1 ***Provide SUPPORT to a third-party CxA to perform commissioning responsibilities as required.***

1.4.2 Perform commissioning tests at the direction of the CxA.

1.4.3 Attend commissioning meetings as scheduled by the CxA.

1.4.4 Attend testing, adjusting, and balancing review and coordination meeting.

1.4.5 Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

1.4.6 Provide information requested by the CxA for final commissioning documentation.

1.4.7 Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

1.5.1 Provide Project-specific construction checklists and commissioning process test procedures for Electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

1.5.2 Direct commissioning testing.

1.5.3 Verify testing, adjusting, and balancing of Work are complete.

1.5.4 Provide test data, inspection reports, and certificates in Systems Manual.

1.6 COMMISSIONING DOCUMENTATION

1.6.1 Provide the following information to the CxA for inclusion in the commissioning plan:

1.6.1.1 Plan for delivery and review of submittals, systems manuals, and other documents and reports.
1.6.1.2 Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
1.6.1.3 Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for electrical systems, assemblies, equipment, and components to be verified and tested.
1.6.1.4 Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
1.6.1.5 Certificate of readiness certifying that Electrical systems, subsystems, equipment, and associated controls are ready for testing.
1.6.1.6 Test and inspection reports and certificates, including Equipment Start-up Sheets.
1.6.1.7 Corrective action documents.
1.6.1.8 Verification of testing, adjusting, and balancing reports.

1.7 SUBMITTALS

1.7.1 Certificates of readiness.

1.7.2 Certificates of completion of installation, prestart, and startup activities.

PART 2 – EXECUTION:

2.1 TESTING PREPARATION

2.1.1 Certify that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

2.1.2 Certify that Lighting control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

2.1.3 Certify that testing, adjusting, procedures have been completed and that testing, adjusting, and reports have been submitted, discrepancies corrected, and corrective work approved.

2.1.4 Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

2.1.5 Inspect and verify the position of each device and interlock identified on checklists.

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

2.2 GENERAL TESTING REQUIREMENTS

2.2.1 Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

2.2.2 Scope of Electrical testing shall include the entire lighting control installation. Testing shall include measuring capacities and effectiveness of operational and control functions.

2.2.3 Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of controllers and sensors.

2.2.4 The CxA along with the Electrical Subcontractor, shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

2.2.5 Tests will be performed using design conditions whenever possible.

2.2.5.1 The CxA may direct that set points be altered when simulating conditions is not practical.

2.2.6 If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

2.2.7 If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

2.3 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

2.3.1 The electrical trade representative will demonstrate to the CxA all lighting control operations and functions as required per IECC 2012, part C408.3.

2.3.2 The electrical trade representative will demonstrate to the CxA all generator and transfer switch operations and functions as required per specifications.

2.3.3 Functional performance testing will include the following systems:

2.3.3.1 Lighting Control Systems.
2.3.3.2 EPSS Emergency Generator and Transfer Switches

END OF SECTION 26 59 95

SECTION 27 06 10 - DATA/VOICE ROUGH-INS

PART 1 - GENERAL

1.1 Each Electrical Contractor's attention is directed to Section 260500, General Provisions, Electrical, and all other contract documents as they may apply to his work. The data/voice cabling portion of this project is in a separate bid-package. This contractor shall coordinate with that bid-package for all rough-in and infrastructure items.

PART 2 - SCOPE OF THE WORK

2.1 The Electrical Contractor shall provide the necessary labor, materials, services, and coordination with the owner to provide the complete data/voice system indicated on the plans and specified herein. This work shall include, but is not necessarily limited to:

2.1.1 All necessary conduit, boxes, pullstrings, labels etc., as required by the owner.

2.1.2 Cover plates for data/voice outlet boxes along with conduit, backboxes and pullstrings.

PART 3 - INSTALLATION

3.1 The contractor shall coordinate with separate bid-package low voltage contractor who is responsible for providing all instruments, wiring, jacks, and equipment for the data/voice system.

3.2 The Contractor shall install conduit system as shown on the plans. Pull strings shall be provided in all conduit to allow installation of data cabling.

END OF SECTION 27 06 00

SECTION 27 08 00 – AUDIO VISUAL SYSTEMS

PART 1 - GENERAL

1.1 A low voltage systems 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.

1.2 The low voltage systems contractor shall be a factory authorized distributor for the products that they propose to furnish. The distributor agreement shall be available for inspection upon request.

1.3 The low voltage systems contractor shall show satisfactory evidence upon request that they maintain, within a 150-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.

1.4 The equipment described and furnished under these specifications shall be the product of one manufacturer to insure single source warranty, engineering, and service responsibility throughout the life of the system.

1.5 All bids shall be based on equipment herein specified. All substitute equipment shall be submitted to the Engineer no later than ten (10) days prior to bid date. Acceptable products will be approved by Addendum. 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.

1.6 All systems provided under this section shall be furnished with a one-year warranty by the systems contractor, from the date of project substantial completion. The systems contractor shall honor manufactures factory warranties that extend beyond the standard one year warranty when applicable.

1.7 All cable jacket colors shall be white.

1.8 All finishes as selected by architect.

1.9 Provide all microphone, speaker and patch cables as required for a complete and operable system.

1.10 Alternate manufacturers will be considered with the submission of the following criteria 10 days prior to bid.

1.10.1 Data sheets on mixer, DSP, amplifiers, and speakers.
1.10.2 Acoustic model analysis of the field utilizing proposed equipment. Data shall demonstrate direct sound pressure coverage and levels.
1.10.3 Wire diagram showing system interconnection and functional diagram of DSP Program.

PART 2 - LOCAL AREA SOUND SYSTEMs (CAFETERIA)

2.1 General

2.1.1 Provide independent local sound systems with mixers, audio processors, amplifiers, speakers, speaker wiring, microphone wiring, dedicated 120 vac power circuits, microphone jacks, microphones and stands, wireless microphones and other accessories etc., for a complete, functioning system.

2.1.2 The entire system shall be warranted for a period of one year from the date of the project's substantial completion, after acceptance testing of the system is performed.

2.2 Products

2.2.1 Equipment Rack

2.2.1.1

Provide (1) Middle Atlantic EWR Series wall rack, 16RU x 17” Deep - #EWR-16-17, Lowell or Approved Equal.

Provide all appropriate blanks and vents as required for proper installation.

Provide Lowell SLS Sliding Shelf, 3U UDE Drawer, and Blank off all unused rack spaces.

2.2.2 User AV Operation and Storage Cabinet

Provide (1) Middle Atlantic 4 Space, Low Profile Wall Rack, Plexi Top, Putty, #VWM-PD-36K-PW, Atlas or Approved Equal. Cabinet must open in the front to provide access to control panels and microphone/cable storage. Locate cabinet at AV/3

2.2.3 Equipment Rack PDU

Provide Furman CN-2400S Power Sequencer.

2.2.4 Equipment Rack Mixer

Provide (2) Audio-Technica ATDM-0604a mixers – linked together with 1RU side by side mount.

2.2.5 Equipment Loudspeaker Management System

Provide (1) DBX feedback eliminator, RTA, ET and remote volume control system, #DriveRack 260 or equal

2.2.6 Amplifiers

Provide Danley Sound labs DNA D5K4-DSP, Dynacord or Linea.

Bridge to 8ohm for OS62s

Engage output limiter for OS62’s

Bridge to 4ohm for TH118

Engage output limiter

2.2.7 Left/Right Main Loudspeakers

The loudspeaker shall utilize the Synergy Horn Paraline patented enclosure. The coverage pattern

shall be 60˚ x20 degrees. The loudspeaker shall have an operating range of +/- dB 113Hz-18kHz. Sensitivity of 101 dBSPL@1m. Output of 127dBSPL/133dBSPL Peak. Power handling shall be 800 Watts continuous, 800 Watts program. The loudspeaker shall be constructed shall be constructed of thermal molded poly composite, with and aluminum grill. The Loudspeaker shall be the Danley Sound Labs OS62.

2.2.8 Subwoofer
Provide (1) Tapped Horn 15" subwoofer – Danley TH115.
Provide painted strut suspension from bar joist. Locate at center of room. Delay to mains.

2.2.9 Custom Input and Operation Plates
Provide Custom Input and Control Plate to Perform the following functions:
Remote Volume Control – DBX #ZC1
XLR Input Plate – Single Gang, Aluminum, Screw Mounted Connectors with Neutrik NC3FD-L-B-1 3-Pin XLRF Panel Mount Connector

2.3 Accessories

2.3.1 Wired Microphone System: Provide one microphone stand and Microphone, Cardoid with on/off switch, Shure SM58S with Gator 10" Round Base Microphone Stand and One Hand Clutch GFW-MIC-1001 with 25', heavy duty low impedance microphone cable.

2.3.2 Wireless Microphone System:
1.Provide Shure QLXD4/85 H50 SERIES dual band system with SM35-50A HEADSET mic, AND SM58 HANDHELD MIC or Approved Equal.

2.3.3 Wireless Microphone Distribution:
Provide (2) UA864US antenna and RG213/U belden 8267 cable in gym remote from receiver. Provide with (2) American time G3012 polycarbonate guards.

2.3.4 AV Direct Box
Provide (1) Switchcraft AV Direct Box with Custom Transformer Model – SC700CT, Radial Engineering or Approved Equal with 25' xlr cable and 6' input pigtail.

2.3.5 Speakers shall be connected to mixer/amplifier outputs via min #12-2 -plenum cable – Belden 6000UE or equal

2.3.6 Provide input module and adapter as required for connection from future multimedia projector audio connections

PART 3 – EXECUTION

3.1 Performance

3.1.1 Provide input module and adapter as required for connection from future multimedia projector audio connections

3.1.2 An Audio Signal Analysis of overall system equalization sound pressure level, and feedback shall be performed utilizing a Real Time, Third Octave Spectrum Analyzer. The RTA Filters must conform to ANSI Class II, Type E Standards. (i.e. Audio Control Industrial Model SA- 3050A).

3.1.3 Measurements shall be made with a pink noise source as the input to the system. The pink noise source shall be 10dB above the ambient noise level. No less than six different areas of the bleachers shall be tested. Furnish hard copy printouts of System Frequency Response curves, STI, and sound pressure Levels at the various testing points to demonstrate that the system has been properly installed and balanced.

3.1.4 Amplifier output limiting shall be provided to prevent overdriving speakers.

3.2 **INSTALLATION**

3.2.1 Installation: Install all equipment where shown on the plans. Wire as required by the manufacturer of the equipment. In case of conflict, notify architect. All wiring shall be installed in a minimum ¾ inch conduit

3.2.2 Coordinate mounting of speakers from press box with fabricator to provide adequate support and maintain structural integrity.

3.3 **TESTING**

3.3.1 Contractor shall test complete system for proper operation. Provide a Certificate after testing is complete verifying the system is complete and operational to specifications. Include in Operation and Maintenance Manuals.

3.4 **INSTRUCTION**

3.4.1 The Contractor shall provide a minimum of (two) two hour sessions of instructional time to the Owner in the operation and maintenance of all equipment and components. Each session shall be on different dates one upon occupying the building and one in the one year warranty period. Provide digital video recording of both training sessions to Owner with close-out documents. A receipt shall be obtained from the Owner that this has been accomplished, and a copy forwarded to the Engineer.

END OF SECTION 27 08 00

SECTION 27 51 16 – INTERCOM, PUBLIC ADDRESS & MASTER CLOCK SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 The drawings and general provisions of the Contract Documents apply to this section.

1.2 SUMMARY

1.2.1 This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system and will be enforced by Bullitt County Schools. It is the responsibility of the contractor to ensure that the proposed product meets or exceeds every standard set forth in these specifications.

1.2.2 The functions and features specified are vital to the operation of this facility, and therefore, the acceptance of alternate manufacturers does not release contractor from strict compliance with the requirements of this specification.

1.2.3 The system shall provide the expansion of the existing Rauland intercom for the new facility.

1.2.4 Existing System:

1.2.4.1 System head end is existing at school. System head end equipment, amplifiers, etc. Provide additional new equipment directly compatible with existing Rauland system as required for scope of work at new MDF/IDF closets. 3rd party expansions of the system will not be accepted.

PART 2 – SUBMITTALS

2.1 Product data for each component.

2.2 Shop Drawings: Prior to proceeding with the work: System integrator shall provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection, and a complete schedule of all equipment and materials with associated manufacturers product information on which are to be used.

2.2.1 Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout the system.

2.2.2 Artwork drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.

2.2.3 Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, System Integrator Company's name in the title block.

2.2.4 Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.

2.3 Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.

2.4 System Integrator Certificates: Signed by manufacturer certifying that System Integrators comply with requirements.

2.5 Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

2.6 Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final transformer tap settings, and signal to ground-resistance measurements certified by System Integrator.

2.7 Maintenance Data: For equipment to be included in maintenance manuals specified in Division 1.

2.7.1 Record of Owners equipment-programming option decisions.

2.7.2 All instructions necessary for proper operation and manufacturers' instructions.

2.7.3 "Proof of Performance" information.

2.7.4 Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.

2.7.5 Manufacturer's maintenance information.

2.7.6 Software programs and information on all programmable features of the installed platform.

2.8 **Record Drawings: Prior to final acceptance, provide three (3) complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing".**

2.9 System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with specifications.

2.9.1 Include with the submittal a preliminary staff development-training program in outline form for review and approval by the owner's representative.

2.9.2 Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the system.

2.9.3 Include with the submittal a current copy of trainer's need's assessment form, which will be reviewed with the owner's designated representative for the system's preliminary system programming and configuration.

2.9.4 Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.

2.10 A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications system is covered with the required **FIVE-YEAR** warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

PART 3 - QUALITY ASSURANCE

3.1 System Integrator Qualifications: An experienced System Integrator who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following with in thirty (30) days after notification to proceed:

3.1.1 Provide a list of installations that the System Integrator has specifically installed for verification by the Owner. Random installations from other vendors and/or System Integrators shall not be accepted. The System Integrator, not its employees, must meet these qualifications.

3.1.2 The System Integrator shall be bondable.

3.1.3 The System Integrator shall demonstrate to the Owners representative that he has:

- Adequate plant and equipment to pursue the work properly and expeditiously.
- Adequate staff and technical experience to implement the work.
- Suitable financial status to meet the obligations of the work.
- Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.

3.2 Any System Integrator, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of a "Installer" who does meet the requirements and who shall provide the equipment, make all connections, and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/ Engineer. The "Installer" shall be identified on bid day.

3.3 Because the life expectancy of this type of communications platform normally exceeds 10 years, the owner expects continuity from the service provider. If the installing/servicing company has not been an authorized provider of the manufacturer's product for at least 10 years, the following is required:

3.3.1 A list of (2) systems manufacturers of which they currently are authorized service providers where the relationship exceeds 10 years

3.3.2 A letter from the manufacturer outlining the details of changes in service providers over the last 10 years and what actions they will take to ensure continuity of service to the customer.

3.4 Each major component of equipment shall have the manufacturers name, address and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL Label, or other data that is die-stamped into the surface of the equipment shall be easily visible.

3.5 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

3.6 Comply with NFPA 70

3.7 Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools. .

3.8 Comply with UL 60950.

PART 4 – not used.

PART 5 – WARRANTY

5.1 Provide a **manufacturer's five-year warranty** of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment, as well as analog clocks, speakers, and call-in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one year warranty shall be provided for labor.

5.2 A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard of quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.

5.3 System Integrator shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the System Integrator shall provide "loaner" equipment to the facility at no charge.

5.4 Make available a service contract offering continuing factory authorized service of the system after the initial warranty period. **Provide minimum FIVE-YEAR WARRANTY PERIOD.**

5.5 System Integrator shall provide documentation for all software maintenance charges required in years 2 -10 as part of their proposal or provide documentation that software maintenance charges are not required to maintain warranty

PART 6 – MANUFACTURERS

6.1 Manufacturers: Subject to compliance with requirements, provide the following system:

6.1.1 Telecenter manufactured by Rauland-Borg Corp

PART 7 - SYSTEM REQUIREMENTS

7.1 The platform shall utilize state of the art IP Technology, Call-in Notification, School Safety Paging and Evacuation tones, IP infrastructure, Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone, Two-way hands-free Internal Intercommunications and Paging, and Program Distribution. The system shall be easy to learn and operate. All standard programming shall be web based and user friendly to allow the system administrator the ability to easily program system features.

7.2 Provide complete and satisfactorily operating school communications and school safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

7.3 The platform shall be a single electronic system consisting of a minimum of 10 intercom channels per facility, (classroom) IP speakers, corridor speakers, inside and outside horns, call-in switches, and SIP phone integration. Refer to drawings for exact zoning required.

7.4 The platform shall lend itself to expansion by simple addition of hardware modules.

7.5 The platform shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility.

7.6 The platform shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands free and will not require any interaction by the classroom user.

7.7 Each classroom shall be provided with a Speaker Module interface and a call switch, each with their own annunciation path and priority.

7.8 IP addressable speaker modules for individual rooms shall be system programmable and may be assigned any two, three, four, five or six digit number as well as name and description. Any extension may be reassigned at any time.

7.9 Call-ins may automatically annunciate (display of priority and location) to administrative consoles, SIP enabled phones, and outside phones.

7.10 Call-ins shall be programmed to automatically change priority and annunciation route based on age of call-in and original priority.

7.11 Call-ins may have priority (and annunciation route) changed by user action from a console or SIP enabled phone.

7.12 IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation. Pre announce tone and supervisory tones shall be disabled during designated emergencies automatically.

7.13 Integrated Master Clock with a minimum of 20 schedules per school, a minimum of 500 events per schedule, and automatic Daylight Savings time correction. Up to 5 schedules may be active on any given day for each school. User shall be able to select from 25 standard included tones or unlimited user created and uploaded audio files for class change signaling and messaging. In addition, scheduled events shall include relay actions, paging and tone exclusion, email notifications and configuration changes. The platform shall allow control of the bell schedules via the district WAN/LAN without the need for a separate computer. Bell schedules can remotely be created, changed, stored, and downloaded to the system by an authorized user from a browser-based interface.

7.14 Each Classroom shall be provided with an IP Speaker module interface and up to 5 different call-in switches, each with their own annunciation path and priority.

7.15 Call-ins may automatically annunciate (display of priority and location) to administrative consoles, SIP enabled phones and outside phones.

7.16 Call-ins shall be programmed to automatically change priority and annunciation route based on age of call-in and original priority.

7.17 Call-ins may have priority and annunciation routing changed by user action from a console or SIP enabled phone.

7.18 Call-in annunciation routing shall include playing pre-recorded audio over speakers, sending a pre-configured e-mail and/or activating relays.

7.19 POE zone page amplifier module. This component will give the schools the ability to play audio to drive groups of speakers from a single device. Depending upon configuration you can have 14 or 35 watts of output. The module can be either wall or rack mounted.

PART 8 - EQUIPMENT AND MATERIAL

8.1 Server Software - EXISTING

8.1.1 System Software must be a ONE-TIME purchase and require on System Server for the School District. Systems that require multiple software packages will not be considered.

8.1.2 The server software supports encryption to ensure secure access.

8.1.3 The server software supports Active Directory interface.

8.1.4 Provides district wide paging, bell event scheduling, emergency notification and configuration for entire district.

8.1.5 Reports on feature usage, system activity, etc. shall be available from the web interface.

8.1.6 Ability to configure system and initiate system features via district wide web based interface.

8.1.7 The software has the ability to sync system time to the Atomic Clock Signal or to the school's network time server

8.1.8 The software will provide a web-browser interface to deliver emergency paging, pre-recorded messages, and tones from any authorized computer in the facility. The software must be capable of automatically notifying personnel via the WAN of an alarm condition.

8.1.9 The software can automatically broadcast page emergency instructions via associated system hardware throughout the entire school when an alarm (e.g. lockdown, lockout, security, fire) is initiated via the web-based interface. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems

8.1.10 The software allows for user-uploaded pre-recorded messages and tones. Software supports the upload of MP3 and WAV file types. User-uploaded pre-recorded messages and tones can be part of emergencies, sequences, and bell schedules.

