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SECTION 200100 – 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 to any part if for work, services, materials or equipment to be used on or applied to this project are hereby directed to familiarize themselves with all documents of Contract Documents. 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 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 Construction Manager responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Construction Manager to the Architect, then to the Engineer. Also, this Section of the Specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

1.6 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.

1.7 This Section of the Specifications or the arrangement of the contract documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

1.8 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.

1.9 In general, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owner at least forty-eight (48) hours prior to the interruption of any services

(gas, domestic water, heating, etc.). The Owners 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.

1.10 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 own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

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

1.12 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.
- KBC - Kentucky Building Code.
- NEC - National Electrical Code.
- NEMA - National Electrical Manufacturers Association.
- NFPA - National Fire Protection Association.
- OSHA - Office of Safety and Health Administration.
- SMACNA - Sheet Metal and Air Conditioning Contractors National Association.
- UL - Underwriters Laboratories.

PART 2 – INTENT AND INTERPRETATION:

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

2.2 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.

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

PART 3 – PLANS AND SPECIFICATIONS:

3.1 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.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 Each Bidder/Proposer shall review all Plans in the Contract Documents to insure that the work they intend to provide does not create a conflict with or affect the work of others in any way. Where such effect does occur it shall be the Bidder/Proposer's responsibility to satisfactorily eliminate any such conflict or effect prior to the submission of their proposal. Each Bidder/Proposer shall in particular insure that there is adequate space to install their equipment and materials. Failure to do so shall result in the correction of

such encroachment conflict or effect of any work awarded the Bidder/Proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to insure adequate spaces.

3.9 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.

3.10 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.

3.11 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.

3.12 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 4 – EXAMINATION OF SITE AND CONDITIONS:

4.1 Each Bidder/Proposer shall inform their self 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.

4.2 Each Bidder/Proposer shall also fully acquaint their self 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 5 – EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS:

5.1 When any Contractor requests approval of materials and/or equipment of different physical size, weight, capacity, function, color, access, 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.

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 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 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.

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

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

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

PART 6 – CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.:

6.1 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.

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

6.3 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.

6.4 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.

6.5 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.

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

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

6.8 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.

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

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

6.11 All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings and Construction, Commonwealth of Kentucky and the American Disabilities Act.

6.12 Work in elevators, elevator shafts and elevator equipment rooms shall comply with the Elevator Code enforced by the Commonwealth of Kentucky.

6.13 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.

6.14 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.

6.15 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.

6.16 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.

6.17 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. 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 Plans and Specifications require better materials, equipment, and construction than these minimum standards, in which case the Plans and Specifications shall be the minimum standards.

PART 7 – QUALIFICATIONS OF CONTRACTOR/WORKERS:

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

7.2 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.

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

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

7.5 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 Kentucky Master HVAC Contractor. This includes any Contractor installing HVAC systems, piping and ductwork.

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

7.7 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 workman is the employee of this Contractor, the workman may be utilized subject to review of their qualifications by the Engineer and after written approval from same.

7.8 All special systems (Pneumatic Tube, 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.

7.9 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 8 – SUPERVISION OF WORK:

8.1 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 9 – CONDUCT OF WORKERS:

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

PART 10 – COOPERATION AND COORDINATION WITH OTHER TRADES:

10.1 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.

10.2 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.

10.3 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 11 – GUARANTEES AND WARRANTIES:

11.1 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 Engineer's Statement of Substantial Completion. Items of equipment which have longer guarantees, as called for in these Specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Engineer shall then submit these warranties, etc. to the Owner. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of their operator or other employees. Refer to other sections for any special or extra warranty requirements.

11.2 All gas fired heat exchangers shall have 20 year warranty.

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

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

PART 12 – COST BREAKDOWNS (SCHEDULE OF VALUES):

12.1 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.

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

- Mechanical Shop Drawings
- Motor Load Coordination with other subcontractors
- Mechanical Record Drawings & Acceptance
- Mechanical O&M Manuals & Acceptance
- Mechanical Owner Training & Acceptance
- Mechanical Startup, Testing, Management Plan, Documentation, Acceptance, Owner Training, etc. (shall equal 1/4 % of Mechanical Contract Value)
- Mechanical Identification Materials & Labor
- Insulation (Piping) Materials & Labor
- Insulation (Ductwork) Materials & Labor
- HVAC Piping Materials & Labor
- HVAC Piping Testing, Cleaning, Documentation, Acceptance, etc. (shall equal 1/2 % of Piping Value)
- HVAC Piping Purging, Flushing, Cleaning (shall equal 1/2 % of piping value)
- Geothermal Materials & Labor
- Geothermal Grouting Materials & Labor
- Geothermal Flushing, Purging, Testing, Documentation, Site Survey Submittal, Acceptance, etc (shall equal 1/2 % of Geothermal Contract)
- 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. (shall equal 1% of Equipment Value)
- Fire Protection Shop Drawings
- Fire Protection Materials & Labor
- Fire Protection Record Drawings & Acceptance
- Sheetmetal Equipment
- GRDs Materials & Labor
- Sheetmetal Materials & Labor
- Sheetmetal Shop Fabrication
- Ductwork Air Leakage Testing, Documentation, Acceptance, etc (shall equal 1/2% of Sheetmetal Contract Value)
- Filters and Racks Materials & Labor
- Spare Filters
- Heat Pump Equipment & Labor
- Heat Pump Equipment Spare Parts
- Heat Pump Startup, Testing, Documentation, Training, Acceptance, etc. (shall equal 1/2 % of Equipment Value)
- Water to Water Heat Pump Equipment & Labor
- Water to Water Heat Pump Startup, Testing, Documentation, Training, Acceptance, etc. (shall equal 1/2 % of Equipment Value)
- Air Handling Unit Equipment & Labor
- Air Handling Unit Startup, Testing, Documentation, Training, Acceptance, etc. (shall equal 1/2 % of Equipment Value)
- Equipment Room A/C Equipment & Labor
- Equipment Room A/C Startup, Testing, Documentation, Training, Acceptance, etc. (shall equal 5% of Equipment Value)
- Equipment Room A/C Spare Parts
- Chemical Treatment Materials & Labor
- Chemical Treatment Startup, Testing, Documentation, Training, Acceptance, etc (shall equal 1/2 % of Chemical Treatment Value)
- Controls Shop Drawings
- Controls Materials & Labor
- Controls Graphics
- Controls Spare Parts
- Controls Startup, Testing, Documentation, etc.
- Controls Training and Acceptance
- Test and Balance Materials & Labor
- Test and Balance Initial Report, Final Report and Acceptance

PART 13 – CHANGES IN MECHANICAL WORK:

13.1 REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 14 – CLAIMS FOR EXTRA COST:

14.1 REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 15 – MATERIALS AND WORKMANSHIP:

15.1 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 this work shall be the responsibility of

the Contractor. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of 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.

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

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

15.4 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.

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

PART 16 – HAZARDOUS MATERIALS:

16.1 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.

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

16.3 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.

16.4 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.

16.5 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.

16.6 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 acceptance of work.

PART 19 – SURVEY, MEASUREMENTS AND GRADE:

19.1 The Contractor shall lay out their work and be responsible for all necessary lines, levels, 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.

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 above ceiling.

PART 24 – BROKEN LINES AND PROTECTION AGAINST FREEZING:

24.1 No conduits, piping, troughs, 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. If

in doubt, contact the Engineer. Do not install piping across or near openings to the outside whether they are carrying static or moving fluids or not. Insulation on piping does not necessarily insure that freezing will not occur.

PART 25 – WEATHERPROOFING:

25.1 Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as 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 to mechanical services (water, sanitary, gas, air, etc.), any terminal equipment, appliances, 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 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 hung 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, 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 OSHA 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. In the absence of other concrete Specifications, all concrete related to Mechanical work shall be 3500 psi minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy

equipment shall not be set on pads for at least seven (7) days after pour. Insert 6-inch steel dowel rods into new and existing floors to anchor pads.

29.2 All concrete pads shall be complete with all pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18" in width shall be reinforced with ½" round bars on 6" centers both ways. Bars shall be approximately 3" 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.

29.3 In general, concrete pads for equipment shall be 4" thick and 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.

29.4 Exterior concrete pads shall be 8" thick with four (4) inches minimum above grade and four (4) inches below grade on a tamped 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 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. 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.

31.4 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.

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 with ten feet of gas lines, fuel lines, electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only in accord with utility company, agency or other applicable laws, standards or regulations.

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 clean of rubbish and debris caused by their operations; and at the completion of the work, 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 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 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 A pre-start-up conference shall be held with the Architect, Owner, General Contractor and the Mechanical Contractor. Equipment shall not be started until after this meeting.

33.4 For Air Handling Units during all phases of construction:

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

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 return air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the "construction" filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.
- At substantial completion of the project the entire unit shall be cleaned to present a like "new" unit for the Owner and all filters shall be replaced with new.

33.6 For Outside Air Units during all phases of construction:

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

PART 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. Unitary equipment, such as small room heating units, small 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.

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

PART 35 – EQUIPMENT/CONTROLS STARTUP & VERIFICATION:

35.1 The Contractor 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 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". This line-item value shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspector(s) shall closely monitor progress and quality of the equipment and controls startup and may withhold pay requests as deemed appropriate.

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 Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer's Checklists. Factory startup is required for all HVAC equipment. 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)
- Water-to-Water Heat Pump Units (Use the attached forms – no exceptions)
- Outside Air Units (Use the attached forms – no exceptions)
- Variable Frequency Drives
- Water Flow Meters/BTUH Meters
- Hot Water Boilers

35.6 Except for the 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. The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.

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 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 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 anticipates commencing work. Failure of the Inspecting Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

36.4 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 Agency Inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

36.5 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.

36.6 Before final acceptance, the Contractor shall furnish the original and three (3) copies of the certificates of final approval by the Agency Inspectors 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 $100.00 per hour for extra trips required to complete either of the above ceiling, below ceiling or final punch lists.

PART 38 – INDEMNIFICATION:

38.1 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 39 - OPERATING INSTRUCTIONS:

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

such demonstrations have taken place, noting the date, time and names of the Owner's representatives that were present.

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

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

PART 40 - RECORD DRAWINGS:

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

40.2 All underground utilities/piping installed as part of this project shall be surveyed by a land surveyor licensed in the State of Kentucky. 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.

40.3 The survey information shall be included in the closeout documentation.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 200200 - SCOPE OF THE MECHANICAL WORK

PART 1 – GENERAL:

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

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

1.3 Complete steam servie connected to central plant distribution piping.

1.4 Complete domestic water service to 5’-0” beyond building footprint. Refer to Civil Drawings/Specifications for additional requirements.

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

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

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

1.8 Complete natural gas service to 5’-0” beyond building footprint. Refer to Civil Drawings/Specifications for additional requirements.

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

1.10 Interior domestic hot, cold and recirculating hot water system.

1.11 Interior soil, waste and vent systems.

1.12 Roof drainage system.

1.13 All plumbing equipment, fixtures and fittings.

1.14 100% automatic sprinkler system.

1.15 All mechanical exhaust systems.

1.16 All insulation associated with mechanical systems.

1.17 Condensate drainage systems.

1.18 Complete heating, ventilation and air conditioning systems.

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

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

1.21 Complete natural gas piping systems.

1.22 All required controls, including self checkout and commissioning.

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

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

1.25 Thorough instruction of the owner's maintenance personnel in the operation and maintenance of all mechanical equipment.

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

1.27 Approved supervision of the mechanical work.

1.28 Procurement of all required inspections, including fees for all inspection services and submission of final certificates of inspection to the Engineers (Plumbing, etc.).

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

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

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

1.32 Required schedule of values breakdown.

1.33 Pipe, duct and equipment identifications.

1.34 Preinstallation meetings and equipment mockups.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 200300 - SHOP DRAWINGS, MAINTENANCE MANUALS AND PARTS LISTS

PART 1 – GENERAL:

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

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

1.4 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.

