MECHANICAL INDEX

200100 - General Provisions
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SECTION 200100 - GENERAL PROVISIONS - MECHANICAL

1. GENERAL

A. The Advertisement for Bids, 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 his Sub-Contractor's work. 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 pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Proposer shall also be governed by any unit prices and Addenda insofar as they may affect his part of the work or services.

C. The Controls Contractor shall be selected based on this package bid with the contract being awarded to the low bid contractor. The successful bidder will then be assigned as a sub contract to the Mechanical Contractor, who will be acting as the General Contractor on the project. The overall project shall include but is not limited to the replacement of air handling units, exhaust fans, ductwork, piping, etc.

D. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Mechanical System(s) indicated or specified in the Contract Documents.

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

F. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor (or Construction Manager, if applicable), 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 General Contractor 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.

G. It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be 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.

H. In general, and to the extent possible, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owners at least two weeks prior to the interruption of any services or utilities. 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 by the Contractors involved until a complete schedule of interruptions can be developed.

I. Definitions and Abbreviations

(1) Contractor - Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of mechanical work (Controls, Plumbing, HVAC, Sprinkler, Gas Systems, etc.) or, the General Contractor.

(2) Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owners, Architect, other Engineers, etc. In this case: CMTA, Inc., Consulting Engineers.

(3) Architect - The Architect of Record for the project.

(4) Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

(5) Provide - Furnish and install complete, tested and ready for operation.

(6) Install - Receive and place in satisfactory operation.

(7) Indicated - Listed in the Specifications, shown on the Drawings or Addenda thereto.

(8) Typical - Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

(9) 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 Owners, etc.

(10) 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.

(11) OSHA - Office of Safety and Health Administration.

(12) KBC - Kentucky Building Code.

(13) The Project - All of the work required under this Contract.

(14) NEC - National Electrical Code.


(16) ASME - American Society of Mechanical Engineers.

(17) AGA - American Gas Association.
J. Required Notices:

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

2. INTENT

A. It is the intention of the Contract Documents to call for finished work, tested and ready for operation.

B. 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.

C. This project is a phased construction in an occupied building. The Construction Documents include Phasing Plans which roughly lay out the sequence of the work. The Contractor may suggest alternate schedules that improve the overall phasing and decrease the duration or limit outages. The Owner and Engineer will review any proposed schedule and determine if it is acceptable.

3. DRAWINGS AND SPECIFICATIONS

A. The drawings 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 drawings are not intended to show every item which may be necessary to complete the systems. All proposers shall anticipate that additional items may be required and submit their bid accordingly.
B. The drawings and specifications are intended to supplement each other. No Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Proposer shall request a clarification not less than twelve 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.

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

D. Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. 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.

F. Should conflict or overlap (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 that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

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

H. Each Proposer shall review all drawings to ensure that the work they intend to provide does not encroach a conflict with or affect the work of others in any way. Where such effect does occur, it shall be the Proposer's responsibility to satisfactorily eliminate any such encroachment conflict or effect prior to the submission of his proposal. Each Proposer shall in particular ensure that there is adequate space to install his equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the 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 ensure adequate spaces.

I. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where 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.

J. 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.
K. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

4. EXAMINATION OF SITE AND CONDITIONS

A. Each Proposer shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. Each Proposer shall also fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. His 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.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests approval of materials and/or equipment of different physical size, 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, electrical services, etc., from that indicated. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall remunerate them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineers does not in any way absolve the Contractor of this responsibility.

B. 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 Paragraph (A) immediately preceding are met. Requested substitutions shall be submitted to the Engineer a minimum of twelve days prior to bids.

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

D. Each Proposer shall furnish along with his proposal a list of specified equipment and materials which he is to provide. Where several makes are mentioned in the specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings is satisfactorily comparable to the items specified and/or indicated.

6. SUPERVISION OF WORK
A. The Contractor shall personally supervise the work for which he is responsible or have a competent superintendent, approved by the Engineers, on the work at all times during progress with full authority to act for him.

7. CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

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

B. 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.

C. 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. Where required by the Code and/or the Authority Having Jurisdiction, provide the services of a field labeling agency to provide a UL label for the entire system in the field under evaluation.

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

E. The Contractor shall ensure that his work is accomplished in accord with the OSHA Standards and that he conducts his work and the work of his personnel in accord with same.

8. EQUIPMENT AND PIPING SUPPORT

A. Each piece of equipment, apparatus, piping, or conduit suspended from the structure 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., as indicated or required by the Structural Engineer. This, in some instances, will require the Contractor to add an angle to a joist to transfer the load to a panel point. If in doubt, contact the Structural Engineer.

9. DUCT AND PIPE MOUNTING HEIGHTS

A. 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.

10. COST BREAKDOWNS (SCHEDULE OF VALUES)

A. Within thirty 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.

11. CORRECTION PERIOD

A. All equipment, apparatus, materials, and workmanship shall be the best of its respective kind. The Contractor shall replace all parts at his own expense, which are proven defective as described in the General Conditions. The effective date of completion of the work shall be the date of the Architect's or 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 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 his operator or other employees. Refer to other sections for any special or extra warranty requirements.

B. It is further clarified that all required and specified warranties shall begin on the date of Substantial Completion, not at the time of equipment start-up.

12. COMPUTER-BASED SYSTEM SOFTWARE

A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

13. CHANGES IN MECHANICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

15. SURVEY, MEASUREMENTS AND GRADE

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

B. 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.

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

16. TEMPORARY SERVICES

A. The Contractor shall arrange any temporary water, electrical and other services which he may require to accomplish his work. Refer also to General and Special Conditions.

17. RECORD DRAWINGS

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

18. MATERIALS AND WORKMANSHIP

A. All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Proposer shall determine that the materials and/or equipment he proposes 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). Ensure, through coordination, that no other Contractor seals off access to space required for equipment, materials, etc.

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

C. 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.

19. COOPERATION AND COORDINATION WITH OTHER TRADES

A. 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.

B. 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.
20. QUALIFICATIONS OF WORKMEN

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

B. All automatic control systems shall be installed by workmen 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, he may be utilized subject to review of his qualifications by the Engineer and after written approval from same.

C. All electrical work shall be installed only by competent workmen under direct supervision of a fully qualified Electrician.