8.1.11 The software shall support Telecenter Campus Controllers and Telecenter Page Modules for a minimum of 1000 facilities.

8.1.12 The software shall support a minimum of 50,000 IP Classroom & Zone modules.

8.2 Single Campus Controller Rauland-Borg Telecenter Series – with the following features and capabilities:

8.2.1 Provides call routing for paging and intercom for a single facility.

8.2.2 System shall connect to the district provided Telephone Network via a SIP connection.

8.2.3 The VX Works based Operating System and system programming database shall be stored in non-volatile flash memory. The Operating System can be easily upgraded through configuration without requiring replacement of any chips.

8.2.4 Support a flexible numbering plan allowing two, three, four, five, or six digit extensions.

8.2.5 The SIP interface to a district provided Telephone Network shall be capable of allowing connected phones to display classroom call-ins, answer internal intercom call-ins, make pages, and change priorities of call-ins in progress.

8.2.6 Direct Dialing, two-way amplified voice intercom between any SIP Enabled telephone or admin console and speaker without the use of a press-to-talk or talk-listen switch.

8.2.7 The ability to answer intercom call-ins registered at pre-selected telephones.

8.2.8 The ability to automatically escalate incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.

8.2.9 The ability to remotely locate IP Campus Controller. The controller shall not need direct connection to any classroom via home run or distributed wiring. It shall communicate solely through the IP LAN network.

8.2.10 Single button access from any telephone on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative telephone shall have priority over all regular system functions.

8.2.11 Stores a minimum of 20 bell schedules worth of Bell Event Schedules, all emergency notification sequences as well as facility wide configuration. Bell schedules can be programmed to annunciate tones, activate relays, send emails, activate program distribution, and notify SIP phones.

8.2.12 System has the ability to sync system time to the Atomic Clock Signal or to the school's network time server.

8.2.13 System's SIP Interface shall provide:

- Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
- Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.
- Ability to initiate school-wide emergencies including lockdown and evacuate sequences.
- Ability to answer a call-in directed to that SIP extension.
- Ability to upgrade a call-in directed to that SIP extension

8.2.14 The system will have the ability to utilize a web-browser and USB microphone to deliver school wide live emergency paging, pre-recorded messages, and tones from any authorized computer in the facility. The system must be capable of automatically notifying personnel via the WAN of an alarm condition.

8.2.15 The system can automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over

intercom/paging speakers and is not meant to replace primary fire alarm or security systems.

8.3 IP addressable Classroom (breakout) Modules: Provide Units as indicated on drawings distributed on a per room basis.

8.3.1 System shall provide multiple IP addressable modules for intercom, paging, and relay activation.

- All modules are POE 802.3af compliant
- All Modules support DHCP
- All Modules connect to network with a single RJ45 connector

8.4 IP Speaker Module shall interface to school's data network, a speaker, and multiple call switches.

8.4.1 A minimum of 5 levels of call-in can be placed from a IP Speaker Module. The call-ins route to designated administrative consoles and select SIP connected telephones and can only be cleared from the system once answered. If a call-in is not answered within a preprogrammed time the call-in may reroute to other telephones and consoles, and announce over selected or all speakers and.

8.4.2 The ability to belong to one or more of a minimum of 100 independent zones for zone paging, program/music distribution zones and class change tone reception; this assignment is a programmable function, change able by time of day. Each IP Speaker Modules location shall be programmed in software to belong to any combination of software zones. Software/hardwired zones must be configured as part of an unlimited number of district wide groups for school district emergency announcements. These district announcements must be accessed via microphone, a web-browser or telephone.

8.4.3 Intercom and paging volume adjustable from Software interface.

8.4.4 IP Speaker Modules shall be mounted to wall above door in ceiling space.

8.5 IP-addressable Zone Paging Module: Provide Units as required for zoning.

8.5.1 Each building to operate as a single zone. IP addressable Classroom (breakout) Modules

8.5.2 Zone paging module shall drive an amplifier to connect multiple speakers for all page, zone paging, bells, audio events and emergency notification.

8.5.3 Zone Paging Modules shall be rack mountable.

8.5.4 Zone Paging modules shall be able to belong to one or more of 100 independent zones for live paging, bells, pre-recorded audio, and emergency notification

8.5.5 IP Addressable Aux I/O Module: Provide no less than ONE

8.5.6 Aux I/O Module shall have two input contacts and two output contacts.

8.5.7 Input and output contacts are individually addressable.

8.5.8 Aux I/O Module shall be wall and rack mountable. **Tie into new fire alarm system for initiation of this zone where the new fire alarm system resides.**

8.5.9 User can program relays to be activated manually, through an event/bell schedule and during emergency notification.

8.5.10 Provide for receiving contact closure notification from School Fire Alarm System when FA System in alarm.

8.6 IP Addressable Program Line Input Module – Rauland Model TCC2055

8.7 Audio Paging/Program Amplifiers: Provide as needed to support a minimum of 10 Paging Zones or more as indicating by zoning on construction drawings. Refer to drawings for zoning required.

8.7.1 Power amplifier(s) shall be provided to provide a minimum of 5 watts of power to each paging speaker, and 15 watts of power to each paging horn.

8.7.2 The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.

8.7.3 Amplifiers shall be located the the nearest MDF/IDF distribution frame room.

8.7.4 Amplifiers to be 25V.

8.8 Normal/Emergency Call Switch – Rauland Dual Level Call In Switch Cancel. Provide as indicated on drawings.

8.8.1 Combination Normal/Emergency Call Switch indicated on the drawings shall provide the following functions and features:

- One (1) “Normal” call switch that shall activate a distinctive “NORM” level call from a single button activation. The button shall be clearly marked “NORM” and will route the call-in to any one or more Administrative Telephones or SIP interface to offsite telephones. This button may also be used as a “check-in” button during crisis situations.
- One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from a single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY” and will route the call-in to any one or more Administrative Telephones or SIP interface for quick and easy response from an Administrative Telephone or off-site telephone.

8.9 Intercom Call Back Stations shall be Quam CIS2/8. Provide required accessories to interface with IP module.

8.10 Tile Ceiling Mounted Intercom Speaker – Rauland Model BAFKIT2X2L8RJ.

8.10.1 Shall be a pre-assembled 2 foot by 2 foot lay-in speaker, baffle and back box assembly consisting of a premium 8 Ohm, 8” speaker, a perforated steel baffle with white baked epoxy finish and an integrated back box that covers the full area of the baffle.

8.10.2 The speaker assembly shall include a female RJ-45 modular socket and mounting bracket to facilitate connection to the TCC2011 IP Speaker Module specified herein. Provide as indicated on drawings.

8.11 Gypsum Ceiling Mounted Intercom Speaker Assembly – Rauland Model ACC1480.

8.11.1 Shall consist of a premium 8 Ohm, 8" loudspeaker mounted on a 12-7/8" round white epoxy steel baffle. The recessed ceiling back box shall be an 8" round enclosure with a plaster flange mounting ring and a depth of 4-1/8" (Rauland Model ACC1110).

8.11.2 The speaker assembly shall include a female RJ-45 modular socket and mounting bracket to facilitate connection to the TCC2011 IP Speaker Module specified herein. Provide as indicated on drawings.

8.12 Recessed Wall Mounted Intercom Speaker Assembly – Recessed speakers shall not be used.

8.13 Pedant Suspended Intercom Speaker Assembly – Lowell Model ESP-62XX w/ aircraft gripple hanger. – COLOR AS SELECTED BY ARCHITECT PRIOR TO ORDERING regardless of suffix.

8.13.1 Shall consist of a premium 8 Ohm, 6.5" loudspeaker assembly aircraft cable suspended AFF to length as indicated on drawing.

8.14 Tile Ceiling Mounted Paging Speaker – Rauland Model BAFKIT2X2L70V.

8.14.1 Shall be a pre-assembled 2 foot by 2 foot lay-in assembly complete with 8" full range speaker, 70Volt line matching, rotary-select tap transformer, perforated steel baffle with white baked epoxy finish and an integrated back box that covers the full area of the baffle.

8.14.2 The speaker assembly shall have a pair of speaker wires through a hole suitable for a ¾"conduit fitting as the connection point for twisted/shielded cabling to the Audio Paging/Program Amplifiers specified herein. Provide as indicated on the drawings.

8.15 Tile Ceiling Mounted Paging Speaker With Volume Control – Rauland Model BAFKIT2X2LVC.

8.15.1 Shall be a pre-assembled 2 foot by 2 foot lay-in assembly complete with 8" full range speaker, 25/70Volt line matching transformer, perforated steel baffle with white baked epoxy finish and an integrated back box that covers the full area of the baffle.

8.15.2 The speaker assembly shall have a pair of speaker wires through a hole suitable for a ¾" conduit fitting as the connection point for twisted/shielded cabling to the Audio Paging/Program Amplifiers specified herein.

8.15.3 The front panel accessible volume control permits the end user to adjust the loudness of the speaker to a comfortable level. Provide as indicated on the drawings.

8.16 Gypsum Ceiling Mounted Paging Speaker Assembly – Rauland Model ACC1400.

8.16.1 Shall consist of a high efficiency loudspeaker (Rauland Model US0188) complete with a 25/70 Volt multi-tap line matching transformer mounted on a round white epoxy steel baffle (Rauland Model ACC1000). The recessed ceiling back box shall be an 8" round enclosure with a plaster flange mounting ring and a depth of 4-1/8" (Rauland Model ACC1110). Provide as indicated on the drawings.

8.17 Recessed Wall Mounted Paging Speaker – Recessed speakers shall not be used.

8.17.1 Shall be an 8" permanent magnet seamless cone type with an additional cone provided to extend high frequency response. It shall have a frequency range of 65-17,000Hz, an 8 watt program power-handling capacity and an axial sensitivity of 93db at 1 watt with a 1 watt input. Voice coil shall be ¾" diameter with an impedance of 8 Ohms. The speaker shall be equipped with a multi-tap transformer (0.312, 0.625, 1.25, 2.5 and 5 watts) at 25V and 70V.

8.17.2 The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4" square by 3.75" deep (Rauland Model ACC1105).

8.17.3 The baffle shall be constructed of 22-gauge cold-rolled steel that is zinc-treated to resist corrosion. The finish is baked, powdered white epoxy which is virtually scratch- and mar-proof. (Rauland Model ACC1003). Provide as indicated on the drawings.

8.18 Surface Ceiling Mounted Paging Speaker – Quam System 1VP.

8.19 Surface Exterior & Joist Mounted Paging Speaker Assembly - Quam 6VPS field painted color to match by Architect.

PART 9 – EQUIPMENT RACKING

9.1.1 All head-end, distribution, and source equipment, including data and power, shall be in racks configured as approved by the Engineer.

9.1.2 Rack mounted equipment shall be accessible from front and rear.

9.1.3 All unused rack spaces will be covered with appropriate blank/vent panels

9.2 UPS equipment provided for this system will include Power Conditioning to smooth current and voltage fluctuations.

9.2.1 UPS equipment will be sized in accordance with the system manufacturer's recommendations.

PART 10 - EXECUTION

10.1 EXAMINATION

10.1.1 Examine conditions, with the System Integrator present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.

10.1.2 Do not proceed until unsatisfactory conditions have been corrected.

PART 11 – INSTALLATION

11.1 General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

11.2 Furnish and install all material, devices, components, and equipment for a complete operational system.

11.3 Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

11.4 Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.

11.5 Necessary Network PoE connections are to be provided by others. All network connectivity including Network Switches, Patch Panels, Patch Cords, Connectors, and wire are to be provided by others.

11.6 Provide necessary speaker and Call Switch wire in Classrooms, and Corridors within this scope of work.

11.7 Provide necessary clock wiring within this scope of work.

11.8 All cabling to be plenum rated.

11.9 All housings are to be located as indicated.

11.10 The System Integrator shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

11.11 Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

11.12 Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.

11.13 Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams. All cable jacket colors shall be Green.

11.14 Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

11.15 CABLE REQUIREMENTS: The wiring systems specified in these guidelines are based upon requirements and recommendations of the IEEE, ANSI, EIA\TIA 568\569 and TSB 36 & 40, and BICSI for horizontal premise wiring. All products used shall be UL listed and meet applicable local and state codes and must match the current Atlanta Public Schools standard.

11.16 Speaker Tapping: Tap speakers at the following locations accordingly.

11.16.1 Exterior – 2W
11.16.2 Corridor – 2W

PART 12 – GROUNDING

12.1 Provide equipment-grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

12.2 Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

12.3 Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

PART 13 - FIELD QUALITY CONTROL

13.1 Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

13.2 Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

13.3 Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at System Integrator's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

PART 14 - FINAL ACCEPTANCE TESTING

14.1 The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the

requirements of this section.

14.2 The System Integrator will provide a Final Acceptance Test record document signed by both the System Integrator and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.

14.3 Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

PART 15 - COMMISSIONING

15.1 The System Integrator shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 4.1, paragraphs 4.1, 4.2 & 4.3 of these specifications. In addition to the Training Materials provided, the System Integrator will also furnish Operators Manuals and Users Guides at the time of this training.

15.2 Schedule training with Owner through the owners representative, with at least seven days advance notice.

15.3 Perform drills to ensure all safety function programming operate correctly

PART 16 - OCCUPANCY ADJUSTMENTS

16.1 The System Integrator shall provide Occupancy Adjustments in accordance with these specifications. A response scenario amenable to both the owner and the System Integrator will be established and followed for the first year of service.

PART 17 - CLEANING AND PROTECTION

17.1 Prior to final acceptance, the System Integrator shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked, and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION 27 51 16

SECTION 28 31 00 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SCOPE AND RELATED DOCUMENTS

1.1.1 The work covered by and the intent of this section of the specifications will include the design, furnishing of all labor, equipment, materials, and performance of all operations in connection with the installation of the Fire Alarm System as herein specified. The drawings indicate a typical basis of design, **but this system is delegated design, signed, sealed, and stamped by a fire protection engineer for approval by the city/state and local authority having jurisdiction. Where the licensed fire protection design engineer feels additional devices are required to be installed and meet current or adopted codes, these items and associated cost shall be included in his final bid and any additions required shall be coordinated with the electrical contractor for any rough-in that may alter their scope of work so that this cost is included in their final bid. System is to be designed and installed complete.**

1.1.2 The requirements of all other applicable conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.

1.1.3 The complete installation shall conform to the applicable sections of NFPA-71, NFPA-72A, B, C, D, 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.

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

1.1.5 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.

1.1.6 Each Contractor's attention is directed to Section 260000 – General Provisions, 260501 – Scope of Work, Electrical Contract Documents, and all other Contract Documents as they apply to his work.

1.1.7 Refer to Specification Section 271300 “Voice/Data Network” for provision and installation of all cabling and all related scope of work.

1.1.8 The work specified under this section shall be coordinated with related work specified elsewhere in these specifications.

1.1.9 Division 26 – Electrical.

1.1.10 The Fire Alarm System shall consist of a raceway system, backboxes, conduit system, conduit sleeves, supports, hangers, cabling, mounting brackets and accessories, devices, cover plates,

equipment, cabinets, connections, terminations, programming, installation as indicated, and all material and labor and labor for devices and equipment specified herein and indicated on drawings. All items specified shall be provided new.

1.1.11 Contractor shall provide all new cabling for Fire Alarm System. Cabling includes, but not limited to multi-conductor cabling, data network cabling, and patch cables.

1.1.12 Provide homerun conduit between equipment and devices specified.

1.1.13 Existing devices and system shall be pre-tested and reported prior to demolition to confirm operation and location/inventory per room.

1.1.14 New system shall be post-tested after completion.

1.1.15 Results of pre-test and post-test report shall be tabulated and sent to Owner and Engineer for review and comment. Submit post-construction certifications to Owner and Engineer.

1.1.16 System shall be operational 7-days prior to substantial completion.

PART 2 - QUALITY ASSURANCE

2.1 Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. Listing of control equipment by alternate testing agencies may be acceptable upon prior written approval by the Engineer.

2.2 The system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits shall be marked in accordance with NEC Article 760-23.

2.2.1 All work specified in this section shall be performed by a technician certified in the State of Kentucky. (NICET Level II certified.)

PART 3 - GENERAL

3.1 Furnish and install an intelligent addressable multiplex fire alarm, with integral voice as a complete 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 devices, communicating upon a Style “4” Signal Line Circuit(s) (SLC) with individual device supervision, appliance circuit supervision, SLC loop isolation when called for, and incoming normal and stand-by power supervision. In general, systems shall include a control panel, manual pull stations, automatic fire detectors, speakers, flashing strobe lights, annunciator(s) (if indicated), raceways, all wiring, connections to devices, connections to valve tamper switches, water flow switches and mechanical controls, outlet boxes, junction boxes, protective covers, and all other necessary materials for a complete, operating fire alarm system.

3.2 FACP Spare capacity: The FACP system shall not exceed 80% of its rated capacity on its address SLC loop, indicating and supervisory lines, allowing for 20% spare capacity for future growth.

3.3 The fire alarm control panel shall allow for loading or editing of any special instructions or operating sequences as required. No special tools, chips, 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. Provide three disk copies of final panel program at close of project, to be included in with the operation and maintenance manuals.

3.4 All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name of each component. The catalogue numbers specified under this section are those of the Simplex Time Recorder Company and constitute the type, quality of design, materials, and operating features desired.

3.5 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. Only Fire alarm systems as manufactured by Simplex, Edwards or Honeywell will be acceptable.

3.6 Equipment submissions for shop drawing review must include a minimum of the following:

3.6.1 Complete descriptive data indicating UL listing for all system components.

3.6.2 Complete sequence of operations of the system.

3.6.3 Complete system wiring diagrams for components capable of being connected to the system and interfaces to equipment supplied by others.

3.6.4 A copy of any state or local Fire Alarm System equipment approvals.

3.6.5 An Autocad Version 2000 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 disk copies of as-built drawings and three prints at close of project, to be included in operations' manual.

PART 4 - OPERATION

4.1 The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:

4.1.1 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. The point label shall display for alarmed devices their physical location by area or room e.g.: “FLR3 N. Top of Stairwell” or: “FLR1 S. Hallway by RM 116”, FLR4 E. MECH RM 411” etc.

4.1.2 A pulsing alarm tone shall occur within the control panel until acknowledged.

4.1.3 Audible/Visual Alarm Indication: By sounding signals on loudspeakers and strobes.

4.1.4 Voice Message: Upon activation of an initiating device, a slow "whoop" tone shall be activated throughout the building for 10 seconds. After a pause, a pre-recorded message is activated, and four complete rounds of this message will be transmitted. Verify message with Department of Public Safety. Voice and tones are to be stored on nonvolatile chip memory.

4.1.5 The voice message shall be a woman's and say as follows: "ATTENTION, ATTENTION. An emergency has been reported. All occupants walk to the nearest exit and leave the building. Do not use the elevators. Upon exiting, stay 25ft from building entrances until an all clear is given."

4.1.6 Activation of the FACP "Alarm/Signal Silence" button shall only silence alarm speakers. All other devices, visuals, door release, HVAC shutdown, alarm signal to DPS, and AUX controls shall remain in the alarmed condition.

4.1.7 This sequence will continue until reset of the FACP.

4.1.8 Upon alarm, all doors normally held open shall close, and all normally locked security "mag-locked" doors shall release. Hold open doors shall also be released in the event of incoming normal power failure.

4.1.9 A supervised signal to notify the local fire department or an approved central station (as required by local codes) shall be activated.

4.1.10 A supervisory signal sent to the mechanical controls shall activate or reconfigure the air handling systems as required by NFPA 101, or as otherwise indicated herein. Additional control (if any) of air handling systems shall be as indicated on the drawings.

4.1.11 The Contractor(s) shall coordinate with each other as necessary to provide all required auxiliary contacts, interlock wiring to MCC interfaces and equipment, etc., as needed to shut down air handling systems per NFPA and all applicable codes. The use of addressable relay controllers on the SLC to accomplish this function will be acceptable, if in compliance with codes.

4.1.12 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.