1.5 All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the General 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.

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

1.7 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.

1.8 The Engineers 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 and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project.

1.9 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.

1.10 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.

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

1.12 All submittals for mechanical equipment shall include all information specified. 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.

1.13 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.

1.14 Any submittals received in an unorganized manner without options listed and with incomplete data will be returned for resubmittal.

END OF SECTION.

DIVISION 20 - MECHANICAL

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

PART 1 – GENERAL:

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

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

1.3 The Contractor shall plan their work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go through; however, when this is not done, 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 buildings by the workers of the responsible Contractor must be corrected or rectified at their own expense.

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

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 by the Mechanical Trades in this section, shall be corrected by the General Contractor at the responsible Contractor’s expense.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 201200 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

PART 1 – GENERAL:

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

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

1.3 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.

1.4 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.

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 be unclassified, and shall include earth, rock, concrete or any other obstructions encountered in excavation and/or trenching to install underground utility pipes 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, 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 does not give any guarantee or warranty as to the accuracy of the data shown and no claim will be considered for additional compensation when the materials encountered are not in accord with the information shown.

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

PART 3 – BENCH MARKS AND MONUMENTS:

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

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 201300 - PIPE, PIPE FITTINGS AND PIPE SUPPORT

PART 1 – GENERAL:

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

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

1.3 Unless otherwise indicated, all materials shall be new and of the best grade and quality for the type specified.

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 insure 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 chilled water, hot water and 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 toward the source. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be ½" size ball valves with 3/4" hose thread end and vacuum breaker. Label each drain valve.

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

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

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

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

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

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

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

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

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

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

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

1.36 When connecting to an existing hydronic water system (chilled, hot, 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.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 201305 - 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.

END OF SECTION.

DIVISION 20 - MECHANICAL

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

PART 1 – GENERAL:

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

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

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

1.4 Provide 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 trading area of the job site or facility.

1.7 Furnish initial supply of the closed loop chemicals for each system. This contractor shall retest the systems after 3, 6 and 12 months to verify the proper dosage is in each system. Provide all closed loop chemicals and anti-freeze for the first year. 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.

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

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

1.10 Water Quality Minimum Performance Requirements:

- Closed hydronic systems shall maintain a pH value within 9 – 10.5.
- Total Aerobic Plate Count - Maintain a maximum value of 1000 organisms/ml.
- Total Anaerobic Plate Count - Maintain a maximum value of 100 organisms/ml.
- Nitrate Reducers - Maintain a maximum value of 100 organisms/ml.
- Sulfate reducers - Maintain a maximum value of 0 organisms/ml.
- Iron Bacteria - Maintain a maximum value of 0 organisms/ml.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202100 - VALVES

PART 1 – GENERAL:

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

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

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

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

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

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

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

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202200 - INSULATION - MECHANICAL

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL 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 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.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202300 - THERMOMETERS, PRESSURE GAUGES AND OTHER MONITORING INSTRUMENTS

PART 1 – GENERAL:

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

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

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202400 - IDENTIFICATIONS, TAGS, CHARTS, ETC.

PART 1 – GENERAL:

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

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 202500 - HANGERS, CLAMPS, ATTACHMENTS, ETC.

PART 1 – GENERAL:

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

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

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

1.4 Power driven anchors and expansion anchors shall be permitted only when permission is granted in writing by the Architect and Engineer.

END OF SECTION.

DIVISION 20 - MECHANICAL

SECTION 203100 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

PART 1 – GENERAL:

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

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

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

END OF SECTION.

DIVISION 21 – FIRE PROTECTION

SECTION 210100 - FIRE PROTECTION SYSTEM

PART 1 – GENERAL:

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

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

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

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

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

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

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

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

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

- Fire Protection Shop Drawings and Approvals

- Fire Protection Materials & Labor
- Fire Protection Record Drawings & Acceptance

PART 2 – SCOPE OF WORK:

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

2.2 Furnish all material, labor, tools, equipment and supervision required for modifications to the existing fire protection system as indicated on the project drawings and within these specifications. Include all necessary piping, sprinkler heads, test connections, valves, drains, etc.

2.3 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.

2.4 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.

2.5 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.

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

2.7 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.

END OF SECTION.

DIVISION 22 – PLUMBING

SECTION 220100 - PLUMBING SPECIALTIES

PART 1 – GENERAL:

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

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

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

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

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

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

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

END OF SECTION.

DIVISION 22 - PLUMBING

SECTION 220200 - PLUMBING FIXTURES, FITTINGS AND TRIM

PART 1 – GENERAL:

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

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

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

1.4 All fixtures and trim shall be new. All fixtures and trim shall be installed as recommended by the manufacturer. All fixtures shall be set level and true and shall be grouted into finished walls, floors, etc. in a neat and workmanlike manner with an approved waterproof non-yellowing grout for such service. All fixtures and trim hall be installed in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost. Pay particular attention to flush valves and bracket concealed portion to building structure during rough-in. Loose, shaky flush valves, lavatories, etc. shall not be acceptable.

1.5 Handicapped accessible fixtures shall be mounted as recommended by the Building Code and ADA. Special Note for Handicap Grab Rails: Coordinate top of shower valves, flush valves, flush tank, etc., with location of grab rails as shown on the architectural plans. The Contractor shall install all items to allow for installation, removal and service without removal of the grab bar.

1.6 Fixture seats shall be Church model 2155CTJ, elongated open front less cover w/ JUST-LIFT, STA-TITE check hinge and DuraGuard Antimicrobial Agent, or approved equal.

1.7 All exposed piping, stops, traps, tailpieces, etc. shall be code approved chrome plated brass unless otherwise indicated or specified. Where acid resistant piping is indicated on the drawing or the specifications, all piping and ancillary components from the sink/lavatory to dilution basin shall be acid resistant as specified and required by code.

1.8 Water supplies shall connect through walls with stops and chrome plated escutcheons with set screws. In general, furnish drinking fountains, wall-hung lavatories and hoseb bibbs with manual loose key stop valves. For all other fixtures, furnish with manual permanent-key stop valves (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 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirement's manufacturers offering plumbing fixtures and trim which may be incorporated in the work include the following:

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

1.12.2 Plumbing Trim: American Standard, Chicago Faucet, Kohler, Delta Commercial, T&S Brass, Just, Speakman, Zurn Aqua-Spec, Moen Commercial, Symmons

1.12.3 Flush Valves: Sloan, Zurn, Delany

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

1.12.5 Service Sinks and Mop Basins: American Standard, Eljer, Fiat, Kohler, Mustee (Mop Basins), Acorn, Zurn

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

1.12.7 Showers: Bradley, Symmons, Chicago Faucets, Speakman Company, Powers, Acorn, Aqua Bath, Florestone, Swanstone, Willoughby, Aquarius

1.12.8 Appliance Connection Boxes: Guy Gray, Oatley, Wolverine

1.12.9 Wash Fountains: Bradley, Acorn, Willoughby

1.12.10 Emergency/Safety Fixtures: Bradley, Acorn, Guardian, Haws

1.12.11 Fixture Seats: Bemis, Church, Olsonite

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

END OF SECTION.

DIVISION 22 - PLUMBING

SECTION 220300 - PLUMBING EQUIPMENT

PART 1 – GENERAL:

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

1.2 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.

1.3 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.

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

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

1.6 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.

1.7 Determine from the Bid Documents the date of completion of this project and insure that equipment delivery schedules can be met so as to allow this completion date to be met.

1.8 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.

1.9 Review the Specification Section - CONTROLS to determine automatic controls requirements through the Building Automation System.

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

END OF SECTION

DIVISION 23 - HVAC

SECTION 230100 - PUMPS

PART 1 – GENERAL:

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

1.2 Electric motors shall be furnished with the pumps and shall be of the size and type scheduled or otherwise specified. All motors shall be UL labeled and shall comply with applicable NEMA standard. Motors to be high efficiency type. Refer to Specification Section – ELECTRIC MOTORS, ETC.

1.3 Shop drawings shall be submitted as required and shall include complete pump specifications, installation and start-up instructions, current and accurate pump performance curves with the selection points clearly indicated, maintenance data and spare parts lists.

1.4 Pumps shall be factory tested, cleaned and painted prior to shipment. Size, type, capacity and electrical characteristics are listed in the pump schedule.

1.5 Insofar as possible, all pumps shall be by the same manufacturer.

END OF SECTION.

DIVISION 23 - HVAC

SECTION 230200 - HVAC EQUIPMENT

PART 1 – GENERAL:

1.1 The Contractor's attention is directed to the General and Special Conditions, GENERAL 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 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.

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

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

1.6 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
- Water-to-Water Heat Pump Units
- Outside Air Units
- Variable Frequency Drives
- Water Flow Meters/BTUH Meters
- Hot Water Boilers

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

1.8 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.

1.9 Determine from the Bid Documents the date of completion of this project and insure that equipment delivery schedules can be met so as to allow this completion date to be met.

1.10 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.

1.11 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.

1.12 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: JCI/York, McQuay, Climate Master, Trane, FHP.

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, hermetically sealed scroll type with internal vibration isolation. Compressors motors shall be equipped with overload protection. Refer to the drawing schedules as multiple compressor types shall be utilized.

2.11 COMPRESSOR SOFT START: The compressors shall be furnished with a soft-start feature for reduced startup inrush amps by 8:1 when compared to normal LRA.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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.

2.17 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.

2.18 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.

2.19 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.

2.20 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.

2.20.1 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.

2.20.2 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.

2.20.3 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.

2.20.4 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.

2.21 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!

2.21.1 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.

2.21.2 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.

2.21.3 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.

2.22 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.

2.23 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 – GEOTHERMAL WATER-TO-WATER HEAT PUMP UNITS:

3.1 ACCEPTABLE MANUFACTURERS: JCI/York, McQuay, Climate Master, Trane, FHP, Mammoth.

3.2 Equipment shall be specifically designed for applications within conditioned interior areas. Capacities shall be rated in accordance with ARI for geothermal applications. Equipment shall be ETL or CSA approved. All equipment shall have decals and labels to aid in servicing and indicate caution areas.

3.3 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.

3.4 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.

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

3.6 CASING AND CABINET: The cabinet shall be constructed of heavy-gauge galvanized steel and factory painted. The interior shall be insulated with 1/2" thick, multi density, coated, glass fiber. All units shall allow front service access to replace the compressor and/or electrical components without unit removal.

3.7 COMPRESSOR: The compressor or compressors shall be high-efficiency, hermetically sealed scroll type with internal vibration isolation. Compressors motors shall be equipped with overload protection.

3.8 WATER-TO-REFRIGERANT HEAT EXCHANGERS: The water-to-refrigerant heat exchangers shall be of a high quality co-axial coil for maximum heat transfer and insulated to prevent condensation at low temperatures. The copper coil shall be fluted to enhance heat transfer and minimize fouling and scaling. The coil shall have a working pressure of 600 psig on the refrigerant side and 400 psig on the water side.

3.9 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.

3.10 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.

3.11 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 120º F entering fluid temperatures. The equipment shall only operate with one variable (entering water temperature or gpm) at an extreme condition. All other variables must be within the nominal range of operation.

3.12 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.

3.13 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) Compressor controller shall be a 24 Vac contactor. All three-phase operated equipment shall have a contactor that interrupts all three-phases providing power to the compressor. (3) 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. (4) High pressure switch shall protect the compressor against operation at refrigerant system pressures in excess of 395 PSIG. (5) Low pressure switch shall prevent compressor operation underneath low charge or catastrophic loss of charge situations. (6) Freeze stats shall be factory installed on both load and source sides.

3.14 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! Hose kit and piping package configuration shall match the Geothermal Heat Pumps. Refer to the Geothermal Heat Pump Specification Section for additional requirements.

3.15 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.

3.16 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 – OUTSIDE AIR UNITS (INDOOR TYPE):

4.1 ACCEPTABLE MANUFACTURERS: McQuay, JCI/York, Carrier, Trane.

4.2 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.