21. CONDUCT OF WORKMEN

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

22. PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from physical, sun, and weather damage during the construction period. Such protection shall be by a means acceptable to the manufacturer and Engineer. All rough-in soil, waste, vent and storm piping, ductwork, 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 his own expense.

23. SCAFFOLDING, RIGGING AND HOISTING

A. 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.

24. ACCESSIBILITY
A. 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.

B. The Contractor shall provide access panels for each concealed valve, control 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.

25. MAINTENANCE OF EXISTING UTILITIES AND LINES

A. 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.

B. Cutting into existing utilities and services where required shall be done in coordination with and only at times designated by the Owner of the utility.

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

26. SMOKE AND FIRE PROOFING

A. The Contractor shall fire and smoke stop all openings made in fire or smoke rated walls, chases, ceilings and floors in accord with the KBC. Patch all openings around ductwork and piping with appropriate type material to stop smoke at smoke walls and provide commensurate fire rating at fire walls, floors, ceilings, roofs, etc. Back boxes in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer provide rated box or fireproofing in code approved manner.

27. CUTTING AND PATCHING

A. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

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

28. WEATHERPROOFING

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

29. OPERATING INSTRUCTIONS, MAINTENANCE MANUALS AND PARTS LISTS

A. Upon completion of all work tests, the Contractor shall instruct the Owner or his representative(s) fully in the operations, adjustment and maintenance of all equipment furnished. The time and a list of
representatives required to be present will be as directed by the Engineer. Turn over all special wrenches, keys, etc., to the owner at this time.

B. The Contractor shall furnish three (3) complete bound sets for delivery to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract prior to substantial completion. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs alone will not be acceptable for operating and maintenance instructions.

C. The Contractor, in the instructions, shall include a preventive maintenance schedule for the principal items of equipment furnished under this contract and a detailed, parts list and the name and address of the nearest source of supply.

D. Per University standards, provide as part of the IOM, an equipment schedule list on 8.5x11 inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the specification section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

E. Per University standards, provide as part of IOM, a detailed valve schedule list. Refer to valve identification specification for details.

30. ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all (1) temperature control wiring; (2) equipment control wiring and (3) interlock wiring. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring thru starters, and shall furnish and install all required starters not factory mounted on equipment.

B. The Contractor shall, regardless of voltage, furnish and install all temperature control wiring and all associated interlock wiring, all equipment control wiring and conduit for the equipment that the Contractor furnishes. He may, at his option, employ at his own expense, the Electrical Contractor to accomplish this work.

C. After all circuits are energized and completed, the Contractor shall be responsible for all power wiring, and all control wiring shall be the responsibility of the Contractor. Motors and equipment shall be provided for current characteristics as shown on the drawings.

D. The Contractor shall furnish motor starters of the type and size required by the manufacturer for all equipment provided by him, where such starters are necessary. Starters shall have overloads for each phase.

31. REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

A. 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.

32. INDEMNIFICATION
A. 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.

33. HAZARDOUS MATERIALS

A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, ensure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall ensure 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.

B. 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.

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

D. 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.

34. ABOVE-CEILING AND FINAL PUNCH LISTS

A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:

(1) For review of above-ceiling work that will be concealed by tile or other materials well before substantial completion.

(2) For review of all other work as the project nears substantial completion.

B. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven 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.

END OF SECTION 200100
1. GENERAL

A. The Mechanical work for this Contract shall include all labor, materials, equipment, fixtures, 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) Relocation of the existing penthouse control air compressor, filter and dryer. Extend control air supply tube from existing location to new air compressor, filter and dryer location.

(2) Splice existing N2 communication trunk line at locations where existing control panels are demolished.

(3) Investigate, identify and relocate existing equipment points currently fed through control panels to be removed into new controls panels. Coordinate this work with the installation of AHU-2. Control panels can be left in place up to the point where AHU-2 is installed and some devices will become obsolete prior to this phase. This scope could include temporary or permanent connections during phased construction involving, but not limited to the following existing devices/items:

   a. PE-18 (UNIDENTIFIED)
   b. EP-5 (AS-12)
   c. EP-4 (AS-11)
   d. EP-2 (AS-3)
   e. PE-15 (AS-2-3E)
   f. PE-11 (AS-1-2E)
   g. PE-10 (AS-1-1E)
   h. ASC DDC DEVICE ADDRESS #74 – USDA EXHAUST FAN
   i. BUILDING CHILLED WATER BOOSTER PUMP DIFFERENTIAL PRESSURE SENSOR

(4) Complete demolition of all currently abandoned or future obsolete control air supply tubing.

(5) All specified or required control work.

(6) All Controls work associated with AHU-6 and the Shell and Tube Heat Exchangers/pumps are bid alternates.

(7) One year guarantee of all controls, materials and workmanship.

(8) Thorough instruction of the owner’s maintenance personnel in the operation and maintenance of all mechanical equipment.

(9) Thorough coordination of the installation of all piping, equipment and any other material with other trades to ensure that no conflict in installation.
(10) Approved supervision of the work.

END OF SECTION 200200
SECTION 230800 – COMMISSIONING HVAC AND HVAC CONTROLS

PART 1 – GENERAL

1.1 RELATED WORK

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and other Division-1 Specification Sections, apply to work of this Section.
2. Division 20 – Mechanical
3. Division 23 – HVAC
4. Division 25 – Building Automation System

1.2 SUMMARY

A. Section includes commissioning process requirements for the following systems:
   1. HVAC
   2. HVAC Controls

B. Section Includes:
   1. General requirements for coordinating and scheduling commissioning.
   2. Commissioning meetings.
   3. Commissioning documentation and contractor submittal requirements
   4. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
   5. Commissioning tests and commissioning test demonstration.
   6. Adjusting, verifying, and documenting identified systems and assemblies.