4.1.13 Elevator Operations under alarm condition: For 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 cab(s) to be recalled according to the following sequence:

4.1.13.1 If the alarmed detector for the elevator is in any location other than the main level of egress, the elevator cab(s) shall be recalled to the main level of egress (Recall to Main)

4.1.13.2 If the alarmed elevator detector is on the main egress level elevator lobby, the elevator cab(s) shall be recalled to the pre-determined alternate recall level (Recall to Alt).

4.1.13.3 If the alarmed elevator detector is at the top or bottom of the shaft or in equipment room, provide a third set of contacts to the elevator controller to “Flash” the fireman’s hat function. Coordinate all equipment terminations and sequence of operation with the elevator contractor. The use of addressable relay controllers on the SLC to accomplish this function will be acceptable, if in compliance with codes. Provide a recall pre-test with owner’s representative present before final acceptance test with elevator inspector is scheduled.

4.1.14 Elevator Controller:

4.1.14.1 Provide auxiliary contacts within the base of each elevator lobby smoke detector, each separate landing to be wired back separately to the elevator controller. Coordinate all equipment terminations and sequence of operation with the elevator installer.

4.1.14.2 Provide heat detectors at elevator room, shaft, and pit to open elevator power circuits as detailed.

4.1.15 The activation of any sprinkler or standpipe water supply valve tamper switch shall activate a distinctive system supervisory audible signal and illuminate a "Supervisory" sprinkler valve tamper switch condition at the main control panel (and the remote annunciator[s]). The point label shall display for tamper switches their physical location e.g.: “FLR3 N. Stairwell landing” or: “FLR1 S. Hallway in RM 116 Ceiling” etc. There shall be a distinction in the audible trouble signals between valve tamper switch activation and opens or grounds on fire alarm circuit wiring.

4.1.16 Activating the trouble silence switch will silence the supervisory audible signal while maintaining the "Sprinkler Supervisory Tamper" and its location showing that a tamper contact is still activated.

4.1.17 Restoring the valve to the normal position shall cause the audible signal and visual indicator to pulse at a fixed rate.

4.1.18 Activating the trouble silence switch shall silence the supervisory audible signal and restore the system to normal.

4.1.19 Include with the control panel, as an auxiliary function, a built-in test mode that, when activated, will cause the following operation sequence:

4.1.20 The city connection circuit shall be disconnected.

4.1.21 Control relay functions shall be bypassed.

4.1.22 The control panel shall show a trouble condition.

4.1.23 The alarm activation of any initiation device shall cause the audible signals to pulse one round of Code identifying the initiation circuit (e.g., an activated smoke detector connected to Zone 4 shall pulse the audible signals 4 times in rapid succession.

4.1.24 The panel shall automatically reset itself.

4.1.25 Any momentary opening of an initiating or indicating appliance circuit shall cause the audible signals to sound for 4 seconds to indicate the trouble condition.

4.1.26 A manual evacuation switch shall be provided to operate the system indicating appliances or initiate "Drill" procedures.

4.1.27 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.

4.1.28 Provide dry contact input from owner's access control system for security lockdown procedure. Upon activation, system shall release all door hold magnets so allow doors to close and latch. Coordinate requirements with owner's access control system.

4.1.29 Fire Pump Monitoring: System shall monitor the status of the fire pump controller. When fire pump is connected to generator power and the controller is calling for the pump to fun – the fire alarm shall send an inhibit signal to the stand by automatic transfer switch to remove non-essential loads from the generator. Signal shall not include any intentional delay.

PART 5 - SUPERVISION

5.1 The system shall contain Style "4" SLC addressable initiation circuits per area/floor as required. A SLC loop shall be so arranged that a fault in any one addressable loop shall not affect any other loop. If one SLC circuit serves more than one floor, each floor shall utilize an isolator per floor (per manufacture specs for isolator use) If the SLC wiring leaves the building, it shall have an isolator and be surge protected with the appropriate device per the NEC. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

5.2 Supervisory initiation circuit(s) shall be wired "Class B" from addressable modules as required, for connection of all sprinkler valve tamper switches. If the "Class B" wiring leaves the building, it shall be surge protected with the appropriate device per the NEC. Wiring methods which affect 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 each tamper switch as indicated by the zoning schedule on the plans or as otherwise indicated.

5.3 There shall be independently supervised and independently fused indicating appliance circuits as required for alarm audible signals and flashing alarm lamps. If remote NAC power extenders are used, a single indicating appliance circuit or module will be used to drive remote NAC(s), with device label as to the NAC's physical location.

5.4 When building smoke control is called for, all auxiliary manual controls shall be supervised so that all switches must be returned to the normal (automatic) position to clear system trouble. Each independently supervised circuit shall include a discrete (amber color) "Trouble" indicator to display status condition per each circuit.

5.5 The incoming power to the system shall be supervised so that any power failure shall be audible 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.

5.6 The system batteries shall be supervised so that disconnection or failure of a battery shall be audibly and visually indicated at the control panel (and the annunciator).

5.7 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.

5.8 Provide connection to the building security system to annunciate panel alarm as directed by Owner.

5.8.1 There shall be independently supervised and independently fused indicating appliance circuits as required for alarm audible signals and flashing alarm lamps.

5.8.2 All auxiliary manual control shall be supervised so that all switches must be returned to the normal (automatic) position to clear system trouble.

5.8.3 Each independently supervised circuit shall include a discrete (amber color) "Trouble" indicator to indicate disarrangement conditions, per each circuit.

PART 6 - POWER REQUIREMENTS

6.1 All fire alarm 120V shall be provided from Emergency Life-Safety Panels connected to the generator.

6.2 The control panel shall receive 120 VAC power via a dedicated circuit. The incoming circuit shall have suitable over current 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.

6.3 If the facility is equipped with an emergency standby power generator, the fire alarm equipment shall be connected to this system, per N.E.C.

6.4 The system 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 minimum of 24hrs, or 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. All batteries used within the system shall be of the same manufacturer, and labeled with their date when put in service.

6.5 All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

PART 7 - FIRE ALARM CONTROL PANEL

7.1 At location shown on the plans, provide and install an Intelligent Addressable Multiplex Voice Fire Alarm System as manufactured by: Edwards EST3/Voice, Simplex 4100U/Voice, or Notifier NFS-640/3030 Voice will be acceptable.

7.1.1 **Note: Provide alternate bid for preferred alternate for Edwards Voice Fire Alarm System and devices. Refer to front end documents.**

7.2 The Intelligent Addressable Multiplex system shall have integral voice communications within the main panel; adjunct voice panels are not acceptable. The Fire Alarm Control Panel Construction shall be modular with solid state, microprocessor based electronics. The FACP cabinet shall not be filled to over 80% capacity to allow for future expansion. All visual indicators shall be high contrast, LCD and LED as needed.

7.3 Main microphone in FACP voice control center shall override the automated voice message and tones when engaged, and resume tone and voice messaging when released. Voice control center operations shall allow for microphone use with and without All-Call tone, for the All-Call of all speakers, and the selection capability to speak to separate floors and or areas of building. If other than floor selection, see prints for area details.

7.4 Provide for (5) Disable/Enable Zone Levels. Levels can be software or front panel switch controlled. Allows for devices in disabled zone to report to panel and DPS monitoring, but no other alarm output shall function, e.g. A/V's, door release, HVAC Shutdown etc. When engaged, shall initiate a trouble condition at the control panel.

7.5 Provide for the following levels:
1. Disable/Enable Smoke Detection zones. Pulls, Heats & Flows can initiate an alarm.
2. Disable/Enable Smoke & Heat Detection zones. Pulls & Flows can initiate an alarm.
3. Disable/Enable Flow & Tamper zones. Smoke, Pulls & Heats can initiate an alarm.
4. Disable/Enable All initiating zones & output controls. Alarms displayed at panel only.
5. Disable/Enable Room Sounder Bases (Dorms Only)

7.6 The FACP, or an adjunct approved sub panel of the same system manufacturer shall contain the feature to accept push-to-talk or audio inputs from other sources for purposes of future connection to a campus wide emergency notification system. If this requires an adjunct sub panel, list as a separate price. Local fire alarm conditions shall take priority over this system.

7.7 A manual evacuation switch shall be provided at the panel to operate the system indicating appliances and/or initiate "Drill" procedures. If a drill switch is not provided on the front of the FACP, a manual pull station shall be installed adjacent to panel. Exception, unless a manual pull station is within 15 feet of FACP.

7.8 The control panel shall include a built-in walk test mode to facilitate testing and system inspection. Dependant on system/manufacturer chosen, contractor shall fully explain functionality of walk test feature.

7.9 System voice amplifiers: Amplifiers shall be 25 Volts rms and supply a minimum of 30 Watts, utilize system battery back-up and supervision for amplifier failure. A back-up amplifier of equal power with auto switch over shall be used in Dorm buildings, or if specifically called for in spec.

7.10 Provide one IP network data cable connection from MDF, one Spare IP data cable from MDF, and one network data cabling connection for cellular monitoring. Refer to “remote reporting” section and provide cellular dialer where required by AHJ.

7.11 The control panel shall contain the minimum following features as per plans:

- Minimum Capacity of 240 Control or Monitor Points
- Addressable Initiation Device Circuits (SLC) (Style 4 or 6 capable)
- Alarm Indicating Appliance Circuit
- Alarm verification per point, and tally.
- Nonvolatile history files for Alarms, Troubles, and Supervisory events.
- Supervised Annunciator Circuits
- Local Energy City Connection, as required
- Form C Alarm Contacts (2.0 Amps ea., 3 total)
- Earth Ground Supervision Circuit
- Automatic Battery Charger
- Standby Batteries
- Resident non-volatile programmable operating system memory for all operating requirements
- Power supplies and batteries as required for auxiliary functions as indicated. Note: Bolt-on terminals shall be used on battery sets if their back-up power current exceeds nine (9) amps in AC off mode. Fast-on terminals to be used otherwise.
- Front panel controls, or programmed software zones for disabling/enabling system functions to facilitate testing or normal building maintenance operations.
- Auxiliary contacts or relays for auxiliary functions as indicated
- All Custom Software and Programming as required to suit the project requirements.

PART 8 - REMOTE ANNUNCIATOR

8.1 Where indicated on the plans, provide, and install annunciator/control panel, with remote microphone. The remote microphone shall have All-Call capability only. The panel shall be of vandal-resistant construction and shall contain a liquid crystal illuminated display for alphanumeric indication of all required functions. The panel shall also contain the following control functions, activated by a master system enable key switch on front panel:

8.1.1 Remote system reset switch, to complement main control panel reset switch.

8.1.2 Remote Microphone, with All-Call capability.

8.1.3 Remote alarm signal silence switch.

8.1.4 Remote trouble silence switch to silence trouble alarms in annunciator panel and main control panel.

8.2 Install panel on properly sized 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.

8.3 Annunciator legends shall mimic the main panel display for indicating the area or device location. The legends shall be electronically generated on an alphanumeric display panel. The fire alarm system vendor shall coordinate the legends with the Engineer at shop drawing review.

8.4 Wiring between main control panel and annunciator(s) shall be fully supervised, and accomplished over twisted shielded pair with red jacket, plenum rated, as required by the manufacturer, per N.E.C.

8.5 Provide all programming and software necessary to place annunciators and controls in full operation. System set-up shall allow for changes in annunciator legends without rewiring or addition of programming or electronics. 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.

PART 9 - PERIPHERAL DEVICES

9.1 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.

9.2 MANUAL PULL STATIONS: 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.

9.3 CEILING-MOUNTED SMOKE DETECTORS, PHOTOELECTRIC TYPE:

9.3.1 Furnish and install where indicated on the plans, ceiling-mounted photoelectric smoke detectors with integral heat detection. Provide standard bases as required. Normal operation: Detector is programmed for verification. Detection of smoke or heat by unit will cause general alarm.

9.3.2 When a smoke detector is used in a dorm room. Detector shall be mounted upon approved sounder base of the same manufacture. Detector is programmed for verification. Detection of smoke shall cause the sounder base to alarm in effected room only, a supervisory room alarm signal is sent to DPS monitoring station via Kidde/Continumm panel, and the alarmed room number and floor/wing to be displayed and logged on the FACP. Point type will as a supervisory alarm signal. Upon activation of the integral heat in room smoke detector, a general building alarm will activate, all room sounder bases will activate, and the alarmed room number and floor/wing to be displayed and logged on the FACP

9.3.3 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 SLC detection loop. Loss of the operating voltage shall cause a trouble signal to be generated at the control panel. Detectors shall be capable of being reset at the main control panel.

9.3.4 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 spring-type, self-wiping contacts. Removal of the detector head shall cause a trouble signal at the control panel and display of its location. The removal of a single detector head shall not cause an open on the SLC loop. Detector design shall provide full solid state construction, and compatibility with other fire alarm detection loop devices such as heat detectors, pull stations, etc.

9.3.5 To minimize nuisance alarms, voltage and RF transient problems, 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 wire guard that are U.L.-listed for the device and that correctly covers the unit.

9.3.6 Remote LED alarm indicators shall be installed for Duct Detection units where required.

9.3.7 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".

9.4 AUTOMATIC HEAT DETECTORS: Automatic addressable heat detectors shall be combination rate-of-rise and fixed-temperature type. When the fixed-temperature portion is activated, the units shall be restorable. Heat detectors shall be 135, 165 or 195F, as indicated on plan. Where not indicated, provide 135F units. Where detector requires or is indicated to be furnished with a wire guard, utilize a U.L. listed unit, correctly covering and compatible with the device.

9.5 AUTOMATIC HEAT DETECTORS (FIXED TEMPERATURE TYPE): 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”.

9.6 WATER FLOW AND SPRINKLER SUPERVISORY SWITCHES: 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.

9.7 AUDIO VISUAL UNITS:

9.7.1 Alarm speaker/strobe assemblies shall include separate wire leads or terminals for proper in/out wiring of each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors shall not be accepted. The speakers shall have field selectable wattage taps. Speaker tap shall be ½ watt per location unless otherwise noted on prints. The audio visual units shall be equipped with a Xenon-type strobe which shall be semi-flush mounted on compatible 4" square outlet box. The speaker/strobes shall be listed under UL 1971 for signal devices for the hearing impaired. All building strobes shall be synchronized.

9.7.2 If an Audio Visual unit is required to mounted: exterior, or in shower room location, units shall be weather proof, and mounted upon appropriate weather proof back box.

9.7.3 The output intensity of all visual units, their locations and mountings shall be in compliance with the latest version of the Americans with Disabilities Act requirements. Provide additional units as needed to meet these requirements.

9.7.4 Ceiling and wall mounted devices are allowed. Refer to drawings.

9.8 VISUAL FLASHING LAMPS:

9.8.1 Visual only indicating appliances shall be Xenon type strobe. These devices shall be UL listed and be capable of either ceiling or wall mounting. The "LEXAN" lens shall project out from back plate. Lettering shall be oriented upright to the standing viewer.

9.8.2 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. The output intensity of all visual units, their locations and mountings shall be in compliance with the latest version of the Americans with Disabilities Act requirements. Provide additional units as needed to meet these requirements.

9.8.3 Ceiling and wall mounted devices are allowed. Refer to drawings.

9.9 DOOR HOLDERS: 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.

9.10 DUCT SMOKE DETECTORS:

9.10.1 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.

9.10.2 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.

9.10.3 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.

9.10.4 **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.**

9.10.5 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.

9.10.6 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. Remote alarm/power indicator and key reset-test switch shall be Simplex type 2098-9782.

9.10.7 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.

9.10.8 Ionization - type detectors will not be permitted for air duct smoke detection.

9.10.9 All air duct smoke detector installations and materials shall be in accord with NFPA-90A, and any other applicable codes.

9.10.10 Written documentation shall be provided to prove proper air flows at and thru sampling tubes.

9.10.11 Detector supervised power and alarm wiring (from F.A. control panel) is to be provided by the Contractor. Interlock wiring from auxiliary contacts to stop air handling unit fan motor is to be provided by the Contractor. Provide auxiliary contacts as required to the main MCC. The use of addressable relay controllers on the SLC loop to accomplish HVAC shut down function will be acceptable, if in compliance with codes.

9.10.12 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.

9.10.13 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.

9.10.14 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.

9.10.15 Ionization - type detectors shall not be utilized for air duct smoke detection.

9.10.16 All air duct smoke detector installations and materials shall be in accord with NFPA, and any other applicable codes.

9.10.17 Installation shall be coordinated between EC and LV Fire Alarm system installer to provide a complete system.

PART 10 - WEATHERPROOF DEVICES AND EXPLOSION-PROOF DEVICES

10.1 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.

PART 11 - REMOTE REPORTING

11.1 System shall be tied into owners central district Edwards Fireworks system which has connection to a U.L. listed Central Receiving Station.

11.2 Where AHJ requires local connection to U.L. listed Central Receiving Station, Provide a cellular dialer communicator for 24 hour service.

11.3 The installation and connection of the remote monitor system for U.L. listed Central Receiving Station 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 cellular system whose system may be utilized for communication. Include any costs associated with cellular or fireworks central monitoring connection. All communication connections shall be in compliance with NFPA 71, chapter five.

11.4 The remote monitoring connection 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.

11.5 Where the AHJ does not accept the connection to the owner's district fire works system and connection to a U.L. listed Central Receiving Station, the services of a Central Receiving Station (as above) shall be engaged for a period of one year from the date of substantial completion. 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.

PART 12 - AUTOMATIC CARBON MONIXIDE DETECTOR

12.1 Not used.

PART 13 – INSTALLATION

13.1 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 and red finished EMT. Field painted raceways will not be accepted.

13.2 All junction boxes and covers shall be manufactured to designate "Fire Alarm". Wiring color code shall be maintained throughout the installation. The number of wiring splices shall be minimized throughout. Excessive wire splicing shall be cause for rejection of the work, as determined by the Engineer.

13.3 Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate tradesmen or other contractors.

13.4 The Contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of installation.

13.5 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.

13.6 All submittals for this project shall list names, license numbers, and telephone numbers of two installers employed full time by the manufacturer to install and test fire alarm systems in the State of Kentucky.

13.7 All connections to fire alarm devices shall be made by a technician both certified by state of Kentucky and NICET Level II fire alarm technician. No exceptions. Electrical contractor can install raceways and pull cables only. Demo also can only be made by NICET Level II and Kentucky certified fire alarm technicians.

13.8 A floor plan drawing indicating fire alarm devices and wiring only, shall be provided by the manufacturing company for job site use. These drawings must be approved by the State Fire Marshal's Office. A copy of this drawing shall be submitted to the Engineer for his review and project records. Provide description of location of each device with shop drawings.

13.9 Provide wire guards for all notification devices in gym. Wireguard shall have clearance around devices. Manual devices in the gym shall be provided with operable polycarbonate covers.

13.10 All surface boxes shall be manufactured for the installed device and shall match devices in size.

13.11 Contractor shall provide a barcode on each device, including main panel. Barcodes shall not repeat in the same building.

PART 14 – TESTING

14.1 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 prior to the Fire Marshal inspection. Upon completion of a successful test, the Contractor shall certify the test results in writing to the Fire Marshal, Owner and Engineer. Provide written 72 hour advance notice of the test to all concerned parties.

14.2 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.

14.3 The Contractor shall provide a minimum of four hours of instructional time to the Owner, for each building, 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.

14.4 The equipment manufacturer shall provide for three of the owner's personnel to be factory certified to maintain and troubleshoot all new equipment. The contractor shall include in their bid all cost associated with three personnel traveling to factory, all training cost, cost for any required computer programs, required software fees for 5 years, expenses, etc.

14.5 Contractor and manufacturer shall be required to accompany the engineer on a complete system verification after the installation has been certified. This shall include physically testing each device and reviewing descriptive device readout. They shall apply to all buildings of this project.

PART 15 - WARRANTY

15.1 The Contractor shall unconditionally guarantee (except for vandalism or misuse) the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of substantial completion.