4.3 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.

4.4 CASINGS

4.4.1 Unit shall be double wall foam injected constructed in all sections. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. Insulate all sections with 2" thick foam injected insulation, 1 ½ lb per cubic foot density. All panels shall be solid on the interior and exterior. Insulation shall comply with NFPA 90A. Fiberglass insulation shall not be acceptable.

4.4.2 Unit shall be constructed of a complete structural frame with removable panels. Removal of all exterior panels shall not affect the structural integrity of the unit. Installing Contractor shall be responsible to provide connection flanges and all other framework that is needed on unit to ensure that removals of unit's panels shall not affect structural integrity.

4.4.3 All exterior panels and structural frames shall be constructed of G90-U galvanized steel. Casings not constructed of G90-U galvanized steel, casings with welds on interior and exterior surfaces that have burned through to exterior surfaces shall be chemically cleaned, coated with rust inhibiting primer and finished with rust inhibiting enamel.

4.4.4 Construct casing sections located upstream of the supply fan for operation at 4 inches water gauge negative static pressure and casing sections located downstream of the supply fan for operation at 6 inches water gauge positive static pressure.

4.4.5 All joints between exterior panels and structural frames shall have seals and gaskets with closed-cell foam gasketing for air seal and acoustical break.

4.4.6 As required for routine service access, unit shall be supplied with full height, galvanized, double wall, hinged, removable access doors. Access door shall have a full perimeter automotive type gasket to prevent

air leakage, and Ventlock style handle that can be opened from unit interior. Doors shall open against system pressure. If access doors open against unit operating pressure, provide safety latches that allow access doors to partially open after the first handle movement and fully open after second handle movement. All handles shall operate easily without special tools.

4.5 FAN SECTIONS

4.5.1 Provide fan sections with fan type as specified on drawings designed and suitable for class or service indicated. Fan sections shall have full height, double wall hinged, removable access doors on drive side for inspection and maintenance of internal components. Fan sections with plug fans shall have galvanized expanded metal access door guards to prevent unauthorized entry into fan sections when access doors are opened.

4.5.2 Provide belt driven fans with adjustable pitch pulley permitting fan speed to be varied. Select pulley for mid-point of adjustable range. Design fan shafts so as not to pass through first critical speed when unit comes up to rated RPM. Statically and dynamically balance fan assemblies in fan housing after final assembly. Belts shall be enclosed as required by OSHA standard 29 CFR 1910 to protect worker form accidental contact with belts and sheaves. Provide multi-sheave/belt/pulley arrangements for fans with motor horsepower 5 hp and greater.

4.5.3 Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with a minimum of 2-inch spring isolators. Provide adjustable motor base, adjusted with mounting bolts, to provide variation in center distance. Provide locking nuts, or similar devices, to secure base in proper position. Install flexible canvas ducts between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A. Fan and motor assembly shall be weighed at the manufacturer's factory for isolator selection. Vibration shall be measured at each fan shaft bearing in horizontal, vertical and axial directions. All fans shall have pillow block bearings with minimum L-50 200,000 hour rating. Provide grease lubricated fan bearings with externally accessible fittings for lubrication. Extend both grease lubrication fittings to drive side of unit with plastic tubes and zerk fittings rigidly attached to drive side bearing support.

4.5.4 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 – ELECTRIC MOTORS, ETC. 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.

4.6 COIL SECTIONS AND DRAIN PANS

4.6.1 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.

4.6.2 All coils shall be tested at 200 psig air pressure while submerged in water. Coil performance shall be certified in accordance with ARI Standard 410. All coils shall have stainless steel casings. Construct coil headers of round copper pipe or cast iron. Clearly label supply and return headers on the outside of the units such that the direction of coil water flow is counter to the direction of air flow. If two or more coils are stacked in the unit, install intermediate drain pan channels between the coils to drain condensate to main drain pans without flooding lower coils or passing condensate through the air stream.

4.6.3 Provide type 304 sealed stainless steel drain pans. Encase insulation between exterior and interior walls. Drain pans shall be sloped in two planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Drain pans shall be installed under the complete cooling coil

section. All drain pan connections will be to the side of the unit to ensure proper trapping. Units without 2-way sloped drain pans shall coat drain pans with anti-microbial treatment.

4.6.4 A 20 gauge, reinforced sheetmetal baffle shall be field or factory provided across the top of the entire coil protected with a freeze-stat. Baffle shall be full width of unit and 24" minimum in length. The purpose of the baffle it to prevent nuisance freeze-stat trips from cold air passing over the top of the coil near the freeze-stat.

4.7 DAMPERS: Provide internally mounted ultra low leak outside air dampers as specified on drawings. 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.

4.8 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.

4.9 FILTERS: Filters shall be 2" thick, 30% efficient 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.

4.9.1 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.

4.9.2 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.

4.10 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.

4.11 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 5 – OUTSIDE AIR UNITS (ROOFTOP TYPE):

5.1 ACCEPTABLE MANUFACTURERS: Greenheck, Innovent, Aaon.

5.2 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. Unit shall be specifically designed for outdoor/rooftop installation.

5.3 CASINGS

5.3.1 Unit shall be of internal frame type construction of galvanized steel. Frame and panels shall be G90 galvanized steel. All panels exposed to the weather shall be a minimum of 18 gauge galvanized steel. Unit

shall be internally lined with galvanized sheet metal creating a double wall. Where top panels are joined there shall be an overlapping, standing seam to insure positive weather protection. All metal-to-metal seams shall be factory sealed, requiring no caulking at job site.

5.3.2 Exterior paint finish for outdoor units shall be powder coated with selection by Architect from manufacturer's standard color chart.

5.3.3 Unit base to be designed for curb mounting. Unit base shall overhang the curb for a positive seal against water run-off. Coordinate with existing roof curb for proper fit.

5.3.4 Weatherhoods shall be the same finish as the unit. Outdoor air weatherhood shall incorporate a louvered design and moisture eliminator. Weatherhoods shall be tested in accordance with AMCA Standard 500-L to prevent water penetration up to 3 in/hr at 29 mph.

5.3.5 Unit casing to be insulated with 1 inch fiberglass. Insulation shall meet requirements of NFPA 90A and tested to meet UL 181 erosion requirements. Insulation to be enclosed in double wall construction.

5.3.6 Construct casing sections located upstream of the supply fan for operation at 4 inches water gauge negative static pressure and casing sections located downstream of the supply fan for operation at 6 inches water gauge positive static pressure.

5.3.7 As required for routine service access, unit shall be supplied with full height, galvanized, double wall, hinged, removable access doors. Access door shall have a full perimeter automotive type gasket to prevent air leakage, and Ventlock style handle that can be opened from unit interior. Doors shall open against system pressure. If access doors open against unit operating pressure, provide safety latches that allow access doors to partially open after the first handle movement and fully open after second handle movement. All handles shall operate easily without special tools.

5.4 FAN SECTIONS

5.4.1 Provide fan sections with fan type as specified on drawings designed and suitable for class or service indicated. Fan sections shall have full height, double wall hinged, removable access doors on drive side for inspection and maintenance of internal components. Fan sections with plug fans shall have galvanized expanded metal access door guards to prevent unauthorized entry into fan sections when access doors are opened.

5.4.2 Provide belt driven fans with adjustable pitch pulley permitting fan speed to be varied. Select pulley for mid-point of adjustable range. Design fan shafts so as not to pass through first critical speed when unit comes up to rated RPM. Statically and dynamically balance fan assemblies in fan housing after final assembly. Belts shall be enclosed as required by OSHA standard 29 CFR 1910 to protect worker form accidental contact with belts and sheaves. Provide multi-sheave/belt/pulley arrangements for fans with motor horsepower 5 hp and greater.

5.4.3 Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with a minimum of 2-inch spring isolators. Provide adjustable motor base, adjusted with mounting bolts, to provide variation in center distance. Provide locking nuts, or similar devices, to secure base in proper position. Install flexible canvas ducts between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A. Fan and motor assembly shall be weighed at the manufacturer's factory for isolator selection. Vibration shall be measured at each fan shaft bearing in horizontal, vertical and axial directions. All fans shall have pillow block bearings with minimum L-50 200,000 hour rating. Provide grease lubricated fan bearings with externally accessible fittings for lubrication. Extend both grease lubrication fittings to drive side of unit with plastic tubes and zerk fittings rigidly attached to drive side bearing support.

5.4.4 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 – ELECTRIC MOTORS, ETC. 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.

5.5 COIL SECTIONS AND DRAIN PANS

5.5.1 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.

5.5.2 All coils shall be tested at 200 psig air pressure while submerged in water. Coil performance shall be certified in accordance with ARI Standard 410. All coils shall have stainless steel casings. Construct coil headers of round copper pipe or cast iron. Clearly label supply and return headers on the outside of the units such that the direction of coil water flow is counter to the direction of air flow. If two or more coils are stacked in the unit, install intermediate drain pan channels between the coils to drain condensate to main drain pans without flooding lower coils or passing condensate through the air stream.

5.5.3 Provide type 304 sealed stainless steel drain pans. Encase insulation between exterior and interior walls. Drain pans shall be sloped in two planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Drain pans shall be installed under the complete cooling coil section. All drain pan connections will be to the side of the unit to ensure proper trapping. Units without 2-way sloped drain pans shall coat drain pans with anti-microbial treatment.

5.5.4 A 20 gauge, reinforced sheetmetal baffle shall be field or factory provided across the top of the entire coil protected with a freeze-stat. Baffle shall be full width of unit and 24” minimum in length. The purpose of the baffle it to prevent nuisance freeze-stat trips from cold air passing over the top of the coil near the freeze-stat.

5.6 DAMPERS: Provide internally mounted ultra low leak outside air dampers as specified on drawings. 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.

5.7 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.

5.8 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.

5.9 FILTERS: Filters shall be 2" thick, 30% efficient 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.

5.9.1 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.

5.9.2 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.

5.10 ELECTRICAL AND CONTROLS

5.10.1 All internal electrical components shall be factory wired for single point power connection. Units with electric reheat will be wired with independent power supply. All electrical components shall be UL Listed, Approved, or Classified where applicable and wired in compliance with the National Electrical Code. Weatherproof, integral door interlocking disconnect switch, motor starters, control circuit fusing, control transformer for 24 VAC circuit, and terminal strip shall be supplied as standard components in the control center. Motor starters consist of a contactor and adjustable overload protection and shall be provided for all motors in the unit.

5.10.2 NEMA 3R door disconnect, controls transformer, motor starters, dial type adjustable overloads, frost control inlet air sensor and timed exhaust control sequence, wheel rotation sensor, mild outside air economizer wheel control sequence, motorized low leak dampers to close the outside air intake and exhaust air relief when the unit is not in operation.

5.11 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.

5.12 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 – HIGH EFFICIENCY CONDENSING BOILERS:

6.1 ACCEPTABLE MANUFACTURERS: AERCO, Buderus and Viessman.

6.2 CONSTRUCTION: Boiler modules shall be natural gas fired, condensing fire tube design with a modulating forced draft power burner and positive pressure vent discharge.

6.3 MODULATING AIR/FUEL VALVE and BURNER: The Boiler burner shall be capable of a 20 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall be nozzle mix design, with spark ignition and flame rectification. The burner head shall be cast stainless steel. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and natural gas input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment.

6.4 PRESSURE VESSEL/HEAT EXCHANGER

6.4.1 The boiler shall be capable of handling return water temperatures down to 40 F without any failure due to thermal shock or fireside condensation. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. The pressure vessel shall have a maximum water volume of 30 gallons. The boiler water pressure drop shall *not exceed* 2 psig at 180 gpm. The boiler water connections shall be 4" flanged 150 lb. ANSI rated. The pressure vessel is constructed of SA53 carbon steel, with a 0.25 in. thick wall and 0.50 in. thick upper head. Inspection openings in the pressure vessel & shall be in accordance with ASME Section IV pressure vessel code.