1.3 REFERENCES

A. Construction drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.
C. ASHRAE Guideline 0 – 2005; Commissioning Process
D. ASHRAE Guideline 1.1 – 2007; The HVAC&R Technical Requirements for the Commissioning Process
E. ACG Commissioning Guideline – 2005
F. 2012 International Energy Conservation Code (IECC); Section C408
G. AABC National Standards – 2002: National Standards for Total System Balance
H. BCA Best Practices in New Construction 2013
J. ICC G4 – 2012 Guideline for Commissioning
K. 2015 International Mechanical Code
L. NECA 90: Commissioning Building Electrical Systems – 2004
M. NFPA 70: National Electrical Code – 2017
N. National Institute of Building Sciences (NIBS) Whole Building Design Guide
O. NFPA 72 – National Fire Alarm and Signaling Code
P. 2018 Kentucky Building Code

1.4 DESCRIPTION OF WORK
A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the commissioned systems have been installed in the prescribed manner, and operate within the performance guidelines set out in the Owner’s Project Requirements (OPR). The Commissioning Authority (CxA) shall provide the owner with an unbiased, objective view of the system’s installation, operation, and performance. This process is not intended to eliminate or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CxA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, general contractor, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning authority (CxA) is contracted directly with the owner for this project. This commissioning plan has been included for reference only to define contractors’ responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

1.5 INSTALLING CONTRACTORS CLOSE-OUT SUBMITTALS

A. Commissioning Report Supplemental Information:
   1. At Construction Phase Commissioning Completion, provide the following:
      a. Startup reports
      b. Approved test procedures
      c. Test data forms, completed and signed
      d. Controls point-to-point verification documentation
      e. Preliminary test and balance report(s)
      f. Progress reports
      g. Commissioning issues reports showing resolution of issues
      h. Correspondence or other documents related to resolution of issues
      i. Other reports required by commissioning authority

B. Provide Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

C. Provide As-Built Redlines (Existing Conditions) of Drawings and Documents.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 ROLES OF THE COMMISSIONING AUTHORITY

A. The primary responsibility is to inform the owner, the general contractor and design team on the status, integration, and performance of commissioned systems within the facility.

B. The CxA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner’s O&M staff.

C. The CxA shall observe and coordinate testing as required to assure system performance meets the Basis of Design and Owner’s Project Requirements.

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

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

F. The CxA shall document the date of acceptance as determined by the general contractor, owner and design team.
G. The CxA will review operation and maintenance materials for commissioned systems.

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

3.2 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. HVAC Systems

B. DDC Control Systems

3.3 CONTRACTOR SCHEDULING

A. Commissioning Schedule: Integrate commissioning into Contractor’s construction schedule.
   1. Include detailed commissioning activities in monthly updated Contractor’s construction schedule and short interval schedule submittals.
   2. Schedule the start date and duration for the following commissioning activities:
      a. Submittals
      b. Preliminary operation and maintenance manual submittals
      c. System verification checklists
      d. Operation & Maintenance Manuals
      e. Startup
      f. Functional performance tests
      g. Operation & Maintenance Training
      h. As-Built/Existing Conditions Documents
      i. Near End of Warranty Review

B. Two-Week Look-Ahead Commissioning Schedule:
   1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning.

C. Owner’s Witness Coordination:
   1. Coordinate Owner’s witness participation via Architect.
   2. Notify Architect of commissioning schedule changes at least one week in advance for activities requiring the participation of Owner’s witness.

3.4 COMMISSIONING PLAN

A. Commissioning Team
   1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Team members shall be provided by each of the parties listed below:
      a. University of Kentucky, Owner Representative (UK)
      b. CMTA Consulting Engineers, MEP Engineer (CMTA)
      c. Facility Commissioning Group, Commissioning Authority (CxA)
      d. Mechanical Contractor (MC)
      e. Sheet Metal Contractor (SM)
      f. Temperature Controls Contractor (TCC)
      g. Controls Supplier (CS)
      h. Test and Balance Contractor (TABC)
      i. Electrical Contractor (EC)

B. Owner’s Project Requirements and Basis of Design Documents
1. The Owner’s Project Requirements (OPR) is a written document prepared by the owner and the design team that details the functional requirements of a project and the expectations of how it will be used and operated.

2. The Basis of Design (BOD) is a document prepared by the design team that records the concepts, calculations, decisions, and product selections used to meet the Owner’s Project Requirements and to satisfy applicable regulatory requirements, standards, and guidelines. This instrument contains narrative descriptions and supporting documentation.

C. The CxA will review the OPR and BOD documents for commissioning provisions, functional performance, optimizing of performance, accessibility, TAB provisions, testing provisions and O&M considerations.

D. Commissioning Meetings
   1. Commissioning meetings will be held in conjunction with progress meetings as necessary. The CxA will be on site for the Cx meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process.

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

F. System Verification Checklists (SVCs) / Manufacturers’ Checklists
   1. The CxA will write SVCs based on the contract documents. These tests will be created for systems and subsystems. See 3.2 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS for list of systems to be commissioned. Draft copies will be submitted to the Commissioning Team for review and comment prior to placement on the job site. A master copy of the SVCs will be bound in a three-ring binder and placed on the job site for completion by the installing contractors. No system will be started until the appropriate SVCs have been completed.
   2. The equipment manufacturers’ checklists must also be reviewed by the CxA prior to startup. These lists must be completed by the installing contractor, and reviewed by the CxA before startup commences.

G. Start-Up
   1. Start-up of major commissioned systems will be witnessed the CxA. The appropriate contractors and/or manufacturer’s representative will be required on site to perform start-up.
   2. A factory-authorized technician will be on site to start equipment when required by the specifications.

H. Controls Monitoring
   1. Close monitoring of the Control Supplier’s (CS) progress will promote efficient coordination of the TAB work. The CS will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing, including controls programming, graphics and systems integrations.

I. TAB Monitoring
   1. The preliminary TAB report set-up will be reviewed prior to HVAC equipment start-up, in order to assure that the final TAB report format and content are acceptable.
   2. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays.
   3. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report and before Functional Performance Testing can be carried out. A written CxA review will be submitted to the TAB contractor and to the DT. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CxA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.
J. Functional Performance Tests (FPTs)
   1. The CxA will write FPT’s based on the OPR. These tests will be created for systems and subsystems. See 3.2 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS for list of systems to be commissioned. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CxA and the owner’s maintenance staff. Witnessing the FPTs will serve as a compliment to the O&M Training. No FPTs will be performed until the system and related subsystems SVCs are completed by installing contractors, start-up reports have been submitted, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
   2. The Functional Performance Tests shall include the following:
      a. Air Handling Units will be tested in designed operating modes. Proper operation will be verified at minimum OA, maximum OA, automatic control, and other modes, if necessary, to achieve OPR conformance.
      b. Exhaust Fans/Fume Hoods will be tested for conformance to OPR and BOD.
      c. HVAC Systems will be tested to assure that the building as an integrated system operates properly and for conformance to BOD.
      d. DDC control systems will be tested as necessary to achieve OPR conformance.
   3. Off-season mode testing will be implemented as necessary to assure conformance with the OPR. Installing contractors will be expected to participate as required by the project specifications.