15.2 The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72H guidelines.

15.3 Spare Parts: The Contractor shall deliver to the owners representative at the completion of the job the following spare parts matching the as installed system components:

(2) Manual Pull Stations.
(2) Addressable Monitor Modules.
(2) Addressable Output Control Modules.

PART 16 – TRAINING

16.1 Provide 4-hours of training for school personnel on the operation and 2-hours of technical training for the personnel of the Electronic Maintenance Department.

16.2 Contractor is to schedule with each on the time and date of the training.

PART 17 – EXECUTION:

17.1 The Division 26 Contractor shall provide all conduits, junction boxes, and materials required for the installation of a conduit system, conduit sleeves, raceways, and 120VAC power and outlets.

Any material and/or equipment necessary for the proper operation of the system not specified or described herein shall be deemed part of this specification.

17.2 The Division 27 and 28 Contractor shall provide all cabling, devices, cover plates, equipment, cabinets, training, programming, and installation of Contractor and Owner furnished equipment as specified herein.

END OF SECTION 28 31 11

SECTION 31 10 00 – SITE CLEARING

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Stormwater Pollution Prevention Plan (SWPPP)
Section 31 25 00 – Erosion Prevention and Sediment Control

1.02 SUMMARY

(A) Section includes removal of surface debris; removal of trees, shrubs, and other plant life; and placement of topsoil excavation.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 EXAMINATION

(A) Verification of existing conditions before starting work: Under provisions of Division 01 Sections.
(B) Identify stockpile areas for placing removed materials.

3.02 PROTECTION

(A) Locate, identify, and protect utilities, from damage.
(B) Protect benchmarks and survey control points from damage or displacement.
(C) Protect site in accordance with SWPPP prior to any clearing and grubbing. Use SWPPP for sequence of activities

3.03 CLEARING

(A) Clear and grub and remove obstructions to areas required for access to site and within clearing and grading limits of site.
(B) Remove trees, stumps, shrubs, roots to a depth of not less than 24” below grade. Any trees indicated to remain shall be protected with barriers during construction. Do not disturb the natural ground surface in the vicinity of the existing trees that will remain, out to the tree drip line.
(C) Clear undergrowth and deadwood, without disturbing subsoil.
(D) Holes left by the removal of trees and brush shall be filled and compacted in accordance with the requirements of Section 31 23 00.
(E) Trees shall not be removed from the secondary spoils area until it is determined that the spoils area will be necessary for the project.

3.04 REMOVAL

(A) Remove debris, trees, shrubs and roots from the site and dispose of in accordance with SWPPP.

3.05 TOPSOIL EXCAVATION

(A) Strip topsoil to whatever depths encountered in a manner to prevent the topsoil from mixing with the underlying subsoil or other materials.
(B) Do not excavate wet topsoil.
(C) Stockpile in area designated on site to a depth not exceeding 8 feet. Construct stockpiles in a manner to freely drain surface water. Protect stockpiles in accordance with SWPPP.
(D) Do not remove topsoil from site without Owner's permission.

END OF SECTION 31 10 00

SECTION 31 22 16 – ROUGH GRADING

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Stormwater Pollution Prevention Plan (SWPPP)
Section 31 10 00 – Site Clearing
Section 31 23 00 – Excavation and Backfill
Section 31 23 16.16 - Trenching

1.02 SUMMARY

(A) Section includes removal of subsoil; and cutting, grading, filling, rough contours, compacting and setting rough grade for site structures, building pads, parking areas and drainage structures.

1.03 SUBMITTALS

(A) Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

2.01 EXAMINATION

(A) Verify site conditions.
(B) Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.

2.02 PREPARATION

(A) Identify required lines, levels, contours and datum.
(B) Stake and flag locations of known utilities.
(C) Locate, identify and protect above and below ground utilities indicated to remain, from damage.
(D) Protect plant life, lawns and other features remaining as portion of final landscaping.
(E) Protect benchmarks, survey control point, existing structures, fences, sidewalks, identified trees, paving and curbs from excavating equipment and vehicular traffic.

2.03 SUBSOIL EXCAVATION

(A) Excavate subsoil from areas to be further excavated and/or regraded.

(B) Stockpile subsoil in area designated on site to depth not exceeding 8 feet. Construct stockpiles in a manner to freely drain surface water. Protect stockpiles in accordance with SWPPP.
(C) Replace damaged or displaced subsoil as specified for backfill.
(D) Any excess material shall be disposed of offsite, in accordance with SWPPP.

2.04 FILLING

(A) All backfill operations will be in accordance with Section 31 23 00.

2.05 TOLERANCES

(A) Top surface of subgrade shall be graded to a tolerance of plus or minus 1/10 foot from required plan elevations.

END OF SECTION 31 22 16

SECTION 31 22 19.13 – FINISH GRADING

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

(B) Related Sections:
Stormwater Pollution Prevention Plan (SWPPP)
Section 31 23 00 – Excavation and Backfill
Section 32 92 00 – Turf and Grasses

1.02 SUMMARY

(A) Section includes site cleanup, subgrade preparation and final grading to provide smooth, positive draining finished grades free of depressions, high spots, loose material and compacted areas. Any items that are normally required to achieve this finish, but are not specifically called for in the Plans and Specifications are to be considered a part of the project.

1.03 SUBMITTALS

(A) Submittal procedures: Under provisions of Division 01 Sections.

1.04 CLOSEOUT SUBMITTALS

(A) Closeout procedures: Under provisions of Division 01 Sections.

1.05 COORDINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.

PART 2 – PRODUCTS

2.01 MATERIALS

(A) Topsoil: Clean, fertile topsoil, without admixture of subsoil material and free from gravel, clay lumps, stones over 1” diameter, roots, sticks or other foreign materials.

PART 3 – EXECUTION

3.01 EXAMINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.

(B) Inspect areas and conditions to which finished grading shall be performed and ensure any unsatisfactory conditions have been corrected prior to proceeding with work.
(C) Finish grades shown on the Site Grading Plan shall be followed, unless discrepancies or inconsistencies are brought to the attention of the Owner prior to or during commencement of work and approval is given to deviate from the plans.

3.02 PREPARATION

(A) The Contractor shall use precaution to prevent damage to existing permanent structures, utilities, plants, trees, pavement and other project components on the site during finished grading procedures. Provide barriers or fences as necessary to protect existing conditions. Use appropriate equipment that will prevent damage to adjacent materials or structures.
(B) All topsoil on the site shall be saved and used on the project area, unless other arrangements are made with the owner.
(C) Do not commence finish grading work when subgrades are saturated with water or are frozen.
(D) Do not commence finished grading work until exterior building work is completed and worker traffic over lawn areas has ceased. All site lighting and utility work shall also be completed.
(E) All construction debris, large stones and other foreign material shall be removed from the site prior to grading operations as discussed in the SWPPP.

3.03 GRADING OPERATIONS

(A) Scarify the lawn and field surfaces to a minimum depth of 6” prior to final grading.
(B) After rough grading has had sufficient time to settle, place topsoil to a 4” minimum depth on all disturbed areas designated for grass.
(C) Slope finish grades to drain surface water away from buildings, walks, paving and other structures unless noted otherwise. Slope finish grades to drain surface water to drainage structures and drain ways as shown on the Grading Plan and Storm Piping Plan of the construction documents.
(D) Add water as necessary to melt clods and induce settlement of the topsoil mixture. When adequately dry, regrade, adding topsoil, if necessary.
(E) Fill and compact any depressions and remove all loose material to finish surface, creating a uniform, compacted surface.
(F) Rake surface until the surface is smooth, friable and has a uniform, fine texture with no lumps or stone over 1” diameter.

3.04 BASEBALL AND SOFTBALL DISTURBANCE GRADING OPERATIONS

(A) Fine-grade subgrade to elevations required to create final finish turf infill elevation flush with proposed curb surface. Field to be on uniform plane and grade.

(B) Subgrade: Laser grade the subgrade to a tolerance of + 0.5” of design elevation. Proof-roll the subgrade to assure a consistent and uniform compaction of a least 92% across the entire field. Owner is to be provided with 24 hour notice of proof-roll. Proof-roll to occur in the presence of owner or owner’s representative. The Owner, or owner’s representative will observe the subgrade and inform the contractor of visual acceptance of the subgrade conditions. Acceptance of the subgrade is required before the contactor can commence drainage installation and/or gravel base

placement. The Owner reserves the right to inspect and test the subgrade as it deems appropriate, including employing a certified surveyor or geotechnical engineer. Such acceptance, however, does not relieve the Bidder of responsibility for complying with these specifications.

3.05 TOLERANCES

(A) Adjacent to building and other structures, finish grade to within ½" required grades and lines per the Project Plans. Elsewhere, finish grade to within 1" of proposed grades. Slopes shall be graded to be smooth and uniform.
(B) Make proper allowances for settlement. Minimum soil depths specified are after settlement.

3.06 SITE CLEANUP

(A) The contractor shall remove all equipment, unused materials and other items or debris from the site once work is complete. The construction site shall be left in a neat, orderly condition, clear of all unsightly items.

3.07 WARRANTY

(A) Settlement in fill or backfill, which may occur within warranty period, shall be corrected at no cost to the Owner.

END OF SECTION 31 22 19.13

SECTION 31 23 00 – EXCAVATION & BACKFILL

PART 1– GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Document: Geotechnical report by Consulting Services, Inc. dated January 25, 2023.
Stormwater Pollution Prevention Plan (SWPPP)
Section 31 10 00 – Site Clearing
Section 31 22 16 – Rough Grading
Section 31 23 16.16 – Trenching

1.02 SUMMARY

(A) Section includes mechanical excavation for building, drives, parking areas, backfilling to subgrade elevations, site filling and backfilling and site grading. Pavement base course is specified in Section 32 12 00 - Flexible Pavement.
(B) Section includes removal of unusable material identified and discovered during excavation.

1.03 REFERENCES

(A) ASTM D698, Moisture-Density Relations of Soils and Soil Aggregate Mixtures, Using a 5.5-lb. Rammer and 12-in. Drop.
(B) ASTM D 1556, Density of Soil In-Place by the Sand-Cone Method.
(C) ASTM D 2049, Relative Density of Cohesionless Soils.
(D) ASTM D 2167, Density of Soil in Place by the Rubber-Balloon Method.
(E) ASTM D 2922, Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
(F) AASHTO T180 (American Association of State Highway and Transportation Officials) - Moisture-Density Relations of Soils using a 10 lb Rammer and an 18-in. Drop.
(G) ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. Rammer and 18 inch Drop.
(H) ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
(I) Local utility regulations as they may apply.
(J) Other local codes as they may apply.

1.04 SUBMITTALS

(A) Submittal Procedures: Under provisions of Division 01 Sections.
(B) Submit qualifications of each excavation contractor.
(C) Test report on borrow material from geotechnical consultant.
(D) Field density test reports from geotechnical consultant. A proctor sample has been provided in the project soils report.

1.05 COORDINATION

(A) Coordination and Project Conditions: Under provisions of Division 01 Sections.
(B) Schedule work to avoid damage to nearby improvements.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 PREPARATION

(A) Identify required excavation limits, lines levels, contours, and datum locations.
(B) Locate, identify, and protect existing above and below ground utilities from damage.
(C) Protect plant life and other features remaining as portion of final landscaping.
(D) Protect benchmarks and survey control points from excavating equipment and vehicular traffic.

3.02 EXCAVATING

(A) The soil report has identified areas with previously placed filled that will need to be removed and replaced. The geotechnical engineer shall be consulted to determine if the material that is removed can be reused as structural fill for the building and pavement areas. All subgrade areas shall be proofrolled and prepared for construction in accordance with the project soils report.
(B) The overexcavation beneath footings where bedrock is encountered and replaced with a soil cushion shall be performed per the project soils report and shall be included in the base bid of the project. (No additional payment for rock excavation).
(C) Existing pavement that is being demolished should be removed and wasted off-site. The crushed stone beneath the asphalt can be left in place or re-used as new fill contingent upon the recommendation of the geotechnical engineer.
(C) Slope banks with machine to angle of repose or less until shored.
(D) Grade top perimeter of excavation to prevent surface water from draining into excavation. Do not allow water to accumulate in excavations. Remove any water that may become trapped in the excavations to prevent softening and stability of subgrades for foundations and pavements. Provide and maintain any necessary dewatering operations to convey water away from excavations.
(E) Hand trim excavation. Remove loose matter.
(F) Remove lumped subsoil, boulders, and rock. Boulders and rocks shall be kept on-site to use in the landscape areas.
(G) Notify Architect/Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume Work.
(H) Unauthorized Excavation: Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from Architect/Engineer. Unauthorized excavation, as well as correction of unauthorized excavation directed by Architect/Engineer, shall be at Contractor's expense.
(I) Stockpile excavated material in area designated on site in accordance with SWPPP.
(J) Excavation Limits:
1. 0'-6" outside face of footing in a vertical plane.
2. 1'-6" outside face of wall in a vertical plane.

3. 0’-6” outside bell of pipe up to 24” in diameter in a vertical plane.
4. 1’-0” outside bell of pipe over 24” in diameter in a vertical plane.
5. 1’-0” below bottom of floor slab as allowance for aggregate base course, unless plastic clay is encountered. In that case, excavation shall extend 2’-0” below the planned finished subgrade. There will be areas where the floor slab is bearing on a controlled fill.
6. 1’-6” below bottom of foundation as allowance for aggregate base and 12” soil cushion, in areas where bedrock is encountered. There will be areas where foundation is bearing on a controlled fill.
7. 0’-6” below barrel of pipe as allowance for bedding.

(K) All cut and fill pads should be constructed with a slight crown and rolled to smoothness at the end of each day of construction to ensure free drainage should the area be subjected to rain. The geotechnical engineer should be advised if fill materials are exposed to excessive moisture or freeze-thaw action.

3.03 APPROVAL OF SUBGRADE

(A) Payment shall not be made for excavations made beyond the excavation limits as identified on the drawings, nor for replacement materials, regardless of the nature of the excavations.
(B) Notify testing agency when excavations have reached required subgrade. Do not place foundation concrete until subgrade has been inspected and approved.

3.04 FIELD QUALITY CONTROL

(A) Field inspection and testing will be performed under provisions noted on the structural drawings.
(B) Compaction testing will be performed in accordance with ASTM D698.
1. Backfill beneath floor slabs shall be placed in lifts and compacted to 98% of the soil’s maximum dry density, as per ASTM D698 (Standard Proctor), as described in the project soils report. Compaction test frequency shall be per the project soils report.
2. Backfill beneath exterior driveways, parking areas, and sidewalks shall be placed in lifts and compacted to 98 % of the soil’s maximum dry density as per ASTM D698 (Standard Proctor), as described in the project soils report. Compaction test frequency shall be per the project soils report.
3. All other exterior areas shall be compacted to 90% of the soil’s maximum dry density as per ASTM D698 (Standard Proctor).
4. If tests indicate work does not meet specified requirements, remove work, replace and retest.

(C) Request visual inspection of bearing surfaces by Architect/Engineer before installing subsequent work.

3.05 PROTECTION

(A) Prevent displacement or loose soil from falling into excavation; maintain soil stability. Protect bottom of excavations from freezing.
(B) Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations. Follow procedures in SWPPP for protection against erosion and sedimentation.

3.06 BACKFILLING

(A) Fill soils should be free of organics, debris, or rocks larger than 8" in diameter. Fill soils shall meet all the requirements outlined in the project soils report. All fill pads should extend laterally a minimum of five feet from the perimeter of any planned building, before beginning a fill slope.
(B) In-place density testing should be performed to ensure adequate compaction energies are applied. Test locations should be evenly spaced throughout the fill area, and should be performed at a frequency of one test every 5000 s.f. per foot of fill depth. No less than three tests per lift are recommended per the project soils report.
(C) Backfill areas to contours and elevations with unfrozen materials.
(D) Systematically backfill to allow maximum time for natural settlement. Do not back fill over porous, wet, frozen or spongy subgrade surfaces.
(E) Soil for fill shall be placed in loose lifts of 8" or less, compacted and tested prior to placing additional lifts. Geotechnical engineer shall inspect each lift of controlled fill.
(F) Reuse of suitable, lean clay soils from site excavations shall be used on building fill areas contingent upon recommendation from geotechnical engineer.
(G) Employ placement method that does not disturb or damage other work.
(H) Maintain optimum moisture content of backfill materials to attain required compaction density.
(I) Make gradual grade changes. Blend slope into level areas.

3. 7 TOLERANCES

(A) Top Surface of Backfilling Under Paved Area: Plus or minus 1/2 inch from required elevations.
(B) Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

END OF SECTION 31 23 00

SECTION 31 23 16.16 - TRENCHING

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Document: Geotechnical report by Consulting Services, Inc. dated January 25, 2023.
Stormwater Pollution Prevention Plan (SWPPP)
Section 31 23 00 – Excavation and Backfill
Section 33 41 00 – Storm Piping and Drainage
Section 33 31 13 – Sanitary Sewer

1.02 SUMMARY

(A) Section includes excavating trenches for any utilities that are a minimum five feet from the outside of the building and extending outward. This section also encompasses compacted fill from top of utility bedding and backfilling (utility envelope) and compaction of that fill material.

1.03 REFERENCES

(A) AASHTO T180 (American Association of State Highway and Transportation Officials) - Moisture-Density Relations of Soils Using a 10 lb. Rammer and an 18-in. Drop.
(B) ASTM C136 - Method for Sieve Analysis of Fine and Course Aggregates.
(C) ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-(D) Aggregate, Using 5.5 lb. Rammer and 12 in. Drop.
(E) ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
(F) ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. Rammer and 18 in. Drop.
(G) ASTM D2167 - Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
(H) ASTM D2922 - Test Method for Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
(I) ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate Mixtures.

1.04 DEFINITIONS

(A) Utility: Any buried pipe, duct, conduit or cable.

1.05 FIELD MEASUREMENTS

(A) Verify field measurements prior to fabrication.

1.06 COORDINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.
(B) Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 – PRODUCTS

2.01 FILL MATERIALS

(A) Fill: As indicated in Section 31 23 00.

PART 3 - EXECUTION

3.01 LINES AND GRADES

(A) Grades:

1. Lay pipes to lines and grades indicated on Drawings.
2. Use laser-beam instrument with qualified operator to establish lines and grades.

(B) Location of Pipe Lines:

1. Location and approximate depths of proposed pipelines are shown on Construction Drawings.
2. Architect/Engineer or Owner reserves right to make changes in lines, grades and depths of pipe lines and manholes when changes are required for Project conditions.

3.02 PREPARATION

(A) Identify required lines, levels, contours and datum locations.
(B) Protect benchmarks, existing structures, fences, sidewalks, paving and curbs from excavating equipment and vehicular traffic.
(C) Maintain and protect above and below grade utilities indicated to remain.
(D) Cut out soft areas of subgrade not capable of compaction in place. Backfill with aggregate and compact to density equal to or greater than requirements for subsequent backfill material.

3.03 TRENCHING

(A) Do not advance open trench more than 200 feet ahead of installed pipe.
(B) Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.
(C) Excavate bottom of trenches maximum 18 inches wider than outside diameter of pipe or structure.
(D) Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.

(E) Slope sidewalls of excavation per OSHA regulations. When sidewalls cannot be sloped provide sheeting and shoring to protect excavation as specified in this section.
(F) When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Architect/Engineer.
(G) Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
(H) Correct over excavated areas with compacted backfill as specified for authorized excavation.
(I) Stockpile excavated material in area designated on site and in accordance with the SWPPP.
(J) All safety practices during trenching operations shall comply with current OSHA regulations.

3.04 SHEETING AND SHORING

(A) Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
(B) Support five feet deep trenches that are excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing or other protection to maintain stability of excavation.
(C) Design sheeting and shoring to be removed at completion of excavation work.
(D) Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
(E) Repair damage to new and existing work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring or bracing.

3.05 BACKFILLING

(A) Backfill trenches to contours and elevations with unfrozen fill materials.
(B) Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
(C) Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
(D) Employ placement method that does not disturb or damage utilities in trench.
(E) Maintain optimum moisture content of fill materials to attain required compaction density.
(F) Do not leave more than 50 feet of trench open at end of working day.
(G) Protect open trench to prevent danger to owner.