6.4.2 The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases. The heat exchanger shall be constructed entirely of 316L stainless steel fire tubes and tube sheets with a one-pass combustion gas flow design. Hybrid designs or heat exchangers utilizing dissimilar metals or any non-ferrous metals shall not be acceptable. The fire tubes shall be 5/8 in. OD with no less than 0.065 in. wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.313 in. thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tubesheets and heat exchanger is available by burner and exhaust manifold removal. Minimum access opening shall be no less than 13.5 in. diameter.

6.5 EXHAUST MANIFOLD: Refer to positive pressure venting specification. The exhaust manifold shall have a gravity drain for the elimination of the condensation with collecting reservoir.

6.6 BOILER CONTROLS: The boiler control system shall be segregated into three components: Control Panel, Power Box, and Input/Output Connection Box. The entire system shall be Underwriters Laboratories Recognized.

6.6.1 The control panel shall consist of 6 individual circuit boards utilizing surface-mount technology, in a single enclosure. These circuit boards shall be defined as follows: display board incorporating LED display to read temperature, and a VFD display module for all message annunciation; CPU board which houses all control functions; electric low water cutoff board with test and manual reset functions; power supply board; ignition /stepper board incorporating flame safeguard control; and connector board. Each board shall be individually field replaceable. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor. The control panel hardware shall support both RS-232 and RS-485 remote communications. The controls shall annunciate boiler & sensor status and include extensive self-diagnostic capabilities that incorporates a minimum of 8 separate status messages and 34 separate fault messages.

6.6.2 The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features are called: Setpoint High Limit, Setpoint Low Limit, and Failsafe Mode. Setpoint High Limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. It is a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to10 degree selectable band from the desired maximum boiler outlet temperature. Setpoint Low Limit allows for a selectable minimum operating temperature.

6.6.3 Failsafe Mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode; hence the control can be set to shut off the unit upon loss of external signal if so desired.

6.6.4 The boiler control system shall incorporate the following features for system interface: system start temperature feature; pump delay timer; auxiliary start delay timer; auxiliary temperature sensor; mA output feature which allows for simple monitoring of either temperature setpoint, outlet temperature, or fire rate; remote interlock circuit; delayed interlock circuit; and fault relay for simple remote fault alarm.

6.6.5 Each boiler shall utilize an electric single seated safety shutoff valve with proof of closure switch in its gas train and incorporate dual over-temperature protection with manual reset in accordance with ASME Section IV and CSD-1.

6.7 TEMPERATURE CONTROL MODES

6.7.1 The boilers shall operate in the control modes listed below:

- Indoor/Outdoor Reset
- Boiler Management System (BMS)

6.7.2 The first six control modes refer to independent boiler settings, while the last two control modes refer to banks of boilers operated as a system by supplied BMS. The BMS shall be programmed to operate the entire bank of boilers in either of the first four control modes.

6.8 INDOOR/OUTDOOR RESET:

6.8.1 Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler plant. The system shall be comprised of a microprocessor-based control utilizing pulse width modulation for bumpless transfer of header temperature. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler and without header temperature swings.

6.8.2 The boiler will operate to vary header temperature setpoint on an inverse ratio in response to outdoor temperature to control discharge temperature $\pm$2ºF. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. The boiler shall have LCD display for monitoring of all sensors and interlocks.

6.8.3 The outdoor air sensor and supply water temperature sensor shall be furnished with the boiler package and installed by the Contractor.

6.9 BOILER MANAGEMENT SYSTEM (BMS):

6.9.1 The Boiler Manufacturer shall supply as part of the boiler package a completely integrated Boiler Management System to control all operation and energy input of the multiple boiler heating plant. The Boiler Management System shall be comprised of a microprocessor based control. The BMS controller shall have the ability to operate up to 32 boilers per BMS panel.

6.9.2 The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The BMS shall control the boiler outlet header temperature within $\pm$2ºF. The controller shall be a PID type controller for accurate temperature control with excellent variable load response. The BMS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

6.9.3 When set on Internal Setpoint Mode, temperature control setpoint on the BMS shall be fully field adjustable from 50ºF to 190ºF in operation. When set on Indoor/Outdoor Reset Mode, the BMS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation.

6.9.4 The BMS controller shall have a LCD display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each module by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central BMS system and individual modules shall be twisted pair low voltage wiring, with the boilers ‘daisy-chained’ for ease of installation.

6.9.5 Manufacturer to provide interface to existing controls. Coordinate with the Owner. Interface to include all hardware necessary to communicate with Lonworks or BacNet protocol, whichever is required. Provide hardware and software identifiers for the interface points, values, units, etc. Provide on-site technical personnel to facilitate the interface with the Owner.

6.10 CONTROLS INTEROPERABILITY:

6.10.1 The control panel and the BMS shall utilize the MODBUS open protocol to interface with third party building automation systems. When the Building Automation System (BAS) does not have MODBUS protocol capability and interoperability is required, the installing contractor shall provide a MODBUS Gateway to act as interface/translator between the BAS via either the RS-485 port of the boiler control panel or the RS-232 port of the BMS.

6.11 INSTALLATION:

6.11.1 All aspects of installation of Boiler Plant shall be in strict accordance with manufacturer's instructions. The vent and air intake system must conform to all manufacturers' recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure for the vent and PVC for the intake. The vent must be sized in accordance with boiler manufacturer's recommendations. Prior to the bid, the boiler manufacturer and Contractor shall confirm the appropriate vent and intake sizes according to the manufacturer's recommendation. Change orders will not be accepted for increases in sizes after the bid.

6.11.2 Boiler plant piping shall be field constructed of materials as specified. Each boiler shall have individually isolating shutoff valves for service and maintenance. Each boiler shall require a minimum gas pressure of 7"W.C. (FM gas train) at 2,000 scfh (full load rated capacity). Each boiler shall be provided with an individual supply gas regulator for proper gas regulation with a 2" NPT connection.

6.12 WARRANTY:

6.12.1 The boiler manufacturer shall provide a complete unit parts and labor warranty for one year from substantial completion.

6.12.2 Beginning at the expiration of the one year parts and labor, the Owner shall be provided with a non-prorated 7 year warranty against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship. The six individual circuit boards of the control panel assembly shall carry a 2 year warranty against failure due to defective materials or workmanship.

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

6.14 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 7 – SHELL & TUBE HEAT EXCHANGERS:

7.1 ACCEPTABLE MANUFACTURERS: Bell & Gossett, Taco, Armstrong.

7.2 Provide U-tube heat exchangers as indicated, of capacity as scheduled, and as specified herein.

7.3 Shell and tube, U-bend removable tube bundle, water in tubes, equipped with mounting legs.

7.4 MATERIALS
- Shell - Steel.

- Tubes - 3/4" O.D. copper.
- Heads - Cast iron with "K" head for easy tube bundle removal.
- Tube Sheets - Steel.
- Tube Supports - Steel.

7.5 Provide bonnet head assembly to permit removal of tubes without affecting piping.

7.6 ASME Construction for 125 psi design pressure at 375ºF.

PART 8 – INDOOR AIR HANDLING UNITS:

8.1 ACCEPTABLE MANUFACTURERS: McQuay, JCI/York, Carrier, Trane.

8.2 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.

8.3 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.

8.4 CASINGS

8.4.1 Unit shall be double wall foam injected constructed in all sections. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. Insulate all sections with 2" thick foam injected insulation, 1 ½ lb per cubic foot density. All panels shall be solid on the interior and exterior. Insulation shall comply with NFPA 90A. Fiberglass insulation shall not be acceptable.

8.4.2 Unit shall be constructed of a complete structural frame with removable panels. Removal of all exterior panels shall not affect the structural integrity of the unit. Installing Contractor shall be responsible to provide connection flanges and all other framework that is needed on unit to ensure that removals of unit's panels shall not affect structural integrity.

8.4.3 All exterior panels and structural frames shall be constructed of G90-U galvanized steel. Casings not constructed of G90-U galvanized steel, casings with welds on interior and exterior surfaces that have burned through to exterior surfaces shall be chemically cleaned, coated with rust inhibiting primer and finished with rust inhibiting enamel.

8.4.4 Construct casing sections located upstream of the supply fan for operation at 4 inches water gauge negative static pressure and casing sections located downstream of the supply fan for operation at 6 inches water gauge positive static pressure.

8.4.5 All joints between exterior panels and structural frames shall have seals and gaskets with closed-cell foam gasketing for air seal and acoustical break.

8.4.6 As required for routine service access, unit shall be supplied with full height, galvanized, double wall, hinged, removable access doors. Access door shall have a full perimeter automotive type gasket to prevent air leakage, and Ventlock style handle that can be opened from unit interior. Doors shall open against system pressure. If access doors open against unit operating pressure, provide safety latches that allow access doors to partially open after the first handle movement and fully open after second handle movement. All handles shall operate easily without special tools.

8.5 FAN SECTIONS

8.5.1 Provide fan sections with fan type as specified on drawings designed and suitable for class or service indicated. Fan sections shall have full height, double wall hinged, removable access doors on drive side for inspection and maintenance of internal components. Fan sections with plug fans shall have galvanized expanded metal access door guards to prevent unauthorized entry into fan sections when access doors are opened.

8.5.2 Provide belt driven fans with adjustable pitch pulley permitting fan speed to be varied. Select pulley for mid-point of adjustable range. Design fan shafts so as not to pass through first critical speed when unit comes up to rated RPM. Statically and dynamically balance fan assemblies in fan housing after final assembly. Belts shall be enclosed as required by OSHA standard 29 CFR 1910 to protect worker form accidental contact with belts and sheaves. Provide multi-sheave/belt/pulley arrangements for fans with motor horsepower 5 hp and greater.

8.5.3 Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with a minimum of 2-inch spring isolators. Provide adjustable motor base, adjusted with mounting bolts, to provide variation in center distance. Provide locking nuts, or similar devices, to secure base in proper position. Install flexible canvas ducts between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A. Fan and motor assembly shall be weighed at the manufacturer's factory for isolator selection. Vibration shall be measured at each fan shaft bearing in horizontal, vertical and axial directions. All fans shall have pillow block bearings with minimum L-50 200,000 hour rating. Provide grease lubricated fan bearings with externally accessible fittings for lubrication. Extend both grease lubrication fittings to drive side of unit with plastic tubes and zerk fittings rigidly attached to drive side bearing support.

8.5.4 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 – ELECTRIC MOTORS, ETC. 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.

8.6 COIL SECTIONS AND DRAIN PANS

8.6.1 Provide double wall casing for coil sections. Inside surfaces of chilled water coil sections 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 chilled water coil casing and all fasteners shall be constructed of stainless steel. Insulate coil section casings and drain pans as prior specified.

8.6.2 All coils shall be tested at 200 psig air pressure while submerged in water. Coil performance shall be certified in accordance with ARI Standard 410. All coils shall have chilled water coils stainless steel casings. Hot water coils shall have mill galvanized casings. Construct coil headers of round copper pipe or cast iron. Clearly label supply and return headers on the outside of the units such that the direction of coil water flow is counter to the direction of air flow. If two or more coils are stacked in the unit, install intermediate drain pan channels between the coils to drain condensate to main drain pans without flooding lower coils or passing condensate through the air stream.

8.6.3 Provide type 304 sealed stainless steel drain pans. Encase insulation between exterior and interior walls. Drain pans shall be sloped in two planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Drain pans shall be installed under the complete cooling coil section. Units with heating coils shall have a drain pan under the complete heating coil segment to ensure proper drainage during cleaning. All drain pan connections will be to the side of the unit to ensure proper trapping. All drain pan connections will be to the side of the unit to ensure proper trapping. Units without 2-way sloped drain pans shall coat drain pans with anti-microbial treatment.

8.7 FILTERS: Filters shall be 2" thick, 30% efficient 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.

8.8 DAMPERS: Provide internally mounted ultra low leak outside air dampers as specified on drawings. 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.