3.5 ROLES AND RESPONSIBILITES OF INSTALLING CONTRACTORS

A. Installing Contractor Roles
   1. Mechanical Contractor (MC)
   2. Sheet Metal Contractor (SMC)
   3. Testing, Adjusting and Balance Contractor (TABC)
   4. Temperature Controls Contractor (TCC)
   5. Electrical Contractor (EC)

B. Mechanical Contractor (MC) Responsibilities
   1. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
   2. Assure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.
   3. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.
   4. Attend commissioning meetings scheduled by the CxA.
   5. Assist the CxA in system verification and performance testing.
   6. Prepare preliminary schedule for commissioned system inspections, O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CxA. Update schedule as appropriate throughout the construction period.
   7. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of commissioned equipment.
   8. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
   9. Notify the CxA a minimum of two weeks in advance of scheduled system start-up.
   10. Update drawings to as-built condition and review with the CxA throughout the construction process.
   11. Schedule vendor and subcontractor provided training sessions as required by project specifications.
   12. Provide written notification that the following work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent.
      a. HVAC equipment including fans, air handling units, dehumidification units, ductwork, dampers, terminal devices, etc.
      b. Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.
c. That BAS is functioning in accordance with design intent.
13. Participate in the Functional Performance Tests as required to achieve design intent.
14. Participate in the off-season mode testing as required to achieve design intent.
15. Participate in O&M Training as required by project specifications.
16. Provide a complete set of as-built drawings and O&M manuals for review.

C. Sheet Metal Contractor Responsibilities (SMC)
1. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
2. Assure cooperation and participation of specialty sub-contractors such as piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.
3. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.
4. Attend commissioning meetings scheduled by the CxA.
5. Assist the CxA in system verification and performance testing.
6. Prepare preliminary schedule for commissioned system inspections, O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CxA. Update schedule as appropriate throughout the construction period.
7. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of commissioned equipment.
8. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
9. Notify the CxA a minimum of two weeks in advance of scheduled system start-up.
10. Update drawings to as-built condition and review with the CxA throughout the construction process.
11. Schedule vendor and subcontractor provided training sessions as required by project specifications.
12. Provide written notification that the following work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent.
   a. HVAC equipment including fans, air handling units, ductwork, dampers, terminal devices, etc.
   b. Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.
13. Participate in the Functional Performance Tests as required to achieve design intent.
14. Participate in the off-season mode testing as required to achieve design intent.
15. Provide a complete set of as-built drawings and O&M manuals for review.

D. Test and Balance Contractor Responsibilities (TABC)
1. Attend commissioning meetings scheduled by the CxA.
2. Submit the TAB procedures and preliminary TAB report to the CxA for review at least two weeks prior to beginning TAB work.
3. Notify the CxA a minimum of two weeks in advance of scheduled TAB work.
4. Provide partial, preliminary TAB Reports by phase, by building section, by system, or as required by the CxA.
5. Assist the CxA in system verification and performance testing.
6. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
7. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the CxA for verification or diagnostic purposes.
8. Participate in the Functional Performance Tests as required to achieve design intent.
9. Provide sound and vibration measurements where required to assist in diagnosis of areas exhibiting unacceptable levels of noise or vibration.
10. Participate in the off-season mode testing as required to achieve design intent.

E. Temperature Control Contractor Responsibilities (TCC)
1. Review control sequence and component selection for conformance with design intent.
   a. Verify that specified safeties and interlocks have been selected.
   b. Verify proper selection of control valves and actuators based on design parameters.
c. Verify proper selection of control dampers and actuators based on design parameters.
d. Verify that sensor selection conforms to design intent.
2. Attend commissioning meetings scheduled by the CxA.
3. Provide the following submittals to the CxA:
   a. Hardware and software submittals.
   b. Control panel construction shop drawings.
   c. Narrative description of control sequences for each commissioned system and subsystem.
   d. Schematics showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access.
   e. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
   f. A complete listing of all software routines employed in operating the control system. Also provide a program narrative that describes the logic flow of the software and the functions of each routine and sub-routine. The narrative should also explain individual math or logic operations that are not clear from reading the software listing.
   g. Hardware operation and maintenance manuals.
   h. Application software and project applications code manuals.
   i. Panel and equipment insert documents.
4. Verify that specified interfaces provided by others are compatible with BAS hardware and software.
5. Coordinate installation and programming of BAS with construction and commissioning schedules.
6. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of commissioned equipment.
7. Provide control system technician to assist during equipment startup.
8. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
9. Participate in the Functional Performance Tests as required by the project specifications.
10. Provide a control system technician to assist during verification and performance testing.
11. Provide system modifications to achieve system operation as defined by the design intent.
12. Provide support and coordination for TAB contractor. Provide all devices, such as portable operator terminals and all software for the TAB to use in completing TAB procedures.
13. Provide written notification that the TCC scope of work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent, and that BAS is functioning in accordance with design intent.
14. Participate in the Functional Performance Tests as required to achieve design intent.
15. Participate in the off-season mode testing as required to achieve design intent.
16. Participate in O&M Training as required by project specifications. Include training on hardware operations and programming.

F. Electrical Contractor Responsibilities (EC)
1. Review design for provision of power to the commissioned equipment.
   a. Verify proper hardware specifications exist for performance as defined by the OPR.
   b. Verify proper safeties and interlocks are included in the design of electrical connections for HVAC equipment.
2. Attend commissioning meetings scheduled by the CxA.
3. Verify proper installation and performance of all electrical services provided.
4. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of commissioned equipment.
5. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
6. Provide an electrical system technician to assist during verification and performance testing.
7. Participate in the Functional Performance Tests as required to achieve design intent.
8. Participate in the off-season mode testing as required to achieve design intent.
9. Participate in O&M Training as required by project specifications.
10. Provide a complete set of as-built drawings and O&M manuals for review.