3.06 TOLERANCES

(A) Top Surface of Backfilling Under Paved Areas: Plus or minus 1/2 inch from required elevations.
(B) Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.07 FIELD QUALITY CONTROL

(A) Testing and inspection requirements are identified as noted on the structural drawings.
(B) Compaction Testing: In accordance with ASTM D2922.
(C) Frequency Test: At each compacted initial and final backfill layer, at least one test for each 150 feet (46m) or less of trench length, but no fewer than two tests.

(D) When tests indicate Work does not meet specified requirements, remove Work, replace, compact and retest.

3.08 PROTECTION OF FINISHED WORK

(A) Protecting finished work: Under provisions of Division 01 Sections.
(B) Reshape and recompact fills subjected to vehicular traffic during construction.

END OF SECTION 31 23 16.16

SECTION 31 23 16.26 – ROCK REMOVAL

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Section 31 23 00 – Excavation and Backfill.
Section 01 41 10 – Testing Laboratory Services.
Section 31 23 16.16 – Trenching
Section 32 92 00 – Turfs and Grasses

1.02 SECTION INCLUDES

(A) Removal of identified and discovered rock during excavation. Expansive tools to assist rock removal.

1.03 REFERENCES

(A) NFPA 495 – Code for Manufacture, Transportation, Storage, and Use of Explosive Materials.
(B) Commonwealth of Kentucky Department of Mines and Minerals, Laws and Regulations Governing Explosives and Blasting.

1.04 DEFINITIONS

(A) Rock: Solid mineral material of a size that cannot be removed with an excavator.

1.05 APPROVAL OF SUBGRADE

(A) Rock Removal: Subgrade shall be inspected and approved prior to placing foundation concrete or soil cushion, as required by design.

1.06 QUALITY ASSURANCE

(A) Rock Removal Firm: Company specializing in the approved method for removal of rock, with five years documented experience. Certificates of insurance shall be provided.

1.07 SCHEDULING

(A) Schedule work to avoid disruption to occupied buildings nearby.

PART 2 – PRODUCTS

2.01 MATERIALS

(A) Mechanical Disintegration Compounds: Grout mix of materials that expand on curing.
(B) Explosives: Type required by authorities having jurisdiction and recommended by explosives firm.
(C) Delay Devices: Type State regulations allow and recommended by explosives firm.
(D) Blasting Material: Type State regulations allow and recommended by explosives firm.

PART 3 – EXECUTION

3.01 EXAMINATION

(A) Verify site conditions and note subsurface irregularities affecting work of this section.

3.02 PREPARATION

(A) Identify required lines, levels, contours and datum.
(B) If explosives are needed, applicable permits should be obtained from authorities having jurisdiction before they are brought to the site or drilling has begun. A pre-blast survey and inspection shall be performed on adjacent structures as required by standard blasting regulations.

3.03 ROCK REMOVAL - EXPLOSIVE METHOD (Not Allowed for this Project)

(A) Explosives

1. The maximum explosive charges that can be used on the property should be determined by calculations performed by a licensed blaster, prior to excavation. The maximum explosive charge should not have any damaging effects on adjacent properties. A written plan for blasting shall be submitted to the Engineer prior to drilling.

2. The contractor should notify the Engineer prior to the use and storage of explosives on site. Explosives should be present only during the time that they are being used. The quantity of explosives on site should only be for the work that is under way and must be stored in a secure manner separate from all tools. The caps and detonators shall be kept 100 feet from the explosives. Once the blasting is complete, all related material must be removed from the property.

3. The contractor is expected to follow all State, Federal and municipal laws, ordinances and regulations related to the transportation, handling, use and storage of explosives. If a licensed blaster is required to be present on site by any of the laws, ordinances or regulations, the said licensed blaster shall have his license on the site and allow examination thereof by the Engineer or other authorities having jurisdiction.

(B) Blasting Precautions

1. Explosives should not be used within 20 feet of building, structures, underground or overhead utilities whether existing or partially constructed.

2. The Engineer must grant written permission before any deviation from the restrictions can occur. However, the responsibility still lies with the Contractor in the event of damage to buildings, structures or utilities.

3. Explosive operations should be handled with care to avoid damage to persons and property. The strength and quantity of explosives used at the site should break the rock on the intended lines and grades without shattering the unexcavated rock. Excessive cracking should be avoided to avoid injury or damage of piping or other structures. Logs and mats should be used to cover the rock where required. All persons in the vicinity of the work should be notified before the blasting operations take place.

4. The responsibility of the blasting operations lies solely with the blasting contractor. The Owner and/or Engineer shall not be held liable for any damages resulting from the blasting operations on this project.

3.04 ROCK REMOVAL - MECHANICAL METHOD

(A) Excavate and remove rock by the mechanical method. Drill holes and utilize expansive tools, wedges, and mechanical disintegration compound to fracture.
(B) Cut away rock at bottom of excavation to form level bearing.
(C) Remove shelled layers to provide sound and unshattered base for footings.
(D) Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 31 23 00.

3.05 FIELD QUALITY CONTROL

(A) Provide for visual inspection of foundation bearing surfaces and cavities formed by removed rock.
(B) Seismograph measurements should be obtained during each blast and shall be made available to the engineer if requested.

END OF SECTION 31 23 16.26

SECTION 31 25 00 – EROSION PREVENTION & SEDIMENT CONTROL

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

(B) Related Sections:
Stormwater Pollution Prevention Plan (SWPPP)
Section 31 10 00 – Site Clearing
Section 31 22 19.13 – Finish Grading
Section 32 92 00 – Turf and Grasses

1.02 SUMMARY

(A) This site will disturb more than one acre, therefore, a KPDES (KYR10) permit from the Kentucky Division of Water will be required for this project. The Contractor is responsible for all measures required to comply with the SWPPP, including site inspections and documentation. Erosion control measures shown on the plans are the minimum requirements and these measures may have to be expanded or amended during the course of construction, as necessary to comply with local rules and regulations. The site shall be subject to weekly inspections. Inspectors shall be defined as a person knowledgeable in the principles and practice of erosion, sediment, and stormwater control and who possesses the skills to assess site conditions and the effectiveness of control measures selected to control the quality of stormwater discharges. Inspector shall have training either by KEPSC, CPESC, CPSWQ, TNEPSC CESSWI or other similar training.

(B) Erosion prevention:

Temporary Soil Stabilization: This Work shall consist of seed bed preparation, furnishing and placing seed, mulch, and caring for such areas until acceptance. Temporary soil stabilization shall be used in the following circumstances and in accordance with the Stormwater Pollution Prevention Plan (SWPPP):

1. In non-paved areas, rough grading and permanent soil stabilization or temporary soil stabilization shall be maintained. In no case shall the time between completion of construction activities and the completion of permanent or temporary stabilization exceed 14 calendar days.

2. Where construction operations are temporarily suspended for 14 days or longer permanent soil stabilization is not practical.

3. When an immediate cover would be desirable to minimize erosion, siltation, or pollution of any area.

(C) Sediment Control: This work shall consist of the temporary sediment control measure to be performed during the life of the Project to control water pollution caused by erosion of exposed soil. Sediment control facilities shall be properly installed and maintained per details, and the drawings. Controls found to be inadequate must be altered to maintain sediment control. All erosion and sediment control measures shall be performed in the sequence, locations and per the instructions of the Stormwater Pollution Prevention Plan (SWPPP).

PART 2 - PRODUCTS

2.01 Materials

(A) Topsoil: Topsoil shall meet the requirements set forth in the Finish Grading specification.
(B) Temporary Seed: Seed used for temporary seeding may be accepted on the basis of purity and germination values shown on the seed bag. The Work of temporary seeding of erosive earth areas shall be done promptly at the locations and times directed under SWPPP. Rye grain, annual rye or winter wheat seed shall be used for temporary seeding and as specified in the SWPPP.
(C) Straw Mulch
(D) Silt Fence
(E) Stone Bag Inlet Protection
(F) Rip Rap: Rock shall be average 6”-12” diameter in accordance with the SWPPP. Rip-rap outlet pads shall have an average rock diameter depending on the size of the outlet pipe & headwall.
(G) Erosion Control Blanket: Temporary, lightweight, photodegradable flexible matting structure used during seeding to provide short-term soil stabilization. Mats shall be composed of a lightweight, single polypropylene net weaved with straw fiber and rated for a maximum permissible velocity of 5 ft./sec. Mats should provide protection for up to 12 months once installed. Products shall be as manufactured by Enviroscape, AEC, North American Green or equal.

PART 3 – EXECUTION

3.01 EROSION PREVENTION

(A) Temporary Soil Stabilization.

1. Preparing the Seed Bed: Areas to be temporarily seeded shall require the preparation of a seed bed only when the soil surface is dry, non-uniform or contains clods or large stones. Disturbance of the soil surface by whatever means that is practical to create a 2 inch thick loose and roughened condition capable of retaining the seed and mulch will be required when the soil surface is dry or non-uniform. Clods and stones larger than 2 inches shall be removed. The preparation of a seedbed will not be required when the soil surface is in an acceptable condition from the normal grading operations.

2. Seeding: Temporary seeding shall be permitted only during the periods indicated in the table below. In order to stabilize erodible areas with vegetation through the winter, temporary seeding must be completed no later than October 31. Working the soil to

cover the seed will not be required. Temporary seeding shall be sown at the appropriate rate of 3lbs. per 1,000 square feet.

Work Item	Accepted Work Interval
Temporary Seeding with Annual Rye	March 1 - Nov. 1
Temporary seeding with Winter Wheat or Rye Grain	September 1 - Nov. 1

3. Protection: All seeded areas shall be promptly protected with straw mulch or wood cellulose fiber mulch. The materials shall be uniformly applied and anchored to the seeded areas.

4. Dormant Season Stabilization: Areas requiring temporary stabilization during the period of November through February, when seeding is not permitted, shall receive only an application of straw mulch and shall be 3 tons per acre.

B) In areas shown on the Stormwater Erosion Control Plan, erosion control blankets shall be installed over the seeded area. Erosion control blankets shall be installed per the manufacturer's instructions and as instructed on the Erosion Control Details of the Project drawings and in accordance of the SWPPP. All blankets shall be anchored with wire U-shaped staples, in accordance with the anchor pattern on the Erosion Control Detail sheet. Ends of blankets shall be anchored in a trench 12" deep and 6" wide across the entire width. Longitudinal anchor slots shall be 4" wide and 4" deep along both sides of the mat/blanket to bury the edges. Overlap end of rolls and adjacent rolls as specified on the in the project details based on time of soil, and slope blankets are being used on. Disturbed areas from the anchor trenches will need to be reseeded. Blankets shall be laid in a horizontal pattern on slopes less than 8' in height and in a vertical pattern for slopes 8' and higher. Mulch shall not be applied in the areas of the erosion control blankets.

3.02 SEDIMENT CONTROL

(A) General: The Contractor shall exercise every reasonable precaution at all times to prevent water pollution by the deposition of sediment in streams, lakes, and reservoirs. All requirements and procedures in the Stormwater Pollution Prevention Plan (SWPPP) and these project specifications shall be followed. The Contractor shall conduct and schedule operations in a manner as to avoid or minimize the muddying or siltation of areas adjacent to the construction site including streets, storm sewers, etc. Specific instructions on how to prevent and minimize pollution of storm water runoff from the site are in the SWPPP. The Contractor shall comply with the applicable provisions of KRS Chapters 220 and 224 of the State Water Pollution Control Laws and other applicable statutes relating to the prevention or abatement of water pollution.

(B) Silt Fence: Silt fence shall be installed, inspected, maintained and removed in accordance with the SWPPP and the following requirements:

1. Installation: Silt fence shall be installed at the toe of the downhill slope at all property lines and around any lakes, streams, creeks or reservoirs that require protection. Silt Fence shall be installed at the locations shown on the plans, prior to the start of construction in areas that drain to the fence location. Silt fence shall be embedded a

minimum of 6" into the ground and shall be located at least 10 feet from the toe of steep slopes. Silt fence shall be installed per the details on the project plans and SWPPP.

2. Inspection and Maintenance: Silt Fence shall be inspected weekly and maintained as needed throughout construction. Built-up sediment shall be removed from silt fence when it has reached one-third of the height of the fence.

3. Removal: Silt Fences temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

(C) Stone and Sand Filled Bag Protection: Stone bag protection shall be installed, maintained, and removed per the SWPPP and the requirements below and as called for on the construction plan.

1. Installation: Stone or sand filled bags shall be woven polypropylene with approximate dimensions of 18.5 inches by 28 inches. Stone and sand bags shall be ¾ to full with KTC No. 57 stone or sand. Tie ends of filled bags with draw strings or wire ties. Interweave the loose ends of the bags so that there are no gaps and end of bags are sealed. Bags should create a barrier around the storm inlet. Bags shall be stacked to a minimum of two courses to a height detailed on the plans.

2. Inspection and Maintenance: Stone and sand bags shall be inspected weekly. Repair any failed bags and clean out sediment from upstream side stacked bags to ensure they are in operation for the full length of the project.

3. Removal: Inlet protection may be temporarily removed to facilitate construction activities and shall be replaced immediately following completion of such activity. Upon completion of construction and once all surrounding areas have been stabilized, remove the inlet protection.

(D) Rip-Rap Outlet Protection: A rip-rap pad shall be constructed at all new storm piping outlets. It shall be constructed, maintained, and inspected per the Project plans, details, and the SWPPP.

(E) Construction Entrance: A construction entrance/exit shall be established and stabilized at the beginning of construction. The pad shall consist of a filter fabric covered with a minimum 6 inches of No. 2 stone.

3.03 INSPECTION REPORTS

(A) Inspection of all storm water control devices shall be documented, including any repairs or maintenance that are required. Log sheets are included as part of the Stormwater Pollution Prevention Plan. Logs of all inspections shall be kept with the SWPPP on the job-site and made available for review anytime during the project duration.

END OF SECTION 31 25 00

SECTION 31 31 16 – TERMITE CONTROL

PART1 - GENERAL

1.01 SUMMARY

(A) Section includes soil treatment for termite control below grade at scheduled locations.

1.02 REFERENCES

(A) EPA (Environmental Protection Agency) - Federal Insecticide, Fungicide and Rodenticide Act.

1.03 SUBMITTALS

(A) Submittal Procedures: Under provisions of Division 1 Sections.
(B) Product Data: Submit toxicants to be used, composition by percentage, dilution schedule, intended application rate in accordance with manufacturer's current pesticide label.
(C) Test Reports: Indicate regulatory agency approval reports when required.
(D) Manufacturer's Application Instructions: Indicate caution requirements and proper procedure.
(E) Manufacturer's Certificate: Certify toxicants meet or exceed specified requirements.
(F) Certify applications followed the National Pest Control Association (NPCA) Approved Referenced Procedures (ARP) for termite control or other regional location guidance.

1.04 CLOSEOUT SUBMITTALS

(A) Project Record Documents: Record moisture content of soil before application, date and rate of application, areas of application, diary of toxicity meter readings and corresponding soil coverage.
(B) Operation and Maintenance Data: Indicate re-treatment schedule and recommendations.

1.05 QUALIFICATIONS

(A) Applicator: Company specializing in performing the Work of this section with minimum 5 years documented experience approved by manufacturer and licensed at Project location in State of Kentucky.

1.06 SEQUENCING

(A) Apply toxicant in accordance with product label supplemented by the NPCA's ARP for termiticiding or local requirements.

1.07 WARRANTY

(A) Furnish five-year warranty.
(B) Warranty: Include coverage for damage and repairs to building and building contents caused by termites. Repair damage. Re-treat where required.

PART 2 - PRODUCTS

2.01 MATERIALS

(A) Toxicant Chemical: EPA approved; proven to prevent termite infestation, synthetically color dyed to permit visual identification of treated soil and not injurious to plants and landscaping.
(B) Diluent: Recommended by toxicant manufacturer.

2.02 MIXES

(A) Mix toxicant to manufacturer's instructions.

PART 3 - EXECUTION

3.01 EXAMINATION

(A) Verify soil surfaces are unfrozen, sufficiently dry to adsorb toxicant, and ready to receive treatment.
(B) Verify final grading is complete.

3.02 APPLICATION

(A) Apply toxicant at locations indicated in Schedule at end of section in strict accordance with National Pest Association standards and with manufacturer's submitted instructions.
(B) Apply extra treatment to structure penetration surfaces including pipe or ducts, and soil penetrations including grounding rods or posts.
(C) Re-treat disturbed treated soil with same toxicant as original treatment.
(D) When inspection or testing identifies presence of termites, re-treat soil and re-test.
(E) Post signs and other warning indicating that soil poisoning has been applied. Protect persons and property from injury or damage from soil treatment work.

3.03 PROTECTION OF FINISHED WORK

(A) Do not permit soil grading over treated work.

3.04 SCHEDULES

(A) Locations:

1. Under Slabs-on-Grade.
2. Both Sides of Foundation Surface.

END OF SECTION 31 31 16

SECTION 32 12 00 – FLEXIBLE PAVEMENT

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Document: Geotechnical report by Consulting Services, Inc. dated January 25, 2023.
Section 31 22 06 - Rough Grading
Section 31 23 00 - Excavation and Backfill: Compacted subbase for paving.
Section 31 23 16.16 - Trenching

1.02 SUMMARY

(A) Section includes asphalt concrete paving, wearing, binder and base course; surface sealer; and aggregate subbase course. Refer to plans for locations of flexible and rigid pavements

1.03 REFERENCES

(A) ASTM D946 - Penetration-Graded Asphalt Cement for Use in Pavement Construction.
(B) TAI - (The Asphalt Institute) - MS-2 Mix Design Methods for Asphalt Concrete and Other Hot Mix Types.
(C) TAI - (The Asphalt Institute) - MS-3 Asphalt Plant Manual.
(D) TAI - (The Asphalt Institute) - MS-8 Asphalt Paving Manual.
(E) TAI - (the Asphalt Institute) - MS-19 Basic Asphalt Emulsion Manual.

1.04 PERFORMANCE REQUIREMENTS

(A) Asphalt Concrete Paving: Designed for medium duty commercial vehicles.

1.05 SUBMITTALS

(A) Submittal Procedures: Under provisions of Division 01 Sections.
(B) Product Data: Submittal product information and mix design.

1.06 QUALITY ASSURANCE

(A) Perform Work in accordance with TAI Manual MS-8 and State of Kentucky Highways standard.
(B) Mixing Plant: Conform to TAI Manual MS-3 and State of Kentucky Highways standard.
(C) Obtain materials from same source throughout.

1.07 QUALIFICATIONS

(A) Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.08 ENVIRONMENTAL REQUIREMENTS

(A) Environmental conditions affecting products on site: Under provisions of Division 01 Sections.
(B) Do not place asphalt when ambient air or base surface temperature is less than 40 degree F, or surface is wet or frozen.

PART 2 – PRODUCTS

2.01 MATERIALS

(A) Asphalt Cement: ASTM D946 ad in accordance with State of Kentucky Highways standards.
(B) Aggregate for Base Course Mix: In accordance with State of Kentucky Highways standards.
(C) Aggregate for Binder Course Mix: In accordance with State of Kentucky Highways standards.
(D) Aggregate for Wearing Course Mix: In accordance with State of Kentucky Highways standard.
(E) Fine Aggregate: In accordance with State of Kentucky Highways standards.
(F) Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
(G) Prime: Homogeneous, medium curing, liquid asphalt.
(H) Tack Coat: Homogeneous, medium curing, liquid asphalt.
(I) Traffic Paint: Shall be used on pavements for parking area, parking lines, lane lines, traffic directional arrows and as otherwise specified or shown on drawings.

1. Color shall be white, except blue for handicap markings and yellow for angled overflow parking in drop off zone.

2. The paint shall be ground to a uniform consistency and shall permit satisfactory application by the pressure spray type of painting machine currently in use.