8.9 FACE AND BYPASS SECTION: Face and bypass section shall include hot and chilled water coil. A horizontal blank off wall shall be factory installed to bypass coil when damper is in the bypass position.

8.10 AIR BLENDER: The air blender shall be constructed of the rotary design with radial blades. Blender shall have the proper distances upstream and downstream to provide minimum mixing effectiveness of 75% when mixing 50% outdoor air and 50% return air at 50 degree F initial inlet temperature differential. Unit shall mix two or more air streams of different temperatures to within a range of 6 degrees F standard deviation of theoretical mixed air temperature and provide a more uniform air velocity contour entering a downstream filter or coil bank. Construct blender of aluminum. Unit panels shall be double wall construction as specified in the CASINGS paragraph of this section. A hinged access door shall be provided in the air blender section, down stream of the actual blender. The door shall be full height, insulated double-wall, with baked-on enamel dogged fasteners to provide airtight compression of the perimeter gasket. The door shall be lift-off type, removable at hinge pin to provide maximum service access.

8.11 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.

8.12 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 9 – OUTDOOR AIR HANDLING UNITS:

9.1 GENERAL

9.1.1 Acceptable manufacturers: JCI-York, McQuay, Haakon or Ingenia.

9.1.2 Provide factory built and factory tested air handling units as indicated, of sizes and capacities as scheduled, and as specified herein.

9.1.3 VFD provided by temperature control contractor.

9.2 CASINGS

9.2.1 Unit shall be double wall constructed in all sections. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 22 gauge solid galvanized. All portions of the interior of the unit exposed to the airstream shall be covered with galvanized steel to allow cleaning and to prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. Unit shall be designed and constructed such that all exterior panels are non-load bearing. Removal of all exterior panels shall not affect the structural integrity of the unit. Units with welds on

exterior surfaces or welds that have burned through from interior welds shall also receive a final shop coat of zinc-rich protective paint in manufacturer's standard color. Insulate all sections handling conditioned air with 2" thick foam injected insulation, R-13 value between two sheets of solid galvanized steel. As required for routine service access, unit shall be supplied with full height, galvanized, double wall, hinged, removable access doors. Access door shall have a full perimeter automotive type gasket to prevent air leakage, and Ventlock style handle that can be opened from unit interior. Doors shall open against system pressure. On units provided with cooling coils, the drain pan shall extend under the complete coil section. It shall be pitched towards the drain connection and shall be designed to totally prevent standing water in order to comply with the current indoor air quality ASHRAE Standard 62. All drain pans shall be of sealed double wall stainless steel construction with the manufacturer's standard insulation sandwiched between the pan layers. Cover casing and frame with protective finish on both sides. Top of the unit shall slope to provide positive drainage.

9.2.2 Provide panels manufactured by the following manufacturers: panels shall be of the same manufacturer as specified in “Sound Attenuators”; substitute manufacturers are not permitted; Vibro-Acoustics, IAC and Commercial Acoustics.

9.2.2.1 Panels shall be 2” tongue and groove type. The exterior sheets shall be a minimum of 18 ga. Galvanized steel.

9.2.2.2 Media: Media shall be incombustible, acoustical quality, shot-free fiberglass insulation with long, resilient fibers bonded with a thermosetting resin. Fiberglass shall be packed with 15% compression during panel assembly. Media shall be bacteria and fungus resistant and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for fiberglass.

9.2.2.3 The acoustical performance of the panels shall be equal to or greater than the following:

Octave Band, Hz	125	250	500	1000	2000	4000
Transmission Loss, dB	21	27	37	48	55	55
Absorption Coefficients	0.74	0.9	0.99	0.99	0.9	0.9

9.2.2.4 Provide acoustical panels where indicated on the drawings.

9.3 COIL SECTIONS

9.3.1 Provide individual double wall casing for heating and cooling coils as required. Design internal structure of coil section to allow for removal of coils, and provide suitable baffles to assure no air bypass around coils. Provide condensate pans and drain connections to cooling coil sections of sufficient size to contain and remove coil condensate. Condensate drain pans and coil casing shall be constructed of stainless steel. Insulate coil section casings and drain pans as prior specified. All coils shall be tested at 400 psig air pressure while submerged in water. Coil performance shall be certified in accordance with ARI Standard 410. All hot water coils shall have mill galvanized steel casings and stainless steel casings for chilled water coils. All coil sections shall be provided with insulated piping chases.

9.4 FAN SECTIONS

9.4.1 Provide forward curved fans specifically designed and suitable for class or service indicated. Provide adjustable motor base, adjusted with mounting bolts, to provide variation in center distance. Provide locking nuts, or similar devices, to secure base in proper position. Provide belt driven fans with adjustable pitch pulley permitting fan speed to be varied. Select pulley for mid-point of adjustable range. Design fan shafts so as not to pass through first critical speed when unit comes up to rated RPM. Provide grease lubricated fan bearings with externally accessible fittings for lubrication. Statically and dynamically balance fan assemblies in fan housing after final assembly.

9.5 FILTER BOXES

9.5.1 Provide filter boxes with hinged access doors at each end. Provide racks to receive filters in angle type pattern. Provide air filters to fit in filter box of the type scheduled on the drawings. Unit shall be provided with the number of sets as noted in Section 15000. One set shall be used during construction and replaced after construction is complete.

9.6 DIFFUSER SECTIONS

9.6.1 Diffuser sections shall consist of casings as specified with an integral perforated aluminum plate placed on the discharge side of the supply fan to ensure even and uniform air distribution over the adjacent downstream component.

9.7 AIR BLENDER

9.7.1 Unit panels shall be double wall construction similar to paragraph “11.2”. A hinged access door shall be provided in the air blender section, down stream of the actual blender. The door shall be full height, insulated double-wall, with baked-on enamel dogged fasteners to provide airtight compression of the perimeter gasket. The door shall be lift-off type, removable at hinge pin to provide maximum service access. Unit shall mix two or more air streams of different temperatures to within a range of 6 degrees F standard deviation of theoretical mixed air temperature and provide a more uniform air velocity contour entering a downstream filter or coil bank.

PART 10 – FAN COIL UNITS:

10.1 GENERAL

10.1.1 The unit shall be manufactured by McQuay, Enviro-tec, Carrier, or JCI-York.

10.1.2 The basic unit is fabricated of galvanized steel with glass fiber lining throughout the coil section. The condensate pan and fan deck shall be fabricated of stainless steel and insulated with the retardant, closed cell foam insulation. Removal of the unit front access panel exposes this pan for easy cleaning. The entire pan and blower assembly shall be readily removed from the unit for servicing. Some units require custom cabinet lengths, see drawings for details.

10.2 CAPACITIES

10.2.1 Unit capacities are certified in compliance with Air Conditioning and Refrigeration Institute (ARI) Standard 440-89.

10.3 CABINET

10.3.1 The entire cabinet of the unit shall be fabricated of heavy gauge steel, (16 ga front/top and 18 ga. sides), bonderized and finished with an attractive, oven-baked paint. The removable front panel to be lined with 1/2" woven glass fiber for thermal insulation and acoustic treatment. This panel to be readily removed and provide complete access to the basic unit, controls compartment and piping compartment. The filter to be completely concealed above the return air toe space and can be removed for servicing without removal of the front panel. All cover locking mechanism to be with recessed hex head. The supply and return air grilles shall be steel construction. The return air grilles shall be installed with screws, not tension clips.

10.4 EXTENDED PIPE END COMPARTMENT

10.4.1 The pipe end compartment shall be extended to match width as indicated on the drawings.

10.5 COILS

10.5.1 The coil shall be minimum of 3 rows. Coils to be constructed with 1/2" O.D. copper tubes with aluminum fins mechanically bonded to the tubes. All coils to leak tested with an air under water test and are suitable for design working pressures of 250 psig @ 200 F.

10.5.2 The fans are to be centrifugal, forward-curved, double-sided walls. Blower housings are to be galvanized steel with special rolled perimeter seams to provide added rigidity.

10.6 MOTORS

10.6.1 All motors to be resilient mounted, three-speed, with UNDERWRITERS listed thermal overload protection. Motor bearings are sleeve type with oversized oil reservoirs provided to assure positive lubrication. Positive speed reduction is assured through careful matching of motor torque to blower loading. Motors are to be high efficiency permanent split capacitor type.

10.7 FILTERS

10.7.1 Provide one inch throwaway glass fiber type. Provide 4 sets per unit, one to be used during construction. Replace filters at substantial completion. A third set shall be provided for JCPS use.

10.8 COLOR

10.8.1 Owner to select color. Provide minimum 10 color selections.

10.9 CEILING HUNG UNITS

10.9.1 Same as above except with hinged bottom panel.

10.10 SECONDARY DRAIN PAN

10.10.1 The secondary drain pan must be constructed by the contractor. A pan provided by the unit manufacturer is not allowed. The pan is to be constructed of stainless steel. The pan is to be broke to the drain pipe connection. Minimum of ¾" sides of pan. A minimum 4" must be maintained on the end to allow for pipe access. A test pan is to be constructed and submitted to JCPS for approval. The pan is to be piped to primary drain pan. Provide sprayed-on insulation on bottom of pan.

10.11 PIPE/ELECTRICAL CONNECTION

10.11.1 Piping/electrical connections to be on opposite ends. Provide a concealed fusible disconnect switch.

10.12 SPECIAL CONDITIONS

10.12.1 Provide extended ends and raised bases where noted on the drawings to conceal existing wall openings.

PART 11 – SQUARE INLINE CENTRIFUGAL FAN – DIRECT DRIVE:

11.1 ACCEPTABLE MANUFACTURERS: Twin City, Greenheck, Cook.

11.2 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. Fans shall be UL 705 listed for electrical.

11.3 CONSTRUCTION: Unit exterior shall be constructed of heavy gauge galvanized steel. The fan housing shall be square in shape and readily attachable to building ductwork. Unit side panels shall be removable

for easy access for maintenance and service. The power assembly shall be removable as a complete module through the side access panel. Fan housings shall have universal mounting brackets to accommodate horizontal or vertical installations. Fans shall bear a permanently attached nameplate displaying model and serial number of the unit for future identification.

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

11.5 MOTOR: Motors shall be of the heavy-duty ball bearing type, closely matched to the fan load. A disconnect switch shall be factory installed and wired to the fan motor as standard. Motor shall be mounted on the outside of the unit, isolated from the airstream. All motors shall be UL recognized.

11.6 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).

11.7 ACCESSORIES: Unit-mounted speed controller, backdraft damper, double-wall insulated, foil faced insulated. Refer to the drawings for additional requirements.

PART 12 – VARIABLE AIR VOLUME TERMINAL BOXES:

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

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

12.3 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.

12.4 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.

12.5 Additionally, the air terminals shall be double wall insulated, foil faced.

12.6 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.

12.7 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.

12.8 Terminal shall include an integral, 2-row (minimum), hot water coil where indicated on the plans. The coil shall be manufactured by the terminal unit manufacturer and shall have a minimum 22 gauge galvanized sheet metal casing. Coil to be constructed of pure aluminum fins with full fin collars to assure accurate fin spacing and maximum tube contact. Fins shall be spaced with a minimum of 10 per inch and mechanically fixed to seamless copper tubes for maximum heat transfer. Each coil shall be hydrostatically tested at a minimum of 450 PSIG under water, and rated for a maximum 300 PSIG working pressure at 200°F.

PART 13 – OA VARIABLE AIR VOLUME TERMINAL BOXES:

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

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

13.3 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.

13.4 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.

13.5 Additionally, the air terminals shall be double wall insulated, foil faced.

13.6 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.

13.7 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.

END OF SECTION.

DIVISION 23 - HVAC

SECTION 231100 - REGISTERS, GRILLES, DIFFUSERS & LOUVERS

PART 1 – GENERAL:

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

END OF SECTION.