END OF SECTION 230800
SECTION 250200 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1. RELATED DOCUMENTS:

   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, General Mechanical Provisions and General Requirements, Division 1 Specification Sections apply to the work specified in this section.

   B. The Controls Contractor shall be selected based on this package bid with the contract being awarded to the low bid contractor. The successful bidder will then be assigned as a sub-contract to the Mechanical Contractor who will be acting as the General Contractor on the project. The overall project shall include but is not limited to the replacement of air handling units, exhaust fans, ductwork, piping, etc.

2. DESCRIPTION OF WORK:

   A. Furnish a BACnet system compatible with existing University systems. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet. This system shall communicate with the University of Kentucky Facility Management’s existing BACnet head-end software using BACnet/IP at the tier 1 level and BACnet/MSTP at the tier 2 level. No gateways shall be used for communication to controllers installed under section. BACnet/MSTP or BACnet/IP shall be used for all other tiers of communication. No servers shall be used for communication to controllers installed under this section. If servers are required, all hardware and operating systems must be approved by the Facilities Management Controls Engineering Manager and/or the Facilities Management Information Technology Manager.

   B. The scope included within this specification shall be bid separately prior to the overall project bid. The successful bid will then be assigned to the Contractor as all Controls work shall be completed as a sub-contract to the Mechanical Contractor.

   C. All Building Automation Devices should be located behind the University firewall, but outside of the Medical Center Firewall and on the environmental VLAN.

   D. Provide all necessary hardware and software to meet the system’s functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers. These must be in compliance with Front End systems PICS and BIBBS and attached Tridium PICS and BIBBS. Provide all hardware and software to backup, restore, troubleshoot and install system. Software licensing upgrades will also need to be included to support all new BACnet devices/points added within the project for the University of Kentucky Facilities Management’s head-end system. Software, backups, unitary, and ASC files shall be delivered to UEM (Utilities & Energy Management) for archiving purposes.

   E. Prepare individual hardware layouts, interconnection drawings and software configuration from project design data.
F. Design, provide, and install all equipment cabinets, panels, data communication network
cables needed, and all associated hardware.

G. Provide and install all interconnecting cables between supplied cabinets, application
controllers, and input/output devices.

H. Provide complete manufacturer’s specifications for all items that are supplied. Include
vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of
system installation, startup, and commissioning.

J. Provide a comprehensive operator, administrator and technician training program as
described herein.

K. Provide as-built documentation, programming software for use site wide, electronic copies
of all diagrams, and all other associated project operational documentation (such as
technical manuals on approved media, the sum total of which accurately represents the final
system.

L. Furnish, install, and fit-up in complete working order, with all accessories required, the
automatic temperature control and monitoring systems shown on the Drawings and
specified herein. The systems shall be properly connected, piped and wired in a manner
conforming to the laws, ordinances and codes now in force in the Commonwealth of
Kentucky.

M. The controls and all listed I/O points from this project shall communicate with the
University of Kentucky Facilities Management’s existing BACnet software head-end
station using BACnet/IP. All BACnet points shall be exposed to the University of
Kentucky Facilities Management’s head-end station. Graphics will be installed by UEM
on the head-end system. All point and device names shall comply with the University
Facilities Management standards and shall be approved before and included in the shop
drawings submittal. Cooperate with the Owner (UEM) to ensure that all specified points
and alarms communicate and operate on the head-end system. All point and device names
shall comply with the University Facilities Management standards (format listed below,
consult Utilities and Energy Management (UEM) for the correct abbreviations) and shall be
included in the shop drawings submittal for review and approval. Point naming
conventions and formats are listed further in this specification in the Direct Digital Controls
Equipment section. Refer to University Standard 230553S02 for the AHU Naming
Convention.

N. Related to the alarms, the contractor is to set up the alarm parameters specified by the
system sequences of operations without enabling the alarms. Contractor is to provide a
list of points containing alarm extensions to Owner (UEM). UEM will be responsible for
doing the alarm names, alarm texts and enabling the alarm points provided on the list.

O. All work must be coordinated and scheduled with the UEM Controls group prior to any
work being done on site.

P. Existing controls equipment (equipment level or building controllers) shall be salvaged
and turned over to the University. Honeywell DGP panels can be discarded.
Q. Thermostats: Each terminal unit requires a thermostat for operation, unless specifically indicated on the Drawings to be slaved to another unit. Slaved terminal units shall be controlled to match the CFM and discharge air temperature of the master unit. Thermostat locations have been identified on the Drawings to the extent possible, but all such locations may not be shown. Provide the required thermostats whether or not shown on the Drawings. For those thermostats not shown on the Drawings, work out an acceptable location with the Architect/Engineer. Thermostats are to be provided with no doors.

R. Provide DDC controls for the air terminal units. Provide electronic operators controlled and monitored by direct digital control systems which shall include, but not be limited to, air handling systems, pumps, terminal units, etc.

S. The control equipment shall be complete and shall include, but not be limited to, all necessary valves, damper operators, pipe, fittings, etc.

T. Electronic Control System installer must physically demonstrate to Owner and Owner's representatives (UEM) via software simulations that the proposed building automation system and control sequences will function as outlined in the contract documents prior to field implementation.

U. The control and monitoring system for this project shall be made up using standard materials, equipment and components regularly manufactured for systems of this type. The system shall be complete in every respect and shall be a functioning system.

V. Electrical power wiring and interlock wiring for all controls, signal devices, equipment, alarms, etc., shall be in accordance with diagrams and instructions from the supplier of the systems. All power and control wiring, conduit and wiring connections required for the complete installation, including wiring to smoke dampers and combination fire/smoke dampers and their motors, shall be provided by this Contractor in accordance with Electrical specification requirements. Controls shall be on emergency power.