3. The paint shall be furnished ready for use without thinning or other modification and shall not settle badly, cake, curdle, liver, gel or show excessive change in viscosity in the container during a period of one year after manufacture and shall be capable of being broken up with a paddle to a smooth consistency. The manufacturer shall furnish any necessary information as to special storage requirements. The paint may be rejected if it contains skins, thickened or jelly-like layers or lumps, coarse particles, dirt or other foreign material. The composition of the pigments and vehicles of the paint are at the option of the manufacturer, provided the paints conform with the requirements specified herein.

4. Specific Requirements:
   (a) Pigment: Federal Standard 141A, method 4022, 54 - 60% by eight.
   (b) Titanium Dioxide: ASTM D476, Types II, III or IV, white only, 1.2 lbs./gallon of paint

(J) Signing: Construct signs for traffic control in areas as shown on the Drawings in accordance with the MUTCD, latest edition.

2.02 ASPHALT PAVING MIX

(A) Use dry material to avoid foaming. Mix uniformly.
(B) Base Course: 3.0 to 6 percent of asphalt cement by weight in mixture in accordance with TAI MS-2 and State of Kentucky Highways standards.
(C) Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with TAI MS-2 and State of Kentucky Highway standards.

2.03 SOURCE QUALITY CONTROL AND TESTS

(A) Testing inspection and analysis requirements: As noted on drawings.
(B) Submit proposed mix design of each class of mix for review prior to beginning of work.
(C) Test samples in accordance with TAI MS-2.

PART 3 – EXECUTION

3.01 EXAMINATION

(A) Verification of existing conditions before starting work: Under provisions of Division 01 Sections.
(B) Verify compacted subgrade and subbase is dry and ready to support paving and imposed loads.
(C) Verify gradients and elevations of base are correct.

3.02 PREPARATION – PRIMER FOR ASPHALT CONCRETE PAVING

(A) Apply primer in accordance with TAI MS-2 and State of Kentucky Highways standards.
(B) Use clean sand to blot excess primer.

3.03 PREPARATION - TACK COAT FOR ASPHALT CONCRETE PAVING

(A) Apply tack coat in accordance with TAI MS-19 and State of Kentucky Highways standards.
(B) Apply tack coat to contact surfaces of curbs.

3.04 PLACING ASPHALT CONCRETE PAVEMENT - DOUBLE COURSE

(A) Place asphalt binder course within 24 hours of applying primer or tack coat.
(B) Place binder course to specified compacted thickness.
(C) Place wearing course within 12 hour of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
(D) Place wearing course to specified compacted thickness.
(E) Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

(F) Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.05 TOLERANCES

(A) Tolerances: As indicated on drawing notes.
(B) Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.
(C) Scheduled Compacted Thickness: Within 1/8 inch.
(D) Variation from Indicated Elevation: Within 1/2 inch.

3.06 FIELD QUALITY CONTROL

(A) Field inspecting, testing, adjusting, and balancing: As indicated on drawing notes.
(B) Take samples and perform tests in accordance with TAI MS-2.

3.07 PROTECTION OF FINISHED WORK

(A) Protecting finished work: Under provisions of Division 01 Sections.
(B) Immediately after placement, protect pavement from mechanical injury for 24 hours or until surface temperature is less than 140 degrees F.
(C) All surfaces to receive pavement markings shall be thoroughly cleaned.
(D) Traffic paint shall be applied only when the pavement temperature is 40 degrees F or above. The wet thickness of the traffic paint shall be a minimum of 0.015 of an inch.
(E) All pavement markings shall be a minimum of 4” wide.
(F) All pavement markings shall be installed as indicated on the drawings, in accordance with the current Manual of Uniform Traffic Control Devices, and as specified herein.

END OF SECTION 32 12 00

SECTION 32 13 13 – PAVEMENTS, WALKS AND CURBS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This Section includes all labor, materials, equipment and related items required to complete the work of pavements, walks, curbs and miscellaneous slabs shown on the Drawings and specified herein.

B. This Section does not include the following related items:

1. Clearing and grubbing.
2. Earthwork, including establishing of subgrades for pavements, walks, and curbs.
3. Storm drainage and utilities.
4. Concrete work in connection with storm drainage.

1.02 COORDINATION

Coordinate carefully the Work specified in this Section with storm drainage and utility installations specified under other Sections of these Specifications. Notify the Engineer promptly of any conflict between work of this Section and that of other trades.

1.03 STATE SPECIFICATIONS

Where the words "State Specifications" are used herein, they shall be understood to refer to the Standard Specifications of the Kentucky Department of Highways. Reference to State Specifications is solely for the purpose of specifying kind and quality of materials and methods of construction.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 SUBGRADES FOR PAVEMENTS, WALKS, AND CURBS

A. Grading. Do any necessary grading in addition to that performed in accordance with these specifications to bring subgrades after final compaction to the required grades and sections for pavements and curbs.

B. Preparation of Subgrades. Loosen exceptionally hard spots and recompact. Remove spongy and otherwise unsuitable material and replace it with stable material. Fill and tamp traces of storm drain trenches.

C. Compaction of Subgrade. Compact the subgrades of all surface areas with appropriate compacting equipment or by other means to such degree as will ensure against settlement of the superimposed work.

D. Checking Subgrade. Maintain all subgrade in satisfactory condition, protected against traffic and properly drained until the surface improvements are placed. Immediately in advance of concreting, check subgrade levels with templates riding the forms, correct irregularities and compact thoroughly any added fill material. On areas to receive concrete pavement, place grade stakes spaced sufficiently to afford facility for checking subgrade levels. Correct irregularities, compacting thoroughly any fill material.

E. Drainage Structures. Check for correct elevation and position all manhole covers, grates, and similar structures located within areas to be paved and make, or have made, any necessary adjustments in such structures.

3.02 CONCRETE WORK

A. General. Concrete and concrete materials for work of this Section shall conform to applicable requirements of Section 03300, and, in addition the following:

1. Concrete used in all work of this Section shall be Class A and shall have a minimum 28-day allowable compressive strength of 4,500 pounds per square inch, shall contain not less than 564 lbs of cement per cubic yard, and shall be an air entrained type, with 4 percent to 6 percent total air content, by use of an approved air entraining agent as specified under Section 03300.

B. Requirements for forms, reinforcement, mixing, placing, finishing and curing shall be generally as specified for other concrete work under Section 03300, as modified hereinafter under particular item specification.

3.03 CONCRETE CURBS

A. General. Concrete curb and gutter and header curb shall be constructed in accordance with State Specifications at locations shown and to details shown on the Drawings. Curved forms shall be used where curbs are curved to a radius of 100 feet or less.

1. The Contractor may, at his option, install extruded section curb and gutter and header curb. If used, the section, equipment, jointing provisions, etc., shall be reviewed by the Engineer and approved prior to installation.

B. Contraction Joints. Construct concrete curbs in sections 6 to 10 feet long by use of 1/8-inch steel division plates. Such plates shall be of size and shape conforming to cross sections of the concrete and shall not be bent or otherwise deformed.

C. Expansion Joints. Provide expansion joints with premolded filler cut to shape of cross section as follows: (1) at ends of all the returns, (2) at not more than 50 feet intervals. Expansion joints shall

be at least 2-inch wide, and if adjoining pavement is concrete, of the same width and at same locations as expansion joints in the pavement.

D. Finish. Tamp and screed concrete as soon a placed. Remove division plates and face forms as soon as practicable; fill any honeycombed places with 1:2 mortar and give exposed surfaces a smooth, wood-float finish without plastering. Finish square corners to 1/4-inch radius and other corners to radius shown.

E. Height. Curb height shall be as detailed on the Drawings. Transition height at handicap ramp locations to meet level of drive and walk pavement.

F. Protection. Remove no forms (except face forms) for 24 hours after placing concrete. Barricade against vehicular traffic 14 days and against pedestrian for 3 days. Compact thoroughly the backfill behind the curb.

3.04 CONCRETE WALKS AND PAVING

A. General. Walks in City streets or in streets to be dedicated shall be constructed in accordance with the local agency having jurisdiction over the roadway impacted or in the absence of same, in accordance with the following specifications for all other concrete walks.

B. Concrete walks shall be one course construction, reinforced concrete nominally 5-inches thick, but in no case less than 4-inches actual thickness, of widths shown on the Drawings. Edges of walks shall be formed adequately and braced to maintain alignment. Use flexible or curved forms for all curves in walks.

1. Provide integral turn-down at walk edges where abutting bituminous paving as detailed.
2. Slopes. Provide grade stakes not more than 25 feet apart for all walk construction. Check tops of forms for grade before pacing concrete. Introduce short vertical curves in all walks as shown on the Drawings, or at points where change in walk grade exceeds 2%. For a distance of 2 feet from top and bottom of steps, walk slopes shall not exceed 2 inch per foot. Provide 1/4 inch per foot cross slope in the direction of natural drainage, and make slight adjustments in slopes at walk intersections as necessary or directed to provide proper drainage.
3. Concrete Finishes:
    a. Standard Concrete Finish. Tamp and screed the concrete true to grade and section bringing sufficient mortar to the surface for finishing and give a wood or carpet-float finish, providing that where the walk grade exceeds 5%, the surface shall be given a belted or broomed finish as directed by the Engineer. Round all edges, including those along expansion joints and scored joints to a 1/4 inch radius. Where walks terminate at curbs, finish the walk 1/4 inch above the curb providing a neat bevel.
    b. Exposed Aggregate Concrete Finish. Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate. 3/8-inch pea gravel with 1/4-inch exposure. 1/4-inch tooled joints. See Landscape Plans for joint pattern. Concrete to

be sealed with a low-VOC, solvent-based, acrylic sealant. Sealant to be selected by landscape architect and owner based upon mock-up review.

c. Mock-up: Contractor to provide 72" x 72" physical mock-up for final approval by Landscape Architect and Owner. Mock-up to be divided into four (4) sections for evaluation of concrete sealant. Sealants for evaluation include: gloss, satin, and brown-tinted sealants. One panel to remain unsealed for comparison.

4. Expansion Joints. Provide 2 inch transverse expansion joints with premolded filler not more than 50 feet apart, also at walk junctions and intersections, at top and bottom of steps and where walks abut curb returns, buildings, platforms, or other fixed structures, or terminate at curbs. Such expansion joints are not required (except for curb returns) between walks and contiguous parallel curbs. At walk junctions and intersections, the required expansion joints shall be located at the end of each rounding or fillet. Expansion joints shall be at right angles to the slab and extend the full depth thereof; the premolded filler shall extend to within 1/4 inch of the walk surface. Locate expansion joints in all walks as nearly as practicable opposite those in abutting curbs.
5. Scored Joints. Between expansion joints, cut grooves 1/8 inch to 1/4 inch wide, at least 3/4 inch deep, and with a spacing approximately equal to the walk width but not greater than 6 feet on centers.

C. Handicap Ramp. Provide ramped sections for handicapped access where shown and as detailed. Ramp surface shall be given a uniform medium broomed finish at right angles to ramp pitch. Install tactile warning strip of width shown in Cobble II pattern as manufactured by Reading Rock, Tuftile or Hanover.

D. Other concrete paving at exterior areas shall conform to requirements shown on the Drawings.

E. Protection. Remove no forms for 24 hours after pouring concrete. Protect concrete walks and paving form pedestrian traffic for a period of 3 days after pouring, and against vehicular traffic for a period of 14 days.

3.05 CONCRETE STEPS

A. Concrete steps shall be constructed under work of this Section where shown and as detailed on the Drawings. Verify elevations at top and bottom landings prior to laying out formwork, excavation or preparation of subgrade.

B. Excavation and Preparation of Subgrade. Excavate for corner posts to dimensions shown, and trim subgrade of concrete to required shape and slope. Footing excavations and subgrades shall be in a firm, moist condition, prior to placing any concrete, clean and free from loose material.

C. Build forms to details shown on the Drawings, and so as to permit their removal without damage to the concrete. Place reinforcement as detailed, properly supported to maintain it in position during placing of concrete.

D. Finish. Place concrete, and thoroughly compact it in the forms by means of spading, rodding, tamping or vibrating so as to thoroughly work into all corners and around reinforcement. All treads shall be pitched as detailed to drain, and shall be given a uniformly textured wood or carpet float finish. Exposed edges of treads shall be rounded smoothly to 2-inch radius. Remove face forms as soon as practicable, patch any surface voids with 1:2 mortar to match color of concrete, and rub with carborundum stone and water to a uniformly textured finish. Plastering of concrete surfaces will not be permitted.

F. Protection. Do not open steps for use for seven days after concrete is placed.

END OF SECTION 32 13 13

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Chain-Link Fences
2. Gates

B. Related Sections include the following:
1. Division 31 Section "Earth Moving" for site excavation, fill, and backfill where chain-link fences and gates are located.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

1. Fence and gate posts, rails, and fittings.
2. Chain-link fabric, reinforcements, and attachments.
3. Gates and hardware.
4. Gate operators, including operating instructions.
5. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.

B. Shop Drawings: Show locations of fences, gates, posts, rails, details of extended posts, extension arms, gate swing, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. UL Standard: Provide gate operators that comply with UL 325.

C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Insert height, limited to 12 feet (3.6 m). Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:

1. Steel Wire Fabric: Polymer-coated wire with a diameter of 0.148 inch (3.76 mm).

    a. Mesh Size: 2 inches (50 mm).
        a) Tennis Court Mesh Size: 1-3/4 inches typical
    b. Polymer Coating: ASTM F 668, Class 2b over metallic-coated steel wire.

        1) Color: Black, complying with ASTM F 934.

    c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

2. Selvage: Knuckled at both selvages.

2.2 INDUSTRIAL FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe, and the following:

1. Group: IA, round steel pipe, Schedule 40 IC, round steel pipe, yield strength 50,000 psi (345 MPa).
2. Fence Height: As indicated on drawings.
3. Strength Requirement: Heavy industrial according to ASTM F 1043.
4. Post Diameter and Thickness: According to ASTM F 1083.
5. Post Size and Thickness: According to ASTM F 1083.

    a. Top Rail: 1.66 inches.
    b. Steel Line Post:
        1) Height up to and including 6 feet – 1.900 inches
        2) Height over 6 feet – 3.000 inches
    c. Steel End, Corner and Pull Post:
        1) Height up to and including 6 feet – 2.375 inches
        2) Height over 6 feet – 4.000 inches

d. Swing Gate Post for fabric height up to and including 6 feet:: According to ASTM F 900 and as follows:
   1) Gate leaf width up to and including 4 feet: 2.375 inches OD pipe, 3.11-lb/ft weight
   2) Gate leaf width over 4 feet to 10 feet: 3.000 inches OD pipe, 4.64-lb/ft weight.

e. Swing Gate Post for fabric height over 6 feet:: According to ASTM F 900 and as follows:
   1) Gate leaf width up to and including 6 feet: 3.000 inches OD pipe, 4.64-lb/ft weight
   2) Gate leaf width over 4 feet to 10 feet: 4.000 inches OD pipe, 8.65-lb/ft weight.

6. Coating for Steel Framing:

   a. Metallic Coating:

      1) Type I Steel Pipe: Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
      2) Type II Steel Pipe: Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, of 30 plus or minimum 15 micrograms, and a clear, verifiable polymer film of 0.5 plus 0.2 mils. Type B inside with a minimum of 0.9 oz of zinc per sq.ft.

   b. Polymer coating over metallic coating.

2.3 INDUSTRIAL SWING GATES

A. General: Comply with ASTM F 900 for single and double swing gate types.

1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1043 and ASTM F 1083 for materials and protective coatings.

B. Frames and Bracing: Fabricate members from round, galvanized steel tubing with outside dimension and weight according to ASTM F 900 and the following:

1. Gate Fabric Height: 2 inches (50 mm) less than adjacent fence height.
2. Leaf Width: As indicated on drawings.
3. Frame Members:

   a. Tubular Steel: 1.66 inches (42 mm) round for gate heights up to and including 6 feet; 1.90 inches (48 mm) round for gate heights over 6 feet.

C. Frame Corner Construction:

1. Welded and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.

D. Hardware: Provide galvanized and coated hardware matching the fence specs as necessary and as follows:

1. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180-degree gate opening. Provide 1-1/2 pair of hinges foe each leaf over 6-foot nominal height.
2. Latch: Forked type or plunger-bar type to permit operation form either side of gate with padlock eye as integral part of latch.
3. Keeper: Provide a keeper for vehicle gates that automatically engages gate leaf and holds it in the open position until manually released.
4. Gate Stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete, and designed to engage a center drop rod or plunger bar. Include a locking device and padlock eyes as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

2.4 FITTINGS

A. General: Comply with ASTM F 626.

B. Post and Line Caps: Provide for each post.

1. Line post caps with loop to receive top rail.

C. Rail and Brace Ends: Attach rails securely to each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
   a. Aluminum: ASTM B 211 (ASTM B 211M); Alloy 1350-H19; 0.148-inch- (3.76-mm-) diameter, mill-finished wire.

H. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.

2. Match Fence materials.

2.5 CAST-IN-PLACE CONCRETE

A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water.

1. Concrete Mixes: Normal-weight concrete with not less than 3000-psi (20.7- MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum size aggregate.

2.6 POLYMER FINISHES

A. Supplemental Color Coating: In addition to specified metallic coatings for steel, provide fence components with polymer coating.

B. Metallic-Coated Steel Framing and Fittings: Comply with ASTM F 626 and ASTM F 1043 for polymer coating applied to exterior surfaces and, except inside cap shapes, to exposed interior surfaces.

1. Polymer Coating: Not less than 10-mil- (0.254-mm-) thick PVC finish.

C. Color: Match chain-link fabric, complying with ASTM F 934.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil.
   1. If not indicated on Drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than four times the largest cross section of post.
   2. Unless otherwise indicated, excavate hole depths approximately 3 inches lower than the post bottom, with bottom of posts set not less than 36 inches below finish grade surface.

B. Post Setting: Center and align posts in holes 3 inches above bottom of excavation. Space a maximum of 10 feet o.c., unless otherwise indicated.
   a) Space a maximum of 8 feet o.c. unless otherwise indicated (Tennis Courts)

   2. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete.
   3. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

      a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
   1. Line Posts: Space line posts uniformly at 10 feet (3 m) o.c.. Height over 6 feet: 8 feet (2.44 m) o.c. maximum

D. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts.

   1. Locate horizontal braces at midheight of fabric 6 feet (1.83 m) or higher, on fences with top rail and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

E. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

F. Bottom Rails: Install, spanning between posts.

G. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches (50 mm) between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, and rails. Anchor to framework so fabric remains under tension after pulling force is released.

H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.

I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at 1 end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.

J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 323113

SECTION 32 31 19 – DECORATIVE FENCES AND GATES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to the Drawings for locations of work to be performed.

1.2 SUMMARY

A. Section Includes:

1. Welded ornamental steel fence.
2. Swinging Gates.

B. Related Sections:

1. Division 03 Section Cast-in-Place Concrete.
2. Division 31 Sections for site excavation, fill, and backfill where decorative metal fences and gates are located.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fence. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches in length for linear materials.

D. Welding certificates.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for decorative metallic-coated steel tubular picket fences, including finish, indicating compliance with referenced standard.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.

C. ASTM D523 - Test Method for Specular Gloss.

D. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.

E. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

F. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

G. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

H. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.

I. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

J. 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.

K. Preinstallation Conference: Conduct conference at Project site.

PART 2 PRODUCTS

2.1 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03 Section "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3500 psi, 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387 mixed with potable water according to manufacturer's written instructions.

B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

2.2 DECORATIVE TUBULAR PICKET FENCES AND GATES

A. Decorative Tubular Picket Fences: Comply with ASTM A653, with a minimum yield strength of 45,000 psi and a minimum zinc (hot-dip galvanized) coating weight of 0.60 oz/ft2 , coating designation G-60.

1. Basis-of-Design Product: Subject to compliance with requirements, Ameristar Montage Plus system, Genesis style, manufactured by Ameristar Fence Products, Inc., in Tulsa, Oklahoma. Or comparable product by one of the following:

a. MasterHalco.
b. Xcel Fence, Inc.