DIVISION 23 - HVAC

SECTION 231200 - SHEET METAL

PART 1 – GENERAL:

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

1.2 This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's Duct Manual and Sheet Metal Construction for Low Velocity Ventilating and Air Conditioning Systems. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.

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

1.4 Prior to purchase and fabrication of ductwork (shop fabricated or manufactured), the Contractor shall coordinate installations with new and existing conditions. Notify the Engineer if there are any discrepancies for resolution.

1.5 For healthcare projects, provide a SMACNA duct cleanliness level "C" per the latest SMACNA standards.

END OF SECTION.

DIVISION 25 – BUILDING AUTOMATION SYSTEM

SECTION 250100 - ELECTRIC MOTORS AND OTHER ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 – GENERAL:

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

1.2 Through coordination with other Contractors, Vendors and Suppliers associated with this Project, this Contractor shall insure a complete, 100% functional, tested, inspected and approved systems. Claims for additional cost or change orders will immediately be rejected. Refer to Specification Section – HVAC EQUIPMENT for additional requirements. All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

1.3 Review the Specification Section - CONTROLS to determine controls, including variable frequency drives, to be furnished.

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

END OF SECTION.

DIVISION 25 – BUILDING AUTOMATION SYSTEM

SECTION 250400 – DDC CONTROLS – WEB-BASED

PART 1 – GENERAL

1.1 The temperature controls for this project shall fully integrated to existing the TAC-VISTA front end system in the Physical Plant. NKU has an on-going service contract with Schneider Electric. The building control system specified herein shall communicate with the TAC-VISTA system via LON protocol. See Section 6 for LON Protocol and LAN communication requirements. Interface and graphics generation on the university's DDC system server is included in this project and shall be consistent with the existing.

1.2 The new VAV terminal units LON controls network communication bus shall be wired to the closest controller. Existing TAC-VISTA terminal unit controller is serving room 352.

1.3 The direct digital control system specified for this project shall seamlessly interface to the existing TAC-VISTA Building Energy Management System Operator Workstations.

1.4 The existing Operator Work Stations (OWS) shall communicate to the direct digital control system specified for this project utilizing the facility management system Ethernet TCP/IP local area network. All new and existing network nodes (OWS and Network Controller) shall provide real-time on-line interface for complete access to the system. All new and existing hardware and software points including system object and control system objects shall be monitored and controllable from the existing Operator Workstations. All software configurations and databases for the new and existing direct digital hardware shall be uploadable and downloadable from the existing Operator Workstations. Providing separate computer workstations, gateways, internet IP Protocol Access, software drivers, JAVA management script programming, Protocol Converter Panels, Windowing between different or loading separate building energy management system software on the existing Operator Workstations for interface to the existing TAC-VISTA Building Energy Management system will not be permitted.

1.5 All application specific controllers on all network controllers shall be configurable, commissionable and downloadable through the Server or Supervisor Network Automation Engine IP connection.

1.6 All unitary and field controllers shall be commissioned, uploadable and downloadable from the university host network automation engine. LON object descriptions that are a jumble of letter/numbers are not acceptable.

1.7 The temperature control system shall be a web based system.

1.8 A pre-programming meeting shall be held with the TCC, Engineer, Owner and TAC-VISTA to discuss program variable names, room name scheme LON SNVT's and system structure.

1.9 All controllers, control interface hardware, services, installation, warranty, training, etc., shall be included as hereinafter specified.

1.10 The Temperature Control Contractor (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.

1.11 The system shall be a complete electronic DDC (Direct Digital Control) temperature control system utilizing "unitary" type controllers. Including such minor details not specifically mentioned or shown, as may be necessary for the complete operation of the system.

1.12 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.

1.13 Control sequences are specified at the end of this section. Provide all control equipment required to perform sequences described.

1.14 Provide all power wiring necessary for the operation of panels, etc., is to be included as work of this section. Refer to electrical specifications.

1.15 Acceptable Manufacturer's: TAC-VISTA by Schneider Electric, Honeywell manufacturers branch office, Johnson Controls manufacturers branch office.

1.16 By allowance, it will be the responsibility of TAC-VISTA to implement this project onto the university's server at the Physical Plant office. Any computer connected to the WAN, utilizing a web browser and having the proper password shall be able to communicate with the university's DDC system.

PART 2 - FUNCTIONAL PERFORMANCE TESTING/SYSTEM VERIFICATION CHECKLISTS:

2.1 The temperature controls subcontractor shall be responsible for completion of (1) hardware checkout sheets and test reports, (2) point-by-point confirmations, (3) sequence of operation confirmation. Each subcontractor shall be responsible for completion of their own System Verification Checklists / Manufacturer's Checklists. Sample checklists shall be submitted to the Engineer and Testing Agent for approval.

PART 3 – SUBMITTALS:

3.1 Shop drawing submittals shall include submittal data on every item of the temperature control system that is to be used. This is to include model and part numbers of all devices of the entire control system.

3.2 Submittals must include a complete points list of all necessary points and point types that will be provided by LON objects implemented into the universities TAC-VISTA system. (This will include any pseudo type points as well as all hard wired points). LON object descriptions are to include the equipment and type of point.

3.3 Submittals shall include a written operating sequence, unitary control wiring, building floor plans showing communicating cabling and labels, as well as logic flow diagrams.

3.4 Submittals shall include the agenda for approval by the engineer and owner of the specified training periods in one hour intervals. (see training section).

3.5 Submittals will include part numbers and manufacturer of all cabling that will be used. (indicate size and intended use).

3.6 Submittals shall include the manufactures recommended grounding procedure for all communication and device cabling.

3.7 The submittal process must be complete before any installation may begin.

3.8 Record Documents:

3.8.1 Provide a complete set of control drawings with as-installed equipment and operating sequences on paper and in electronic format (Visio 2000 or AutoCAD v. 2000 or higher versions). “As-built” (i.e., as-installed and debugged and after system acceptance) documentation shall include the following as minimum:

- All data specified in the shop drawings and submittals in their final "as-built" form.
- Schematic outline of the overall control system for quick reference.
- Adequate record of the work as installed, including exact location of control panels.
- Electronic files shall include sequence of operation.
- System hardware specification data, which provides a functional description of all hardware components.
- System engineering information, which provides all of the information for the system set-up, definition and application.
- System database information that provides the point names and application data programmed into the controllers.
- All of the information, data, procedures and drawings shall be supplied in the form of manuals and electronic copies where applicable.

3.8.2 Provide as-installed (after system acceptance) control logic diagrams showing all points (real and virtual).

3.8.3 DDC systems that use line-based programming must reference line code number with control logic diagrams and/or with sequence of operation text. Control Contractor shall discuss final format with owner.

3.8.4 For application oriented control units, provide sequence of operation text and answers to menu-driven configuration software.

3.8.5 Provide licensed electronic copies of all software provided by allowance. 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.

3.8.6 The Control Contractor shall document deviations from the shop drawing submittals. Documentation should include what equipment was changed and the reason for the change.

3.8.7 Provide copy of final test reports.

3.9 Operating and Maintenance Materials

3.9.1 Provide operation and maintenance data on all equipment requiring service or adjustment.

3.9.2 Operation and Maintenance Manuals: Provide three complete sets of manuals bound in loose-leaf binders. Final copies delivered shall include all modifications made during installation, checkout, and acceptance.

3.9.3 Manuals shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and have nearest service representatives for each item of equipment and each system.

3.9.4 Identify each manual’s content on the cover. Place tab sheets at beginning of each chapter or section and at beginning of each appendix. Operation and Maintenance Manuals to include software manual, operations manual, maintenance manual, and acceptance manual.

3.9.4.1 Software Manual: The software 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. Provide one software manual per Host Terminal. Hard copy or CD-ROM acceptable.

3.9.4.2 Operator's Manual: The operator's manual shall provide all procedures and instructions for operation of the system, including, but not limited to:

- General description including an overview of the system, its organization, the concepts of networking and central site/field hardware relationships.
- DDC panels and peripherals.
- System start-up and shutdown procedures.
- Use of system, command, and applications software.
- Alignment and calibration procedures.
- Alarm presentation and reports
- Recovery and restart procedures.
- Report generation
- System schematic graphics
- Establish set-points and schedules
- Download and upload information to or from field hardware
- Generate, collect, and review trends
- Back up system software and data files and
- Interface with third party software (e.g., Excel, Netscape).

3.9.4.3 Maintenance Manual: The maintenance manual shall include: Provide descriptions of maintenance for all equipment including:

- Inspection
- Periodic preventive maintenance
- Fault diagnosis
- Repair or replacement of defective components
- Emergency procedures for failure or fire
- Disassembly and shutdown procedures
- Maintenance instructions for each piece of equipment
- Proper lubricants and lubricating instructions
- Cleaning, replacement and/or adjustment schedule

3.9.4.4 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.

3.9.4.5 Field copies of wiring for Primary and Secondary Control Units. (Laminated and permanently affixed in or above controller).

3.9.4.6 For all equipment not manufactured by the Control Vendor, the Control Vendor shall provide an alphabetical list of system components with the name, address and 24-hour telephone number of the company responsible for servicing each item during the first two years of operation.

PART 4 - MAINTENANCE MANUAL/MAINTENANCE TOOLS:

4.1 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. A hard copy of the entire database shall also be furnished.

4.2 Wiring and control diagrams shall be as installed. This means as-built drawings, not design (submittal) drawings.

4.3 All as built drawings (Wiring Diagrams, Flowcharts, and Floor plans) shall be supplied to the owner on AutoCad. (Compact Disc).

4.4 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 5 – WARRANTY:

5.1 The temperature control system shall be free from defects in workmanship and material for a period of twelve months from substantial completion of project. If during this period from the signed (see below) date of final acceptance, any of the equipment furnished or installed by the TCC is proved to be defective (workmanship or material), it shall be replaced or repaired, free of charge.

5.2 The TCC shall include service required for start-up and calibration of all installed equipment for one season of heating and one season of cooling. A confirmation letter to the Engineer will be required for this work.

PART 6 – PRODUCTS:

6.1 General SI

6.1.1 TAC/Tour Andover Controls shall act as the University's Systems Integrator (SI) to provide several key aspects of the overall LonWorks®-based University Facility Management and Control System (FMCS) systems. These include but are not limited to:

- The TCP/IP level of the system architecture
- All computer servers and operator workstation.
- Data logging and reports of FMCS data
- Alarm presentation
- Time scheduling algorithms
- Graphical representation of data
- Web-based delivery of information
- Adjustment of application parameters (i.e., setpoints)
- Periodic adjustment of calibration offsets

6.1.2 In order to deliver these functions, TAC will provide one or more IP to LON routers and one or more area controllers (AC) depending on the number of devices to be installed by the building controls contractor under Div 25 specifications. The Systems Integrator (TAC) may combine the IP to LON router and area controller into a single physical component.

6.1.3 The area controller (AC) serves several key functions.

- It executes time schedules and broadcasts occupancy commands to the building controllers that it serves.
- It receives data from the building controllers and collects trends of the data.
- It receives data from the building controllers, applies alarm criteria and transmits alarms to the operator workstation alarm handling software provided by TAC.

6.2 Network Physical Interface With the Systems Integrator

6.2.1 For each IP to LON router and area controller provided by TAC, the building controls contractor shall provide a FTT-10 field bus or building LAN to which the building controllers will be connected. The number of building controllers that the building HVAC controls contractor shall be allowed to connect to each field bus is a function of the design of the field bus and the amount of data carried by the field bus. The average bandwidth utilization of any segment of the field bus shall not exceed 20% as measured by the LoyTech Network Analysis Tool over a 1-hour period during occupied mode.

6.2.2 TAC will provide a set of FTT-10 terminals adjacent to each area controller to which the building controls contractor shall attach their FTT-10 LAN.

6.2.3 The building HVAC controls contractor shall be responsible for the FTT-10 LAN terminators. The installation of network terminators shall conform to the guidelines published by Echelon. These guidelines are available on Echelon.com.