W. Refer to other Mechanical Division sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.

X. Emergency Electric power for the control panels, modules, unit controller, valve motors, etc., shall be derived from the building emergency electric system. Power shall not be derived from the HVAC equipment power source or equipment low voltage transformers (internal or integral).

   a. All controls panel located in the main mechanical/electrical rooms and penthouses shall be provided with emergency lighting as well. If there is not lighting on emergency power in the area needed to provide a minimum of 30 foot candles lighting, then the controls contractor is responsible for providing at least these panel locations. These shall include control of the following system.

      i. All Air handling unit control systems
      ii. Heating hot water system control
      iii. Chilled water system control
      iv. Emergency generator system control
      v. Communication Room HVAC system control

Y. All exterior electrical work, equipment, etc. shall be waterproofed.
Z. UK Communications department (UK ITS) shall provide all required HUB’s routers and switches required to interface to the campus WAN network. The cost for this work shall be included by the controls manufacturer. The controls contractor is responsible for providing all data drops necessary for their control panels and acquiring all necessary IP addresses from the UK ITS. Obtain pricing from the UK Campus Communication Department prior to bid.

3. QUALITY ASSURANCE:

A. Manufacturer: Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work at Tier 1 BACnet/IP include the following:

Honeywell
Johnson Controls
Vykon

B. Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work at Tier 2 BACnet/MSTP include the following:

Honeywell
Johnson Controls
Alerton
Distech

C. Acceptable controls manufacturers shall include any controls manufacturers which utilize a BACnet protocol in accordance with the specification. If the bidding manufacturer is not listed above, documentation for approval as an equal must be submitted 10 days prior to the bid opening date to allow for evaluation by the university.

D. Installing Contractor: Installing controls contractors must comply with the following requirements:

E. The installing systems integration contractor has been in the business of installing BACnet controls for the last 5 years minimum. In addition, the installing systems integration contractor needs to demonstrate with documentation that they have provided the controls in a minimum of (3) hospital or university renovation projects of similar size and scope where they utilized a BACnet system.

F. The systems integration contractor must have on staff the following number of key personnel as a minimum, each with a minimum of 5 years of related BACnet controls installation experience: Project Manager - 2, Controls Applications Engineer - 2, Programmer - 2, Installation Supervisor - 2, Controls Technician - 5.

G. Prefer contractor staff to include Niagara Tridium AX/N4 certified technicians.

H. Contractor to have experience with successful integrations of controls with Niagara Tridium systems.

I. Contractor to have a minimum of 3 years of installation history with the brand of controls being bid.
J. Contractor must have a help desk operation or staff available for phone contact 24/7 for providing technical support to university staff. Call forward and emergency service numbers are not acceptable during normal business hours.

4. CODES AND STANDARDS:

A. Electrical Standards: Provide electrical components of pneumatic control systems which have been UL-listed and labeled, and comply with NEMA standards.

B. NFPA Compliance: Comply with NFPA 90A "Standard for the installation of Air Conditioning and Ventilating Systems" where applicable for controls and control sequences.

C. Kentucky Building Code: Comply with requirements where applicable for controls.

D. Provide products of the temperature control system with the following agency approvals:

- **UL-916**: Energy Management Systems
- **UL-873**: Temperature Indication and Regulating Equipment
- **UL-864**: Subcategories UUKL, OUXX, UDTZ; Fire Signaling and Smoke Control Systems
- **CSA**: Canadian Standards Association
- **FCC**, Part 15, Subpart J., Class A Computing Devices

E. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, NEC, Local and National Codes.

5. SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes, also include installation and start-up instructions.

   A. Shop Drawings, Product Data, and Samples

1. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; BAS Contractor name, address and phone number; BAS Contractor project manager, quality control manager, and project engineer names and phone numbers.

2. Each submittal shall include the following information.

   a. BAS riser diagram showing all DDC controllers, network repeaters, and network wiring.
   
   b. One-line schematics and system flow diagrams showing the location of all control devices.
c. Points list for each DDC controller, including: Tag, Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Module Type, Terminal ID, Panel, Slot Number, Reference Drawing, and Cable Number. The initial shop drawing submittal for review needs to include all point names meeting the naming convention outlined in this specification for UEM approval at the shop drawing phase prior to the contractor beginning any programming.

d. Vendor’s own written description for each sequence of operations, to include the following:
   - Sequences shall reference input/output and software parameters by name and description.
   - The sequences of operations provided in the submittal by the BAS Contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
   - Points shall be referenced by name, including all software points such as programmable setpoints, range limits, time delays, and so forth.
   - The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.

e. Detailed Bill of Material list for each panel, identifying: quantity, part number, description, and associated options.

f. Control Damper Schedules. This spreadsheet type schedule shall include a separate line for each damper and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.

g. Control Valve Schedules. This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calc CV, Design Pressure, Actual Pressure, and Actuator Type.

h. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, and so forth.

i. Range and scale information for all transmitters and sensors. This sheet shall clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.
j. Hardware data sheets for all local access panels.

k. Software manuals for all applications programs to be provided as a part of the programming devices, and so forth for evaluation for compliance with the performance requirements of this Specification.

l. The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for each device.

3. BAS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. BAS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

4. Submittal shall have approved point names.

6. Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device. Include that type data, product and shop drawings in maintenance manual.

7. Operation and Maintenance Instructions:

A. This contractor shall prepare an electronic Operations Manual entitled "Automatic Temperature Control and Monitoring Systems Operation and Maintenance Data." Manual shall be PDF files with separate PDFs for each of the items noted below.

B. Each manual shall contain the following information:

Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor (name and address).

Complete brochures, descriptive data and parts list, etc., on each piece of equipment, including all approved shop drawings.

Complete maintenance and operating instructions, prepared by the manufacturer, on each major piece of equipment, including preventative maintenance instructions.

Complete shop drawing submittal on temperature and monitoring controls including control diagrams updated to reflect "as-built" conditions.

All wiring and component schematics necessary for Owner (UEM) to troubleshoot, repair and expand the system.

All manuals shall be submitted to the Engineer prior to final inspection of the building.

Provide a laminated copy mounted in a sleeve on the outside of the panels for the controls sequences pertinent to equipment supplied by that specific controls panel.
8. Controls Program Backup: At the end of the project, the contractor is to supply digital back-up copies of all final complete operating controls programs. These shall be delivered to UEM for archiving purposes.