B. Fence Height:
a. As indicated on Drawings.
b. Decorative Fence to be located above masonry site walls as noted on drawings.
c. Where fence is not located above a masonry wall, align top of fence with adjacent site wall fence height.

C. Steel material for fence panels and posts shall conform to the requirements of ASTM A653, with a minimum yield strength of 45,000 psi and a minimum zinc (hot-dip galvanized) coating weight of 0.60 oz/ft2 , coating designation G-60.

D. Material for pickets shall be 3/4" square x 18 Ga. tubing. Horizontal rails shall be 1.5" x 1.4375" x 14 Ga. Picket holes in the rail shall be spaced at 3.5” o.c. Fence posts and gate posts shall meet the minimum size requirements of Table 1.

Table 1 – Minimum Sizes for Montage Plus Posts	
Fence Posts	Panel Height
2-1/2” x 16 ga.	Up to and including 6’-0” height

2.3 GATE MATERIAL

A. The materials used for cantilever gate framing (uprights & diagonal bracing) shall be manufactured from ASTM A653 Steel with yield strength of 34,800 PSI, a tensile strength of 37,700PSI and a standard mill finish. The steel extrusions for top and bottom enclosed tracks.

B. Material for pales shall be 2.75” x 1/8” wall steel. Pales shall have a standard airspace of 3 inches.

C. Material for gate uprights shall be 2 ½” X 16 ga. and diagonal bracing shall be 2” square x 16 ga. steel. The cross-sectional shape of the enclosed-track shall confirm to the manufacturers Traverse-Trak™ design with a single extrusion consisting of a 3.75” x 7” channeled support with integrated 3” x 3” enclosed-track raceway. Gates less than 18-foot openings shall be constructed as a single-track system, gates greater than 20-foot openings shall be constructed as a spliced track system.

D. Steel material for fence posts shall be galvanized prior to forming in accordance with the requirements of ASTM A653/A653M, with minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft^2 (276 g/m^2), Coating Designation G-90. Depending on application and gate size, material for gate support posts shall be 4” x 11 Ga., or 6” x 3/16”.

E. Support carriage trolly assemblies, for the gates enclosed bottom track, shall have two mounting options: concrete slab or post mount bracket configuration, and shall support the vertical load of the gate. The gates center of gravity shall be centered on the bottom support carriage trolly

assemblies. Installation of the carriage trolly assemblies shall be per manufacturer's installation instructions (written or video).

2.4 FENCE AND GATE FABRICATION

A. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by Ameristar's proprietary fusion welding process, thus completing the rigid panel assembly.

B. Gate frame uprights and diagonal bracing shall be prefabricated and pre-punched to accept frame fasteners. Enclosed track shall be pre-punched to accept gate uprights. Pales shall be precut to specified length and predrilled to accept pale to track fasteners. Posts shall be precut to specified lengths.

C. Top and bottom enclosed track extrusions shall be mechanically fastened to vertical gate uprights and intermediate supports, as required by assembly instructions. Diagonal bracing shall be mechanically fastened to vertical gate uprights and intermediate supports, as required by assembly instructions. Pales shall be mechanically fastened to top and bottom enclosed track, as required by assembly instructions.

D. The manufactured panels and posts shall be subjected to an inline electrode coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils. The color shall be black. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2.

E. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for commercial weight fences under ASTM F2048.

F. Completed fence panels shall be capable of supporting a 200 lb. load (applied at midspan) without permanent deformation.

G. See AS Drawing for gate located in masonry site wall and modifications to the typical picket style.

Table 2 – Coating Performance Requirements

Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 1,500 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).

Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60˚ Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.

C. Post Excavation: Where required, drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth required for each post footing as indicated by the manufacturer.

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

      a. Exposed Concrete: Hold back 8" below grade. Finish and slope top surface to drain water away from post.

   3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth.

4. Post Spacing:

Table 3 – Montage Plus – Post Spacing By Bracket Type						
Span	For CLASSIC, GENESIS, MAJESTIC, & WARRIOR 8' Nominal (91.95" Rail)					
Post Size	2-1/2"	2-1/2"	2-1/2"	3"	2-1/2"	3"
Bracket Type	Montage Plus Universal (BB112)	Montage Plus Line Blvd. (BB114)	Montage Plus Flat Mount (BB111)		Montage Plus Swivel (BB113)*	
Post Settings ± 1/4" O.C.	95"	95"	95"	95-1/2"	*95"	*95-1/2"
* Note: When using BB113 swivel brackets on either or both ends of a panel installation, care must be taken to ensure the spacing between post and adjoining pickets meets applicable codes. This will require trimming one or both ends of the panel.						

3.4 GATE INSTALLATION

A. Cantilever support posts shall be set in concrete footers having a minimum depth of 48" (Note: In most cases, local soil, code restrictions and inclement weather conditions may require a greater depth). Posts shall be spaced according to gate specific submittal drawings. Optional Safety Kit must be included if the gate is automated. The "Earthwork" and "Concrete" sections of this specification shall govern material requirements for the concrete footer.

B. Gate to be installed per manufacturers gate installation instructions (written or video). For Gates that will be automated, the contractor shall be responsible to ensure the gate, and installation, meet ASTM F2200 and UL325 Standards.

C. Gate posts shall be spaced according to the manufacturers' drawings, dependent on clear opening. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

3.5 GATE INSTALLATION MAINTENANCE

A. When cutting/drilling posts adhere to the following steps to seal the exposed steel surfaces;
   1. Remove all metal shavings from cut area.
   2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
   3. Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Manufacturer spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

3.6 CLEANING

A. The contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.

END OF SECTION 32 31 19

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Sodding.

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

2. Erosion Control drawings and specifications.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

2. Certification of each seed mixture for turfgrass seed. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Experience: Five years' experience in native seed installation and maintenance in addition to requirements in Section 014000 "Quality Requirements."
4. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
5. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawncare Manager.
    c. Landscape Industry Certified Lawncare Technician.

6. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver and install sod within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Native Seed Areas: October 15 - March 1.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 TURFGRASS SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality: State-certified seed of grass species as listed below for solar exposure.
2. Full Sun: Turf-type Tall Fescue (Festuca spp.) a minimum of three cultivars.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

1. Full Sun: Turf-type Tall Fescue (Festuca spp.) a minimum of three cultivars.

2.3 FERTILIZERS

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Contractor shall verify that all subgrade elevations are properly established to allow for the correct top soil depth prior to placing top soil and finish grading.

D. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF SOD AREA PREPARATION

A. Placing Turf Sod Soil: Place and mix 6” of unamended, stockpiled topsoil, over prepared subgrade.

1. Reduce elevation of planting soil to allow for soil thickness of sod.

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDED AREA PREPARATION

A. Placing Seeded Area Soil: Place 6” unamended, stockpiled topsoil, over prepared subgrade within limits of grading and where existing soil is disturbed by construction activities.

1. Existing unamended soil preserved in place may be used as seeded area soil in areas not disturbed by construction activities.
    a. Mow area to a height of 4-6” to remove existing vegetation and apply an approved herbicide. Time herbicide application according to manufacturers recommendation for areas to be seeded.

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Lightly scarify soils just prior to seeding to loosen surface of soil and ensure good soil to seed contact.

3.5 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Refer to Erosion control drawings and specifications.

3.6 TURF SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 8 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas on slopes with erosion control blanket. See CIVIL drawings and specifications for erosion control requirements.

E. Protect level seeded areas by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.7 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy. Do not lay sod if temperature will exceed 80 Degrees Fahrenheit within 14 days of installation.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow turf-type tall fescue to a height of 2 to 3 inches.

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb./1000 sq. ft. to turf area.

3.9 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.11 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established. Turf shall be free of weeds, surface irregularities, open joints greater than ½", bare areas exceeding 5 by 5 inches and shall have coverage exceeding 95 percent over any 10 sq. ft,

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.12 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion.

    a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: 30 days from date of Substantial Completion.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.

B. Related Sections:
1. Section 329200 "Turf and Grasses" for turf (lawn) materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

D. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

H. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

I. Planting Area: Areas to be planted.

J. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.
3. Plant Photographs: digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Compile photographs for delivery into a single PDF document. Each plant shall utilize one "letter" sized sheet (8.5" x 11") and include the following information:

a. Color Photograph with multi-colored scale rod or adult
b. Full Latin and common name of plant.
c. Size of plant.
d. Name of growing nursery.
e. City, State of nursery.

Picea abies
Norway Spruce
8' Ht, or 3.5" Cal.
Acme Nursery
Small Town, MO

B. Samples for Verification: For each of the following:

1. Organic Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified landscape Installer. Provide 3 references of projects similar in size, scope and expected craftsmanship as those shown in the Contract Documents. Include photographs demonstrating Installer's capabilities and experience. Provide project name, address, year completed, and owner's or general contractor's name and current contact information.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Material Test Reports: For existing native surface topsoil, existing in-place surface soil, and imported or manufactured topsoil.

D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

E. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation. Landscape Contractor shall be approved by Owner.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
b. Certified Ornamental Landscape Professional, designated COLP.

5. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Landscape Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for plant growth.

a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

E. Plant Material Observation: Landscape Architect and Owner may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect and Owner retain right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect and Owner of sources of planting materials seven days in advance of delivery to site.

F. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, mulch, sawdust, or other material acceptable to landscape Landscape Architect.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Construction Manager no fewer than five days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Construction Manager's written permission.

C. Planting Restrictions: Plant during the following period. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Trees and Shrubs: Fall 2021 (September 15 - December 15)

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf Areas (Lawns): Plant trees after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.9 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.
c. Faulty performance of tree stabilization.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of Substantial Completion:

a. Trees and Shrubs: 12 months.

b. Landscape Architect and Owner shall review all plants prior to closure of the 12 month warranty period, and provide written documentation of trees to be replaced under the warranty conditions.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.

b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.
e. Contractor shall return all adjacent elements and systems modified during the removal and replacement of plants to the condition in which they were found, including shrubs, perennials, ornamental grasses, planting soil, mulch, and hardscape elements.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

E. On-site inspections by the Landscape Architect and Owner shall be permitted upon arrival or at any time prior to planting. The Landscape Architect or Owner may inspect plant material for size and condition of the root ball, root system, insects, injury, defoliation, wind burn and/or latent defects. Contractor shall remove unsatisfactory or defective plant material and replace at no additional cost to the Owner.

F. The Landscape Architect or Owner may reject a specific nursery source and associated plants if he/she determines before, during, or after receipt of plants any of the following:

a. Nursery stock does not meet health standards set forth, including disease and infestation.
b. Nursery stock does not meet the requirements of the Landscape Architect's basis of selection.
c. The nursery cannot supply the specified plants or acceptable substitute.

G. Substitutions: In the event the Contractor is not able to obtain plant material specified, the Contractor shall provide a list of possible substitute plants of equal size, quality, and value of the plant originally specified for Landscape Architect's consideration and selection.

H. Plants that are field grown shall be freshly dug. Plants that have been pre-dug the previous season shall not be accepted.

I. Plants larger than specified may be used if approved by the Landscape Architect and if root ball is proportionately larger at no change in contract price.

J. Plant Character: Plants shall be typical of their species and/or variety and shall have a normal habit of growth and be legibly tagged with the proper name. Form and size shall comply with ASNI Z60.1, current edition.

K. Root Balls: If root flare is buried 2-inches or greater, provide a larger diameter or greater depth root ball to compensate for buried root flare. The soil over-burden shall be removed prior to planting, therefore, reducing the size of the root ball.

L. Girdling Roots: Inspect root crown for girdling roots. Inspection for girdled roots shall be done at the nursery to the extent possible. If girdled roots 1/2-inch or greater are discovered during planting operations prior to acceptance, the tree shall be rejected.

M. Container Stock: Root system shall be well-developed. Plants loose in the container are not acceptable. The root zone shall be free of circling or kinked roots. Large matted roots at the sides or bottom of the container are unacceptable. Container grown plants may be substituted for field grown stock if approved by the Landscape Architect.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; yard trimmings; or source-separated or compostable mixed solid waste.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

E. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 21-gram tablets.

2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

F. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

2.5 PLANTING AREA SOILS

A. Planting Area Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth. Mix existing, native surface topsoil with the soil amendments and fertilizers in the quantities recommended by the soil testing agency to produce planting soil.

2.6 MULCHES

A. Leaf Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; yard trimmings.

2.7 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys – for trees on slopes greater than 6:1:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end, or metal 'T' post.

2. Guy Cables: Five-strand, 3/16-inch-diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
3. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long shall be attached to all guy cables.

B. Root-Ball Stabilization Materials – for all trees on level ground (below 6:1 slopes):

1. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized according to manufacturer's written recommendations unless otherwise indicated.

2. Manufacturers:
    1) Platipus Earth Anchoring Systems
    2) Tree Staple, Inc.

2.9 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Burlap: Non-synthetic, biodegradable.

C. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

2.10 TREE-WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

B. Manufacturers:
1. Spectrum Products, Inc.
2. BIO-PLEX
3. Engineered Watering Solutions; PQ Partners, LLC

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
5. Contractor shall verify that all subgrade elevations are properly established to allow for the correct top soil depth prior to placing top soil and finish grading.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Beginning work prior to repairs being completed means the Contractor accepts substrates, previous work, and other site conditions. The Contractor shall not place plants or planting soil until all work in adjacent areas is complete and accepted by Landscape Architect.

1. If Contractor encounters incomplete or unsatisfactory conditions that will be detrimental to plant health or satisfactory completion of the Work, he shall notify General Contractor immediately.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

D. Deliver materials and plants only after preparations for planting have been completed, including, but not limited to: planting soil placement, irrigation, rough grading, utilities, decompaction of soils, remediation of soils.

1. Sufficiently protect plants during transport. Adequately support the trunks of trees on the end of the trailer. Trees delivered to the site without sufficient protection and support are subject to rejection.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

G. If planting is delayed more than 4 hours after delivery, trees shall be properly heeled in, protected, and maintained.

3.3 PLANTING AREA ESTABLISHMENT

A. Till subgrade of planting areas to a minimum depth of 8 inches. Remove stones larger than 1 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply superphosphate fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting area soil to a depth of 6 inches, but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately one-half the thickness of planting area soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting area soil.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at application rate specified by manufacturer.

3.4 EXCAVATION FOR TREES

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further

disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately two times as wide as ball diameter for balled and burlapped, balled and potted, and container-grown stock.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
8. If drain tile is shown on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Subsoil and topsoil removed from planting pit excavations may be used as backfill.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet , whichever is less, and backfill with free-draining material.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Provide root ball pedestal composed of subgrade fill immediately beneath the ball or root mass. Pedestal shall provide the relationship to finish grade described below and prevent settlement of the plant. Compact pedestal to 85% standard proctor.

D. Prior to setting the height of the root ball pedestal, Contractor shall determine if trunk flare is buried within the root ball. If buried, contractor shall expose the trunk flare by removing excess soil on top of the root ball, taking care not to damage roots or bark. Adventitious and girdling roots shall be

removed with sharp pruners. Performing a "spade chop" is not acceptable. Adust the root ball pedestal as necessary to ensure the root flare is 2 inches higher than proposed finish grade.

E. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Use soil excavated from planting pit as backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. Set container-grown stock plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Use soil excavated from planting pit as backfill.
2. Carefully remove root ball from container without damaging root ball or plant.
3. If container grown stock is root bound, Contractor shall scarify the root ball with a 2-inch sharp blade. Rest plant on its side and scarify 'X" on the bottom of the root mass. Make vertical cuts the full height of the root ball every 3 inches on center the full circumference of the root ball.
4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
6. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

C. Cut exposed roots cleanly during transplanting operations.

D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

E. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Trunk Stabilization: Install trunk stabilization in sloped areas, 6:1 slopes and above.

1. Upright Staking and Tying: Stake trees all trees. Use a minimum of three stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Space stakes equally around trees.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Root-Ball Stabilization Materials: Install root-ball stabilization in flat areas, below 6:1 slopes.

1. Proprietary Root-Ball Stabilization Devices: Proprietary below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized according to manufacturer's written recommendations unless otherwise indicated.
   a. Platipus Earth Anchors, Root Ball Stabilizing System – Strap.
   b. MPS Civil Products Group; Duckbill Earth Anchor.

3.9 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring of 2-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 6 inches of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. within 6 inches of trunks or stems of trees and shrubs. Do not burry perennial plants.

3.10 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.11 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.12 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.13 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

SECTION 33 11 00 – POTABLE WATER MAINS

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Section 31 23 16.16 - Trenching
Section 03 30 00 - Cast-in-Place Concrete.

1.02 SUMMARY

(A) Section includes potable water main piping, fire protection piping, fittings and accessories, bedding, valves, hydrants and testing.

1.03 REFERENCES

(A) AASHTO T180 (American Association of State Highway and Transportation Officials) - Moisture-Density Relations of Soils Using a 10-lb. Rammer and an 18-in. Drop.
(B) ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

1.04 SUBMITTALS

(A) Submittal procedures: Under provisions of Division 01 Sections.
(B) Product Data: Submit data indicating pipe, pipe accessories, valve and hydrants.
(C) Bacteria Testing: Submit copies of results of the water-sampling test to the Architect/Engineer.

1.05 CLOSEOUT SUBMITTALS

(A) Closeout procedures: Under provisions of Division I Sections.
(B) Project Record Documents:
    1. Accurately record actual locations of pipe runs and connections.

1.06 COORDINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.
(B) Coordinate the Work with termination of plumbing connections outside building, trenching.

PART 2 – PRODUCTS

2.01 MATERIALS

(A) Potable Water Main Piping:

1. Plastic Pipe: ASTM D2241, Poly (Vinyl Chloride) (PVC) material, Class 200, SDR 21 minimum. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D3139 and F477.
2. Ductile iron pipe (D.I.P.): ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, 250 psi pressure rated, cement lining, bituminous outside coating. Joints shall be 250 psi, Class 125 flanges or mechanical joint with gasket and accessories.

(B) Gate Valves:

1. All gate valves shall be of the resilient wedge type, iron body, non-rising stem, fully bronze mounted with O-ring seals. Valves shall conform to the latest revisions of AWWA C-500 and have a rated working pressure of 200 psi.

2. Gate valves for buried service shall be furnished with mechanical joint connections, unless specified otherwise. The end connections shall be able to connect with PVC pipe, unless ductile iron is specified.

3. The valve casting shall be stamped with the manufacturer's name, year the casting was made, size of the valve and the working pressure.

4. Buried service gate valves shall be provided with a 2" square-operating nut and shall open by turning counter-clockwise.

5. Gate valves shall be installed in vertical position with cast iron or PVC valve box with a cast iron or aluminum cover. The box shall be set such that the cover is flush with the finished grade. There shall be a 24" square, 4" thick concrete pad around the top of the valve box.

6. Valves shall be manufactured by Kennedy, Mueller, M & H Valve Company, American or approved equal.

(C) Tapping Valves and Sleeves:

1. Valve shall be a gate valve with a mechanical joint outlet and a flanged joint connection to the sleeve. All other valve requirements shall comply with Item B in this section.

2. Sleeve shall be of the mechanical joint type and have a 200-psi working pressure. Mechanical joint gaskets shall be sized to match the existing tapped pipe outside diameter. A flanged outlet shall connect to the tapping valve. Provide thrust blocking per plan details. When tapping into asbestos cement or PVC pipe, stainless steel sleeves shall be used.

(D) Fire Hydrants:

1. Fire hydrants shall be AWWA approved compression model with 5 ¼" hydrant valve, two (2) 2 ½" hose outlets, one (1) 4 ½" pumper nozzle, national standard threads and national standard pentagon operating nut opening counter-clockwise. Hydrant shall be equipped with safety flanges designed to prevent barrel breakage when struck by a vehicle. All hydrants shall be 3 ½ foot bury type, unless noted otherwise on the plans. Fire hydrants shall be connected to mains, 6" and larger. Fire hydrants shall be as manufactured by Kennedy, Mueller, American and M & H Valve Company or approved equal.

2. Inlet cover depth shall be 36" and the minimum dimension from the ground to the centerline of the lowest opening above ground shall be 18". Thrust blocking and a drainage pit shall be provided as detailed on the plans.