6.3 Application Development In Concert With the Systems Integrator (TAC/Tour Andover Controls)

6.3.1 Time Schedules

- Time schedules are the domain of the SI (TAC). Time schedules will be programmed in the area controller(s) (AC) by TAC and occupancy commands shall be bound from the area controller to the building level controllers by TAC where the applications require time based control.
- The SNVT type to be used for the commands shall be SNVT_occupancy.
- The building controls contractor shall inform the SI of all occupancy commands required, the corresponding time schedules, the controllers to which the occupancy commands shall be bound and the name of the receiving variable.

6.3.2 Other Direct or Supervisory Applications

- With the exception of time schedules or optimized start/stop algorithms, all applications shall be programmed within the building controllers. The building controls contractor should not expect the SI to provide any application support within the area controller to execute the required sequence of control.

6.4 Application Configuration Parameters

6.4.1 Programmable Devices

- Within an application program there are numerous parameters that must be adjusted during the commissioning of a system and/or be available for adjustment as requirements change. Some examples are:
- Setpoints
- Timing parameters, i.e., “Fan shall continue to operate until the electric heat has been off for 120 second.”
- PID loop gain
- PID loop integral time constant
- PID loop derivative time constant
- Two position control loop differential
- Calibration offsets for analog inputs

6.4.2 For all applications in programmable building level controllers, configuration parameters shall be input network variables (nvis) to the building level controllers. As a result, these configuration parameters will be accessible to the SI for incorporation into the HMI database and can be adjusted by a systems operator without an application program download.

6.4.3 Application Specific Devices

6.4.3.1 There are two techniques for exposing configuration parameters currently in use by manufacturers of application specific devices.

- Configuration parameters of a specific SNVT type written to EEPROM.

- Configuration parameters that use the Standard Configuration Parameter Type (SCPT) format defined by Echelon.

6.4.4 The configuration parameters of a specific SNVT type have the same characteristics as a dynamic network variable and the Building Controls Contractor's primary obligation is to submit a list of these configuration parameters to TAC. The submittal shall include the parameter name, purpose and SNVT type.

6.4.5 If the Building Controls Contractor chooses to use an application specific device that uses the SCPT concept, the Building Controls Contractor shall use LonMaker for Windows Integration Software Tool to construct a LonMaker database for the field bus where the application specific device is used. This database shall be provided to TAC.

6.5 DATA COORDINATION WITH TAC/Tour Andover Controls (SI)

6.5.1 Test Mode and Test Values

- This concept only applies to programmable devices.
- The Test Mode / Test Value concept applies to physical or external input points within an application. Using this concept, a system operator can place a physical input point into the test mode and assign a user defined value. When this is done, the electrical signal from the sensor shall be ignored by the application and the test value used in its place.
- The Building Controls Contractor shall provide two network variables for each physical input point associated with a programmable device. The first variable shall be used to place the physical input point into the test mode. The second variable shall be used to assign a test value.
- The Building Controls Contractor shall submit a list of the Test Mode / Test Value network variables to the SI. The list shall define the physical point and the variable names and SNVT types.

6.5.2 Manual Command and Manual Command Value

- This concept only applies to programmable devices.
- The Manual Command / Manual Command Value concept applies to physical or external output points within an application. Using this concept, a system operator can place a physical output point under manual control and assign a manual value or state. When this is done, the external output point ignores the command it routinely receives from the control logic and assumes the value or state of the manual command value.
- The Building Controls Contractor shall provide two network variables for each physical output point associated with a programmable device. The first variable shall be used to place the physical output point into the manual mode. The second variable shall be used to assign a manual command value or state.
- The Building Controls Contractor shall submit a list of the Manual Mode / Manual Command Value network variables to TAC. The list shall define the physical point and the variable names and SNVT types.

6.6 Alarm Data From the Building Controls to the Systems Integrator (TAC)

6.6.1 Alarm data can be either binary or analog. With binary alarm data, the variable has a value of either 0 or 1 and one of these states is defined as the alarm state. With analog alarm data, there is a corresponding

threshold that creates an alarm condition (example, mixed air temperature falls below 42 F). A binary alarm can be created by applying the alarm threshold within the building level controllers.

6.6.2 Within an application, alarms can be either self correcting or latching. Self-correcting alarms will return to normal without operator intervention if the conditions within the application return to normal. Latching alarms will remain in the alarm state until an alarm reset parameter is toggled by the system operator.

6.6.3 For binary alarm conditions, the Building Controls Contractor shall expose an output network variable that defines the alarm. If the alarm is a latching alarm, an input network variable shall be established to allow TAC to affect an alarm reset from the HMI. If the binary alarm is created from analog data and an alarm threshold, the Building Controls Contractor shall expose an input network variable that defines the alarm threshold.

6.6.4 For analog non-latching alarms, the Building Controls Contractor shall expose the analog variable as an output network variable and define for TAC the alarm threshold. TAC will apply the alarm threshold within the area controller to create the alarm condition within the HMI.

6.6.5 For analog latching alarms, the Building Controls Contractor shall apply the alarm threshold within the application and create a binary alarm variable and expose it as an output network variable. The Building Controls Contractor shall also create and expose as an input network variable a reset parameter to be toggled by the system operator.

6.6.6 If timing parameters are required by the sequence of control with respect to the creation of alarms ("alarm condition must exist for 60 seconds before an alarm is transmitted"), and the alarm is created in a building level controller, the timing parameter must be exposed as a input network variable.

6.6.7 The Building Controls Contractor shall submit a list of the alarm value network variables to TAC. The list shall define the alarm names and SNVT types.

6.7 Calibration of Analog Inputs

6.7.1 This concept only applies to programmable devices.

6.7.2 As part of each application for each analog sensor input a calibrated value shall be established. The value read from the sensor shall be added to the calibration-offset parameter to create the calibrated value. An output network variable shall be established that transmits the calibrated value to the HMI.

6.7.3 The Building Controls Contractor shall submit a list of the calibration network variables to TAC. The list shall define the point names and SNVT types.

6.8 Dynamic Data Reporting

6.8.1 Data from both application specific and programmable devices shall be exposed as output network variables for access by TAC.

6.8.2 Output network variables from application specific devices are pre-established as part of the embedded application. There is no specific programming work to be done by the Building Controls Contractor. The Building Controls Contractor shall submit to TAC an electronic copy of the application documentation for each application specific node installed.

6.8.3 Output network variable from programmable devices shall be established as part of the applications. As a minimum, the following output network variables are required:

- Status of binary input devices
- The calibrated value for analog input devices

- Status of binary output commands
- The value assigned by the application to analog outputs
- All mode indicators (occupied, unoccupied, summer, winter etc.)
- The output of all PID control objects
- The output of all floating control loop objects or subroutines

PART 7 - SYSTEM ARCHITECTURE:

7.1 The network controller/supervisor links the primary, secondary, and application control units with the host computers for central reporting and system communication via the Wide Area Network (WAN).

7.2 The system shall be configured as a distributed processing network(s) capable of expansion as specified in this section.

7.3 The system architecture shall consist of a multi-level Wide Area Network (WAN), which supports Control Units, networked Operator Workstations, and LAN Interface Devices. The following indicates the functional description of the system structure.

7.3.1 Interbuilding LAN: Used for communication between Primary Controller LANs located in each building, and multiple networked Operator Workstations located in selected buildings. This WAN will consist of using the University's Ethernet backbone with TCP/IP protocol. DDC workstations, network/controller supervisors, and the LAN Interface Device shall employ native TCP/IP protocol with the Ethernet 10BaseT (IEEE802.3) physical layer standard for connection to Ethernet/ATM routers. DDC workstations or network/controller supervisor shall not require third party routers, gateways or translators for TCP/IP protocol. At a minimum, the Network/controller supervisors shall communicate via LON IP. The network/controller supervisor shall provide LON SNVT's via the university's Ethernet LAN for interface to the university's TAC-VISTA system.

- Control Contractor shall coordinate with university computer personnel on acceptable LAN protocol and interfacing.

7.3.2 Primary Controller LAN: Used to connect Primary Control Units (Primary Control Units-which generally control central plant equipment, terminal equipment, and air handlers) within a building.

7.4 Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Control Units, LAN Interface Devices, and Operator Workstations whether directly connected (via campus backbone) or connected remotely (using the university's WAN).

7.5 The communication speed between the Control Units, LAN interface devices, and MWS computer shall be sufficient to ensure fast system response time under the maximum future loading condition.

7.6 The Operator Workstations shall provide for overall system supervision, operator interface, management report generation, alarm annunciation and remote monitoring.

7.7 The primary and secondary control units shall monitor, control, and provide the field interface for all field points. Each Primary Control Unit or Secondary Control Unit shall be capable of performing DDC functions independent of other Primary Control Units or Secondary Control Units and operator interface devices (Stand-alone).

7.8 Interruptions or fault at any point in the primary LAN shall not interrupt communications between other nodes on the network.

7.9 All line drivers, signal boosters, repeaters, and signal conditioners etc. shall be provided as necessary for proper data communication.

PART 8 - NETWORK CONTROLLER/SUPERVISOR (EXISTING):

8.1 The Network Controller shall be a fully user-programmable supervisory controller. The Network Controller shall monitor and communicate the network of distributed primary, secondary, application-specific control units, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers/Supervisors.

8.2 Controllers shall be microprocessor-based with a maximum program scan rate of one (1) second. They shall be multi-tasking, multi-user, and real-time digital control processors. Controller size and capability shall be sufficient to fully meet the requirements of this Specification.

8.3 Network Controller/Supervisor shall support/communicate with a minimum of 100 primary/secondary control units with no more than 90% of maximum capability used. Memory size shall have at least 20% of availability free for future use.

8.4 Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control units. In addition, if memory for historical data trending is not on primary and/or secondary control units, then sufficient memory is required on the network controller to capture and record historical trending data. The network controller / supervisor shall issue all summer/winter commands, clock or other shared commands to all unitary and primary controllers within the building network. If for any reason communications between the unitary(s) and the network controller / supervisor 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.

8.5 Network Controller/Supervisor shall be capable of interacting host workstations.

8.6 The Network Controller/Supervisor shall have an integrated real-time clock.

8.7 Error detection, correction, and re-transmission to guarantee data integrity.

8.8 Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The network controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

8.9 In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Nonvolatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

8.10 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.

8.11 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

8.12 Should a primary/secondary controller memory be lost for any reason, the Network Controller/Supervisor shall be able to reload the program with back-ups provided by TCC.

8.13 The network controller / supervisor shall have the capability of being remotely monitored over telephone modem via V90 modem. Additional capabilities shall include automatically dialing out alarms, gathering alarms, reports and logs, programming and downloading database.

8.14 The network controller / supervisor shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:

8.14.1 Assume a predetermined failure mode.

8.14.2 Emit an alarm.

8.14.3 Display card failure identification.

8.15 Install the network controller / supervisor 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.

8.16 The network controller shall support both LonWorks enabled devices using the Free Topology Transceiver FTT10.

8.16.1 All LonWorks controls devices shall be LonMark certified.

PART 9 - SYSTEM SOFTWARE:

9.1 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 Host computer(s) and laptop(s).

9.2 System software shall, at a minimum, provide:

9.3 Monitor and supervise all control points.

9.3.1 Add new points and edit system database.

9.3.2 Change control setpoints, timing parameters and loop tuning of PID coefficients in all control loops in all control units.

9.3.3 Enter programmed start/stop schedules.

9.3.4 View alarm and messages.

9.3.5 Modify existing control logic (or sequence of operation) in all control units.

9.3.6 Upload/Download programs, databases, control parameters, etc.

9.4 Sequence of Operation Programming “Methodology”

9.4.1 The application software shall be user programmable. Application programming shall be provided by the following conventions:

- Line type programming that uses text programming in a language similar to BASIC or FORTRAN.
- 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.
- Graphical programming shall include:
  - 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.
  - 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 manufacturers unique programming language.