9. DELIVERY, STORAGE AND HANDLING:

Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

PART 2 - PRODUCTS

1. DIRECT DIGITAL CONTROL SYSTEM

General: This specification defines the minimum hardware and performance requirements for a computer-based building automation system to be furnished and installed.

SCOPE OF WORK:

2. System Requirements:

A. Contractor shall provide all equipment, engineering and technical specialist time to check the installation required for a complete and functioning system. The contractor shall furnish and install all interconnecting system components. Components to include, but not be limited to: power line conditioners, field panels, sensors, motor starter interfaces, and any other hardware items not mentioned above but required to provide the Owner with a complete workable system.

B. Any feature or item necessary for complete operation, trouble-shooting, and maintenance of the system in accordance with the requirements of this specification shall be incorporated, even though that feature or item may not be specifically described herein. This shall include hardware and software.

C. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall be thoroughly tested and proven in actual use.

3. Input/Output Summary:

A. The system as specified shall monitor, control and calculate all of the points and functions as listed in the Input/Output Summary.

4. System Start-Up and Acceptance:
A. Upon completion of the installation, the BAS Contractor shall start-up the system and perform all necessary testing and debugging operations. An acceptance test in the presence of the Owner's representative shall be performed. The vendor shall check all sensors that exhibit any problems or faulty reading. When the system performance is deemed satisfactory in whole by UEM, the system parts will be accepted for beneficial use and placed under warranty. The BAS Contractor is to be available for system commissioning at the end of the installation when requested by the Engineer and/or Owner. The contractor is to also be available for seasonal commissioning for the other seasons beyond the initial commissioning.

B. This Contractor shall work with the Owner (UEM), who is developing the graphics, to ensure that all points report, function and alarm as required on the BACnet head-end system. The Contractor will also work with the Project Manager or CNS/MCIS to obtain all necessary IP’s and Ethernet drops needed for BACnet panel. The Owner (UEM) will assign all BACnet/IP instance numbers and all BACnet/MSTP network numbers for use by the Contractor. All BACnet/IP devices will report directly to the head-end system.

C. UEM will be performing their own complete point by point evaluation as part of this project, independently of the commissioning activity. This will occur during the warranty period of the project.

5. Facilities Management’s Instruction:

A. The BAS Contractor shall provide two copies of an electronic version of the operator's manual describing all operating and routine procedures to be used with the system. This user's manual should contain subjects such as: standard operation, error message explanations, software usage, commands, system troubleshooting, etc. The Contractor shall also provide wiring schematics for all system components.

B. The BAS Contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than eight (8) hours during four 4 hour sessions. These instructions are to be conducted during normal working hours at the Owner's convenience and are to be prearranged with the Owner. The owner can request this training any time within the one-year warranty period and may request any number of classes adding up to the total number of hours. The contractor shall provide an hourly unit price for additional on-site training.

C. The instructions shall consist of both hands-on at the job site and classroom training at a classroom location on the University of Kentucky campus coordinated with the Project Manager and UEM.

D. Upon completion, the attendees shall be able to operate the system and implement system changes including start-up, boot load, add point to the data base, enter messages, and down line load field units.

E. Prior to the scheduling of the sessions, an agenda outlining the training topics must be submitted for approval. Agenda items shall include, but not be limited to, the following topics:

1) Explanation of control sequences. Include which sensors are used and how output device operates.
2) Explanation of control drawings and manuals, including symbols, abbreviations,
and overall organization.

3) Walk-through of project to identify controller locations and general routing of network cabling.

4) Review of operation and maintenance of hardware devices including air compressor, air dryers, controllers, instruments, and sensors. Include schedule for routine maintenance.

5) Programming Application Specific Controllers
   (a) Backing up and Restoring Application Specific Programming
   (b) Adding/Deleting/Editing points on Application Specific controllers
   (c) Troubleshooting Application Specific controllers
       (inputs/outputs/logic/master – slave relationships/bus issues)

6) Programming Building Specific Controllers
   (a) Backing up and Restoring Building Specific Controllers Programming
   (b) Adding/Deleting/Editing points on Building Specific Controllers controllers
   (c) Troubleshooting Building Specific Controllers controllers
       (inputs/outputs/logic/network issues)

7) How to use tools and cables

6. Warranty

The system including all hardware and software components shall be warranted for a period of one year when the system performance is deemed satisfactory in whole by UEM. The system parts will be accepted for beneficial use and placed under warranty at that time. A Certificate of Occupancy does not initiate the control system warranty. Any defects in materials and workmanship arising during this warranty period shall be corrected without cost to the Owner.

All applicable software as detailed in this specification shall be updated by the BAS Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the BAS Contractor.

7. Direct Digital Control (Ddc) Equipment

System Software

A. All software required for monitoring, modifying, configuring and backup for the system shall be embedded in the controller and accessible via VT terminal, hyper-terminal or the web. This software shall allow any computer with access (and security) to the University’s network to perform the work described above using a web browser or provided software. No software upgrades should be required unless provided at no additional cost to the customer. The software version used for installation of any new devices must either be at the current software version used on the University Facilities Management campus at the current JAVA version or the new software at the most current JAVA version must be installed on all devices and the current system prior to the installation of the new devices. All software is to also operate on the latest version of Microsoft Windows operating system. All configuration and programming tools required for the upgraded version must be provided at the time of installation.

Provide a USB, standard RS-232 9 pin female, Bluetooth, RJ11, RJ12 or RJ45 connection for on-site access.
8. BACnet Conformance

A. Building Controller shall as a minimum support MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a BACnet device and shall support simultaneous routing functions between all supported LAN types. Global controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:

1. Clock Functional Group
2. Files Functional Group
3. Reinitialize Functional Group
4. Device Communications Functional Group
5. Event Initiation Functional Group

B. Please refer to end of this section for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data.

C. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. Alarms should also be setup on this system with limits. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data.

D. The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork. It must support interoperability on the campus area network and function as a BACnet Broadcast Management Device (BBMD) and/or a BACnet router.

9. Building Controller (B-BC)

A. General

B. Building Controller (B-BC) shall be minimum 16 bit microcomputer based, utilizing a multi-tasking, multi-user operating system.