3. Fire hydrants shall receive two coats of approved OSHA red enamel.

(E) Solid Copper Insulated Tracer Wire:

1. Number 12 solid copper VW-1 rated 600 volts, 15 mils insulation, gasoline and oil resistant. Number 12 wire to be run the full length of the PVC pipe and terminate up to the ground surface through gate valve boxes.

PART 3 – EXECUTION

3.01 EXAMINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.
(B) Verify trench cut base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.02 PREPARATION

(A) Hand trim excavations to required elevations. Correct over excavation with aggregate.
(B) Remove large stones or other hard matter, which could damage piping or impede consistent backfilling or compaction.

3.03 BEDDING

(A) Excavate pipe trench in accordance with Section 31 23 16.16 for work of this Section.
(B) Pipe may be supported on undisturbed earth, with additional excavation around the bells of each joint to ensure the joints are not strained in their final resting position.

3.04 INSTALLATION - PIPE

(A) Install pipe, fittings, and accessories in accordance with ASTM C12. Seal joints watertight.

(B) Water main shall be provided with 30" minimum cover. Water mains laid adjacent and parallel to proposed and existing drives and roadways shall be placed a minimum of 24" below roadway or drive elevation.
(C) For an earth-bottom trench, backfill material may be rock-free earth. Backfill material may be machine placed without compaction. Uneven places should be leveled, with no clods or rocks. Piping beneath pavement shall be covered with No. 9 aggregate to the pavement subbase and compacted in accordance with Section 02315, Excavation and Backfill.
(D) Concrete encasement shall be used at locations specified on the plans. Concrete shall have 3000 psi compressive strength and shall be poured to the spring line of each pipe/conduit.
(E) At all tees, plugs, caps and bends of 11 ¼ degrees and over, and at reducers or in fittings where changes in pipe diameter occur, movement shall be prevented by using a suitable harness, thrust block or ballast. Thrust block details and dimensions are shown on the project plans. Care shall be taken to leave weep holes unobstructed and allow for future tightening of all nearby joints. Thrust blocks shall be placed such that pipe and fitting joints will be accessible for repair.

3.05 FIELD QUALITY CONTROL

(A) Testing and inspection services: As indicated on drawing notes.
(B) Request inspection prior to placing backfill over pipe.
(C) Piping shall be pressure tested to 250 percent of the normal system operating pressure or to 150 percent of the rated working pressure of the pipe, whichever is less. At no time shall the test pressure exceed 150 percent of the pipe's working pressure. A section of pipe will be accepted if the test pressure does not fall more than 5 psi during the minimum 2-hour test period. The pipe shall be tested for allowable leakage per the latest revision of AWWA C-600 concurrently with the pressure test.
(D) Water mains shall be disinfected by the use of chlorine or chlorine compound in such amounts to produce a concentration of at least 50 ppm and a residual of at least 25 ppm at the end of twenty-four hours. Lines shall be thoroughly flushed upon meeting the chlorine residual requirements. Water samples shall be taken by the Contractor and submitted to an approved, certified laboratory for testing. No lines shall be placed in service until the samples have been tested and approved.
(E) When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.06 PROTECTION OF FINISHED WORK

(A) Protecting finished Work: Under provisions of Division 01 Sections.
(B) Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.

2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION 33 11 00

SECTION 33 31 13 – SANITARY SEWER

PART 1 GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Section 31 23 16.16 - Trenching
Section 03 30 00 - Cast-in-Place Concrete

1.02 SUMMARY

(A) Section includes gravity site sanitary sewerage piping, fittings and accessories, bedding, manholes and testing.

1.03 REFERENCES

(A) AASHTO T180 (American Association of State Highway and Transportation Officials) -Moisture-Density Relations of Soils Using a 10 lb. Rammer and an 18 in. Drop.
(B) ASTM D 3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

1.04 SUBMITTALS

(A) Submittal procedures: Under provisions of Division 01 Sections.
(B) Product Data: Submit data indicating pipe, pipe accessories and manhole structures.

1.05 CLOSEOUT SUBMITTALS

(A) Closeout procedures: Under provisions of Division I Sections.
(B) Project Record Documents:

1. Accurately record actual locations of pipe runs, connections, manholes, and invert elevations.

1.06 COORDINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.
(B) Coordinate the Work with termination of sanitary sewer connection outside building, trenching.

PART 2 PRODUCTS

2.01 MATERIALS

(A) Sewer Pipe Materials:

1. Plastic Pipe: ASTM D3034, Type PSM, Poly (Vinyl Chloride) (PVC) material, SDR 35 minimum for 8" diameter pipe. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D3212 and F477.

2. Ductile iron pipe (D.I.P.): ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, 250 psi pressure rated, cement lining, bituminous outside coating. Joints shall be 250 psi, Class 125 flanges or mechanical joint with gasket and accessories.

(B) Manholes:

1. Manhole shall be fabricated from precast concrete sections, 5" minimum wall thickness, conforming to ASTM C478, as manufactured by Forterra Pipe & Precast, Oldcastle Infrastructure, S&M Precast or equal. All manholes shall have precast reinforced concrete developed bases. Joints between precast barrel sections shall be made watertight by installing a gasket or butyl sealant conforming to ASTM C443. Provide two (2) 3" precast concrete grade rings for each manhole to allow for grade adjustments.

2. Invert channels may be factory constructed when the developed base is fabricated. The inverts shall conform accurately to the size of the adjoining sewer pipe. Where there are directional changes, inverts shall be laid out in smooth curves of the longest possible radius and remain tangent, within the manhole, to the centerlines of the adjoining sewer pipes.

3. Castings shall be at least Class 30 conforming to ASTM A48, cast iron. Frames shall be fabricated so that the manhole covers sit flush with ring edge and with contact edges machined to prevent rocking of covers.

4. Manhole Covers: 24" in diameter, weighing not less than 350 pounds per frame and cover. The surface shall have sufficient corrugations to prevent slipperiness and marked in large letters "SANITARY SEWER".

5. Manhole Steps: Steps shall be the polypropylene plastic type reinforced with a deformed steel rod. Steps shall be at 12" vertical spacing and line up over the downstream invert of the manhole. The steps shall be embedded a minimum of 3 3/8" into the manhole wall.

6. Premolded Elastomeric-Sealed Joints: Holes for pipe connections in manhole shall have a factory-installed flexible rubber gasket, conforming to ASTM C443.

7. Manhole drop sections shall be precast concrete, factory constructed per the plan details.

PART 3 EXECUTION

3.01 EXAMINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.
(B) Verify trench cut base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.02 PREPARATION

(A) Hand trim excavations to required elevations. Correct over excavation with aggregate.
(B) Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.03 BEDDING

(A) Excavate pipe trench in accordance with Section 31 23 16.16 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
(B) Place bedding material at trench bottom, level materials in continuous layer not less than 6 inches compacted depth. Bedding material shall be No. 9 crushed stone aggregate.

3.04 INSTALLATION - PIPE

(A) Install pipe, fittings, and accessories in accordance with ASTM C12. Seal joints watertight.
(B) Lay pipe to slope gradients noted on drawings.
(C) Install No. 9 aggregate at sides and over top of pipe. Install top cover to minimum compacted thickness of 12 inches, compact to 95 percent. Piping beneath pavement shall be covered with No. 9 aggregate to the pavement subbase.
(D) Refer to Section 31 23 00 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.
(E) Concrete encasement shall be used when the vertical clearance between the proposed sanitary sewer pipe and utility pipe crossing is 18” or less. Utility pipe includes underground water, gas, telephone or electrical conduit, storm sewers, etc. Concrete shall have 3000 psi compressive strength and shall be poured to the spring line of each pipe/conduit.
(F) Creek crossings in earth shall maintain a 30” minimum cover below stream bed. Creek crossing in solid rock shall be encased in concrete a minimum of 10 feet into each bank.
(G) When sanitary sewer lines are running parallel with potable water mains, a 10 feet horizontal clearance shall be maintained between the two lines.

3.05 FIELD QUALITY CONTROL

(A) Testing and inspection services: As noted on the drawings.
(B) Request inspection prior to placing aggregate cover over pipe.
(C) Compaction Testing: In accordance with ASTM D2922.
(D) When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
(E) Infiltration Test: Test in accordance with ASTM C 969.
(F) Low Pressure Air Test: All new sewer lines shall be tested on each manhole-to-manhole section by the low pressure air test method.
(G) Vacuum Testing: In accordance with ASTM C1244.

3.06 PROTECTION OF FINISHED WORK

(A) Protecting finished Work: Under provisions of Division 01 Sections.
(B) Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.

2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION 33 31 13

SECTION 33 31 15 – SANITARY SEWER FORCE MAINS

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Section 31 23 16.16 - Trenching
Section 03 30 00 - Cast-in-Place Concrete.

1.02 SUMMARY

(A) Section includes sewer force main piping, fittings and accessories, bedding, valves and testing.

1.03 REFERENCES

(A) AASHTO T180 (American Association of State Highway and Transportation Officials) - Moisture-Density Relations of Soils Using a 10-lb. Rammer and an 18-in. Drop.
(B) ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

1.04 SUBMITTALS

(A) Submittal procedures: Under provisions of Division 01 Sections.
(B) Product Data: Submit data indicating pipe, pipe accessories, valve and hydrants.

1.05 CLOSEOUT SUBMITTALS

(A) Closeout procedures: Under provisions of Division I Sections.
(B) Project Record Documents:

1. Accurately record actual locations of pipe runs and connections.

1.06 COORDINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.
(B) Coordinate the Work with termination of plumbing connections outside building, trenching.

PART 2 – PRODUCTS

2.01 MATERIALS

(A) Sewer Force Main Piping:

1. Plastic Pipe: ASTM D2241, Poly (Vinyl Chloride) (PVC) material, Class 200, SDR 21 minimum. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D3139 and F477.
2. Ductile iron pipe (D.I.P.): ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, 250 psi pressure rated, cement lining, bituminous outside coating. Joints shall be 250 psi, Class 125 flanges or mechanical joint with gasket and accessories.

(B) Gate Valves:

1. All gate valves shall be of the resilient wedge type, iron body, non-rising stem, fully bronze mounted with O-ring seals. Valves shall conform to the latest revisions of AWWA C-500 and have a rated working pressure of 200 psi.

2. Gate valves for buried service shall be furnished with mechanical joint connections, unless specified otherwise. The end connections shall be able to connect with PVC pipe, unless ductile iron is specified.

3. The valve casting shall be stamped with the manufacturer's name, year the casting was made, size of the valve and the working pressure.

4. Buried service gate valves shall be provided with a 2" square-operating nut and shall open by turning counter-clockwise.

5. Gate valves shall be installed in vertical position with cast iron or PVC valve box with a cast iron or aluminum cover. The box shall be set such that the cover is flush with the finished grade. There shall be a 24" square, 4" thick concrete pad around the top of the valve box.

6. Valves shall be manufactured by Kennedy, Mueller, M & H Valve Company, American or approved equal.

(C) Solid Copper Insulated Tracer Wire:

1. Number 12 solid copper VW-1 rated 600 volts, 15 mils insulation, gasoline and oil resistant. Number 12 wire to be run the full length of the PVC pipe and terminate up to the ground surface through gate valve boxes.

PART 3 – EXECUTION

3.01 EXAMINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.
(B) Verify trench cut base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.02 PREPARATION

(A) Hand trim excavations to required elevations. Correct over excavation with aggregate.
(B) Remove large stones or other hard matter, which could damage piping or impede consistent backfilling or compaction.

3.03 BEDDING

(A) Excavate pipe trench in accordance with Section 31 23 16.16 for work of this Section.
(B) Pipe may be supported on undisturbed earth, with additional excavation around the bells of each joint to ensure the joints are not strained in their final resting position.

3.04 INSTALLATION - PIPE

(A) Install pipe, fittings, and accessories in accordance with ASTM C12. Seal joints watertight.
(B) Sewer force main shall be provided with 30" minimum cover. Sewer force mains laid adjacent and parallel to proposed and existing drives and roadways shall be placed a minimum of 24" below roadway or drive elevation.
(C) For an earth-bottom trench, backfill material may be rock-free earth. Backfill material may be machine placed without compaction. Uneven places should be leveled, with no clods or rocks. Piping beneath pavement shall be covered with No. 9 aggregate to the pavement subbase and compacted in accordance with Section 02315, Excavation and Backfill.
(D) Concrete encasement shall be used at locations specified on the plans. Concrete shall have 3000 psi compressive strength and shall be poured to the spring line of each pipe/conduit.
(E) At all tees, plugs, caps and bends of 11 ¼ degrees and over, and at reducers or in fittings where changes in pipe diameter occur, movement shall be prevented by using a suitable harness, thrust block or ballast. Thrust block details and dimensions are shown on the project plans. Care shall be taken to leave weep holes unobstructed and allow for future tightening of all nearby joints. Thrust blocks shall be placed such that pipe and fitting joints will be accessible for repair.
(F) Coordinate force main location into the building with the plumbing plans for depth and exact entry location into the building.
(G) Terminate force main at existing sanitary sewer manhole. Manhole shall be cored to allow pipe entry at the invert of the manhole. Replace the invert channel in manhole, as necessary, to allow for smooth flow transition from the force main into the manhole. Repair pipe opening in manhole to ensure a water-tight connection. Manhole shall be vacuum tested after all modifications are completed.

3.05 FIELD QUALITY CONTROL

(A) Testing and inspection services: As indicated on drawing notes.
(B) Request inspection prior to placing backfill over pipe.
(C) Piping shall be pressure tested to 250 percent of the normal system operating pressure or to 150 percent of the rated working pressure of the pipe, whichever is less. At no time shall the test pressure exceed 150 percent of the pipe's working pressure. A section of pipe will be accepted if the test pressure does not fall more than 5 psi during the minimum 2-hour test period. The pipe shall be tested for allowable leakage per the latest revision of AWWA C-600 concurrently with the pressure test.
(D) When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.06 PROTECTION OF FINISHED WORK

(A) Protecting finished Work: Under provisions of Division 01 Sections.
(B) Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.

2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION 33 31 15

SECTION 33 41 00 – STORM PIPING & DRAINAGE

PART 1 – GENERAL

1.01 RELATED WORK

(A) Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
(B) Related Sections:
Stormwater Pollution Prevention Plan (SWPPP)
Section 31 25 00 – Erosion Prevention and Sediment Control
Section 31 23 16.16 – Trenching
Section 03 30 00 – Cast–in-Place Concrete

1.02 SUMMARY

(A) Section includes gravity site storm sewerage drainage piping, fittings and accessories, downspout hub connection, bedding, catch basins, cleanouts, culverts with end sections, paved area drainage, and site surface drainage.

1.03 REFERENCES

(A) AASHTO T180 (American Association of State Highway and Transportation Officials) – Moisture Density Relations of Soils Using a 10-lb. Rammer and an 18-in. Drop.
(B) ASTM C 76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
(C) ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
(D) ASTM C969 - Practice for Infiltration and Exfiltration Acceptance Testing of Installed Concrete Pipe Sewer Lines.
(E) ASTM D2729 – Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
(F) ASTM D3033 - Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
(G) ASTM D 3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
(H) ASTM A74 – Standard Specification for Cast Iron Soil Pipe and Fittings.
(I) ASTM C564 – Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

1.04 SUBMITTALS

(A) Submittal procedures: Under provisions of Division 01 Sections.
(B) Product Data: Submit data indicating pipe, pipe accessories and drainage structures.

1.05 CLOSEOUT SUBMITTALS

(A) Closeout procedures: Under provisions of Division 01 Sections.

(B) Project Record Documents:

1. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts and invert elevations.

1.06 COORDINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.

(B) Coordinate the Work with termination of downspouts outside building, trenching, connection to foundation drainage system.

PART 2 – PRODUCTS

2.01 MATERIALS

(A) Storm Pipe Materials:

1. Plastic Pipe: ASTM D3033, Type PSP, Poly (Vinyl Chloride) (PVC) material, SDR 35 minimum for 8" diameter pipe. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D3212 and F477.

2. Corrugated Polyethylene Pipe (CPP) Smooth Interior: ASTM F405, ASTM F667, ASTM D2321, as manufactured by Advanced Drainage Systems (ADS), Hancor, Haviland Drainage Prodcuts or equal.

3. Cast Iron Pipe (Above grade): ASTM A74 service weight with cast iron fittings. Joints shall be neoprene gasket system or lead and oakum conforming to ASTM C564

(B) Culvert Pipe Material:

1. Reinforced Concrete Pipe (RCP): KDOT, Standard Specification for Road and Bridge Construction or equal.

(C) Headwalls:

1. Dimensions shall comply with KDOT standard drawings or as shown on the plan details.

2. Precast headwalls may be used for pipe dimensions of 24" diameter and less. Precast reinforced concrete shall comply with ASTM C478, as manufactured by Forterra Pipe & Precast, Oldcastle Infrastructure, S&M Precast or equal.

3. Cast-in-place reinforced concrete headwalls shall comply with Division 03 30 00.

(D) Catch Basins:

1. Dimensions shall comply with the plan details.

2. Precast reinforced concrete shall comply with ASTM C478, as manufactured by Forterra Pipe & Precast, Oldcastle Infrastructure, S&M Precast or equal.

3. HDPE drain basins shall comply with ASTM D3350 or ASTM 335400C, as manufactured by Advanced Drainage Systems, Hancor, Haviland Drainage Products or equal.

4. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for heavy-duty service. Include flat grate with small square or short-slotted drainage openings. Size: 24" x 24" minimum, unless otherwise indicated on plan details.

(E) Underground Detention System:

1. Two underground detention systems shall be provided beneath the proposed as part of this project. The StormTech chamber system, manufactured by Advanced Drainage Systems, has been provided on the plan as a basis of design. Specifications for the systems have been included in the plans. Other manufacturers with similar systems include Contech Engineered Solutions and Construction Eco Services. Plans and specifications for alternate systems shall be submitted to the engineer for approval.

(F) Channel Lining & Aprons:

1. Rip-Rap: Rip-rap shall consist of Class III limestone as per KY DOT standard Specifications.

2.02 ACCESSORIES

(A) Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.03 METAL DOWNSPOUT BOOTS

(A) Provide downspout boots made from cast gray iron pipe in heights indicated with inlets of size to accept downspouts.

1. Outlet: Vertical, to discharge into storm pipe.

PART 3 – EXECUTION

3.01 EXAMINATION

(A) Coordination and project conditions: Under provisions of Division 01 Sections.

(B) Verify trench cut base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.02 PREPARATION

(A) Hand trim excavations to required elevations. Correct over excavation with aggregate.
(B) Remove large stones or other hard matter that could damage piping or impede consistent backfilling or compaction.

3.03 BEDDING

(A) Excavate pipe trench in accordance with Section 31 23 16.16 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
(B) Place bedding material at trench bottom, level materials in continuous layer not less than 6 inches compacted depth. Bedding material shall be No. 9 crushed stone aggregate.

3.04 INSTALLATION - PIPE

(A) Install pipe, fittings, and accessories in accordance with ASTM C12. Seal joints watertight.
(B) Lay pipe to slope gradients noted on drawings.
(C) Install No. 9 aggregate at sides and over top of pipe. Install top cover to minimum compacted thickness of 12 inches, compact to 95 percent. Piping beneath pavement shall be covered with No. 9 aggregate to the pavement subbase.
(D) Refer to Section 31 23 00 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.
(E) Install non-conducting dielectric connections wherever jointing dissimilar materials.
(F) Support cast iron drainage piping at every joint and to exterior wall.
(G) Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

3.05 FIELD QUALITY CONTROL

(A) Testing and inspection services: Noted on the structural drawings.
(B) Request inspection prior to placing aggregate cover over pipe.
(C) Compaction Testing: In accordance ASTM D2922.
(D) When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
(E) Infiltration Test: Test in accordance with ASTM C 969.

3.06 PROTECTION OF FINISHED WORK

(A) Protecting finished Work: Under provisions of Division 01 Sections.
(B) Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.

2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION 33 41 00