- 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.
- 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 and all block outputs in real time.

9.5 Unitary Control Unit Database Archiving

9.5.1 The host software shall provide capability to upload sequence of operation, database, and other control parameters from each controller.

9.5.2 Uploaded programs shall be retained on hard disk for system backup.

9.5.3 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.

9.6 Operator Interface Graphic Software (EXISTING)

9.6.1 All graphic software shall be in the html web browser format or pinpoint graphics 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.

9.6.2 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.

9.6.3 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.

9.6.4 The contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, heat pumps etc.), mechanical system components (e.g., pumps, cooling towers, boilers, etc.), complete mechanical systems and electrical symbols.

9.6.5 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.

PART 10 - EXECUTION - SYSTEM SETUP:

10.1 This section further defines the responsibilities of the installer and building level and the Metasys programmer.

10.2 The following features shall be incorporated into the final delivered product.

10.3 Schedules

10.3.1 Schedule will be installed using time parameters provided by owner or obtained on drawings.

10.3.2 Stand-by mode shall be installed with Owner's approval.

10.3.3 Scheduling editor shall be provided at each Host computer.

10.3.4 Scheduling editor shall be capable of, at a minimum:

- Easy method for selecting time periods and days for occupied and unoccupied periods for each object (e.g., AHU).
- Holiday and breaks shall be shown clearly on the calendar.
- Weekly Schedules: The weekly schedules screen shall display a full week with holidays and special days included.
- Provide a method for allowing several related heat pump systems or other equipment to follow a similar schedule.
- It shall be possible to easily and directly copy the schedule for any scheduled event to any other scheduled event without reentering all times.
- Each schedule shall accept a unique descriptor of up to at least 20 characters to identify the schedule on screen.
- Annual Schedules: An annual schedule calendar mechanism shall be provided to schedule Holidays, time changes and Special school days a minimum of one year in advance. A full screen editor in calendar format shall be provided to allow speedy selection and review of holidays and special days.
- Dated schedules shall be self-managing and automatically deleted after execution.
- Schedule Overrides (Provided by Allowance):
  - It shall be possible to easily override, to the on or off condition, any programmed scheduled event at any operator workstation. There shall be no limit to the number of schedules that can be overridden at any one time. Conditions shall revert to schedule when override period ends.

10.4 Graphic Screens

10.4.1 Color graphic Operator Interface:

- Provide dual or multiple function windowing to allow user to view two or more screen and toggle between simultaneous operations.
- Update all point values a minimum of every 10 seconds.
- Each colorgraphic terminal shall be driven by software allowing the operator to access all system information via a system penetration method.
- System penetration shall allow the operator to begin at an entire site plan colorgraphic display and progressively select portions of the site plan to be chosen for closer inspection or selection of a more detailed colorgraphic display of a desired system without being required to enter any commands via the keyboard. Specifically,
  - Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Using a mouse or other pointer device shall access graphics. The system shall provide a visual indication of which building, floor and zone the user is accessing at any time.
- Graphics shall be provided for all mechanical equipment and devices controlled by the DDC system. These graphics shall include:

- Flow diagram or graphic diagram showing all devices (e.g., valves, dampers, sensors, fans, pumps, boilers, etc.)
- Current status of all I/O points being controlled and applicable to each piece of equipment.
- Operating mode (occupied, unoccupied, overridden, etc.)
- Time and date
- Percentage valve/damper open or closed (include "open" or "closed" on the screen.
- Analog readouts in mA or VDC (for commissioning and can be located on a separate screen if needed to reduce screen clutter)
- All analog and digital input and output points settable from the screen.
- Place all values in appropriate engineering units and in appropriate locations on the graphic representation.
- Electrical Schematics associated with all mechanical equipment and devices controlled by the DDC (These schematics should also be provided with as-builts).

- All color graphic screens shall be standardized for similar mechanical equipment and control devices. The type of points displayed will be the same for similar colorgraphic screens.

10.4.2 Other colorgraphic screens shall include:

- Temperature setpoints for all rooms/zones.
- All adjustable points

10.4.3 Global commands on other colorgraphic screens shall include:

- Open all dampers to maximum cooling/heating flow rate.
- Close all dampers to maximum heating/cooling flow rate.
- Open/Close all hot/chilled water valves.

10.4.4 Accessible System Information:

- Available for display or modification in any specific colorgraphic display shall include, but not be limited to:
  - Real-time value display of any connected point in the system
  - Alarm status condition of any desired system alarm point (change in color when out of range).
  - Any software parameter such as setpoints for control sequences, minimum position adjustments.

10.4.5 Centralized Scheduling and Modification:

- The colorgraphic terminal shall support operator access to the Scheduling Screens that allow the operator to review and modify any or all schedules as desired. The centralized Scheduling function shall allow modification of equipment schedules, modification of facility holiday schedules, and when desired allow assignment of temporary schedules for designated portions of the facility or specific equipment.

10.5 Labeling and Identification

10.5.1 All devices relating to the work or systems included herein, including controllers, valves, motors, relays, etc., shall be identified with a unique identification number or name on the submitted engineering drawings.

10.5.2 Tagging/labeling shall be computer generated or wire markers, input/output wiring, at both ends. These labels will correspond to the identification numbers or names on the AS BUILTS.

- Cable and wiring not specifically associated with an input or output shall be labeled with a number and a function description such as: 120 VAC, Panel #, ect. (e.g., actuator/unit ventilator ect., power supply).
- Category 5 Ethernet cabling and communication cabling shall be easily identified as a unique color and labeled at each end throughout the building.

10.6 Programming Guidelines

10.6.1 All control loops will be standardized throughout the programming code.

10.6.2 All adjustable set-points shall be developed as software points stored at memory locations so that setpoints can be changed by recommending the data stored at the memory location rather than by entering the program and changing parameters and lines in program code.

10.6.3 Control sequences that use outdoor air conditions to trigger certain specific operating modes shall use data generated by one outdoor air temperature sensor. In other words, the data from one sensor shall be shared by the entire system.

10.7 System Commissioning and Training

10.7.1 During all pre-installation meetings and construction meetings with Mechanical Contractor, Engineers, and/or Owners, the Control Contractor attending the meetings must be the application engineer or programmers that are/will design and program the DDC system.

10.8 Demonstration Commissioning

10.8.1 This portion of commissioning must be performed with a representative of the NKU Physical Plant staff and the Engineer present.

10.8.2 Work and/or systems installed under this section shall be fully functioning prior to Demonstration, Acceptance Period and Contract Close Out. Control Contractor shall start, test, adjust, and calibrate all work and/or systems.

10.8.3 Software shall be fully configured to view project specific database and shall include trend logs, specified graphic screens, and reports.

10.8.4 As problems are found, a log shall be completed showing the date, technicians and Owners initials, and any corrective action taken or needed.

10.8.5 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Control Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

10.8.6 All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of this document.

PART 11 – CABLING:

11.1 A complete cabling system shall be furnished and installed, which shall adhere to the highest workmanlike standard of quality and appearance. Lines shall be installed square with building lines.

11.2 All cabling shall be concealed in walls and above ceilings where ceilings exists. Cabling may be ran above lay-in ceilings without being in conduit. Support from structure. Where cabling is installed in mechanical rooms, or above non-lay-in ceilings, all wiring shall be installed in conduit.

11.3 Install conduit in wall from wall thermostats to above ceiling for cabling.

11.4 Acceptable manufacturers are Belden, West Penn or Alpha. Any cable other than the above must have prior approval.

11.5 All unitary to unitary zone communication cabling shall be a minimum of 18 AWG minimum. All other sizing of cabling shall be according to manufacturer's recommendation.

11.6 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.

11.7 Wall space temperature sensor cabling (from the sensor to the unitary controller) shall have a minimum of four (4) conductors.

11.8 All cabling shall be stranded. "NO" solid conductors will be accepted. All cabling shall be 100% shielded with appropriate drain wire and insulation.

11.9 All cable connections shall be continuous run (including shield) whenever possible. 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.

11.10 All shields must be terminated as per manufacturer's recommendation. Shield termination requirements by the manufacturer must be provided with submittals.

PART 12 - ELECTRICAL WIRING SYSTEMS:

12.1 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.

12.2 Any power for controls shall be fed from circuits in electrical panels shall not be taken from receptacles, lighting, or equipment circuits. Unitary control power may be taken from the equipment served. If power is taken from the equipment served, the power may not be interrupted to the electronics if the terminal unit is off for any reason. This contractor is responsible for the power source to the unitary controllers and all other control power requirements.

12.3 All control circuits within the electrical panels shall be marked to indicate equipment served.

12.4 The TCC shall do all temperature control interlock wiring. This is to include on/off control of chillers, boilers, pumps, fan coil units, zone controls, cooling towers, etc.

12.5 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.

PART 13 - TEMPERATURE SENSORS:

13.1 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 .24 degrees over a year period. Space sensors must be tested and accurate to within .75 degrees F. Outside air, water and duct sensors must be tested and accurate to within 2.0 degrees F.

13.2 SPACE SENSORS: Thermostats shall be provided with a "warmer/cooler" dial.

13.3 Thermostat/sensor's shall be installed 5'0" above the finished floor. Except where mounted next to a light switch. At this location, the thermostat shall be mounted at the same height as the light switch. If there is a question consult engineer prior to rough-in. Refer to the drawings for proper type.

13.4 DISCHARGE AIR AND DUCT ROOM RETURN AIR SENSORS: Shall be rigid insertion type. In all applications, care must be taken to insure that the sensors are securely mounted as not to allow any vibration and installed in such a manner as to indicate the truest possible temperature.

PART 14 - VALVES, DAMPERS AND ACTUATORS:

14.1 Valves under this section, shall be furnished and sized by the Temperature Control contractor. 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.

PART 15 – EQUIPMENT:

15.1 UNITARY and PRIMARY CONTROLLERS: Controllers utilized in the network must have full stand alone capability required to meet the sequence of operations. Any re-programming of the electronics shall be performed on location using a portable personal computer with appropriate software or through the Network Controller / Supervisor. The entire unitary database shall have the capability of being backed up and or downloaded locally and via modem if required. All primary controllers shall have built in displays for local access and adjustment of control parameters.

15.2 Controller 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 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.

15.3 GLOBAL CONTROLLER: The global controller shall have an integral keypad and display and issue, summer/winter commands, or other shared commands to all unitary controllers within the building network. If for any reason communications between the unitary(s) and the global 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.

15.3.1 The global controller shall have battery back-up to allow a minimum of seven days of operation. The global controller shall be composed of one or more independent, stand-alone, microprocessor to manage the global strategies described in Application software section. The global controller shall have ample memory to support its operating system, database and programming requirements. The operating system of the global controller shall manage the input and output communications signals to allow distributed unitary controllers to shale real and virtual point information and allow central monitoring and alarms. The database and custom programming routines of the global controller shall be editable from a single operator station or laptop computer.

15.3.2 The global controller shall have the capability of being remotely monitored over telephone modem. Additional capabilities shall include automatically dialing out alarms, gathering alarms, reports and logs, programming and downloading database.

15.3.3 The global 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.

15.3.4 Install the global 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.

15.4 RELAYS: Relays for starting and stopping fractional horsepower motors shall be rated as follows:

15.4.1 For 1/4 horsepower motors or less use 15 ampere rated relays.

15.4.2 For 1/3 horsepower motors use 20 ampere rated relays.

15.4.3 For 1/2 horsepower motors use 30 ampere rated relays.

15.4.4 Relays used for pilot duty service shall be rated at a minimum of 10 amperes.

15.5 PANELS: All panels must be surface mounted type, NEMA type 1 enclosures, with a removable hinged door. Provide a flush mounted key lock. (All temperature control panels are to be keyed the same.) All control panels must be painted the same color and identified. (premiered panels will not be acceptable) The boxes are to be made from 16 gauge material. Panels should not be provided with knockouts.

END OF SECTION