C. The B-BC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board B-BC controller database shall be performed on-line using the built-in software. Systems which require the B-BC to be removed from service while DDC control sequences are modified shall not be acceptable.

D. B-BC controllers shall utilize true floating point arithmetic capabilities.

E. All B-BC controllers shall have open licensing to connect to existing UK UEM Tridium BACnet BAS.

10. Databases and Memory Back-Up
All programming defining the functions to be performed by the B-BC, including but not limited to application programs and point database within each B-BC, shall be protected from loss due to power failure for a minimum of 72 hours. All database and backup shall be provided to the UK UEM Controls group.

11. Service Ports

B-BC controllers shall be equipped with a minimum of one operator service port for the connection of a laptop computer. The service port shall be either a built-in standard RS-232 data terminal port, USB port, CAT5 cable or RJ11/12 connection.

Connection of a service device, to a service port, shall not cause the B-BC controller to lose communications with its peers or other networked device controllers.

12. Display and Readout Capability

The B-BC controller shall additionally provide diagnostic LED indication of device transmit and receive data communications for all communication port and peripheral ports, normal operation, abnormal operation and control relay operation indication.

13. Manual/Auto Control and Notification

The B-BC controller shall provide commanded override capability from the built-in operator interface. Such overrides shall be annunciated to the head-end station. Such overrides shall be valid as long as power is applied to the controller.

14. Adjustments

Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual B-BC. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the B-BC. From a single B-BC user interface, any other B-BC shall be accessible and full adjustment capabilities shall be provided.

15. B-BC Naming Convention

B-BC devices shall be named using the following naming convention:

- BuildingName_BuildingNumber_Floor_RoomNumber_B-BC Device Type OR
- BuildingNumber_BuildingName_Floor_RoomNumber_B-BC Device Type

All B-AAC points shall be named using the following format:

Building_Floor_RoomNumber_Device Type_Equipment ShortName_Function

Examples:

A B-BC device located in the Pavilion HA mechanical room HA4001 would be named as follows:

PAVHA_0293_04_HA4001_JACE
An exhaust fan status point for a fan in Pavilion HA mechanical room HA3001 fed directly from the above panel would be named as follows:

PAVHA_03_HA3001_HVA_EF1_STAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

16. Advanced Application Controller (B-AAC)

General

A. Controls shall be microprocessor based, Advanced Application Controllers (B-AAC’s). B-AAC’s shall be provided for Air Handling Units, packaged Rooftops, primary and secondary pumping loop systems and other applications as shown on the drawings. B-AAC’s shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-AAC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the owner. If the input points are not fully universal in nature, unused points must be equal in quantity between Analog Inputs and Digital Inputs.

B. All B-AAC controllers shall have open licensing to connect to existing UK UEM Tridium BACnet BAS.

C. Contractor shall provide a minimum of one B-AAC controller per air handling or mechanical system as shown on the drawings.

D. The BAS contractor shall provide and field install all B-AAC’s specified under this section. Mechanical equipment manufacturers desiring to provide B-AAC’ type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.

E. All input/output signals shall be directly hardwired to the B-AAC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

F. B-AAC’s shall be in continuous direct communication with the network which forms the facility wide Building Automation System. The B-AAC’s shall communicate with the B-BC at a minimum baud rate of 9,600 baud.

17. Non-Volatile Memory
A. All control sequences programmed into the B-BC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-BC shall allow for the creation of unique application control sequences. Systems that only allow selection of sequences from a library or table are not acceptable.

B. All control sequences shall be fully programmable at the B-AAC, allowing for the creation and editing of an application control sequence, while at the unit.

C. The B-AAC shall be provided with an interface port (standard RS232 data terminal port or USB port) for a laptop computer. The interface port shall allow the laptop to have full functionality as described above. From the interface port or network terminal, the laptop shall be able to directly access any B-AAC or B-ASC in the network.

D. The B-AAC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples, per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days.

E. Systems unable to provide the above capability shall provide for the individual Input/Output point trending at the B-BC. Specifics as to how each B-AAC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-AAC’s per B-BC that can be expected.

F. The B-AAC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.

G. The B-AAC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the B-AAC, without loss of setting. The battery for the time clock shall be replaceable by the customer. The B-AAC shall be provided with integral time schedules; as a minimum, two seven day schedules with eight on/off periods per day shall be provided. Holiday override of weekly schedules shall be provided for pre-scheduling of holidays, for the year in advance.

18. Controller Location

A. To simplify controls and mechanical service troubleshooting, the B-AAC shall be capable of being mounted directly in or on the controls compartment of the air handling system. The B-AAC shall be housed in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The B-AAC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. This shall allow all controls maintenance and
troubleshooting to be made while at the air handling unit. The B-AAC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

B. Every controller and control panel shall be labeled with a lamacoid plate permanently secured to the device. Sticky tape or glued labels are not acceptable. The labeling shall describe the device and include related information such as MAC address, IP address, BACnet Instance numbers, etc.

C. All power feeds shall be clearly identified and shall include panel number, breaker and electrical panel location if not in the same room.

D. For compatibility to the environment of the air handling unit, B-AAC’s shall have wide ambient ratings. B-AAC’s shall be rated for service from -40 DegF (Degrees Fahrenheit) to 140 DegF.

E. Contractor shall submit description of location of B-AAC’s on all mechanical and air handling equipment.

19. B-AAC Naming Convention

B-AAC devices shall be named using the following naming convention:

B-AAC devices shall be named using the following format:
Building.Floor.RoomNumber_B-AAC Device Type_Equipment Short Name

All B-AAC points shall be named using the following format:
Function

Examples:

An Air Handler controller in the Pavilion HA mechanical room HA4001 for AHU7 would be named as follows:

PAVHA_04_HA4001_HVA_AHU7

The mixed air temperature point for the above system would be named as follows:

MAT

Therefore, when this point is learned, the entire point name will be:

PAVHA_04_HA4001_HVA_AHU7_MAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

20. Application Specific Controller (B-ASC)

General

A. Controls shall be microprocessor based Application Specific Controller (B-ASC). B-ASC’s shall be provided for Unit Ventilators, Fan Coils, Heat Pumps and other applications
as shown on the drawings. B-ASC’s shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-ASC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter.

B. Contractor shall provide a minimum of one B-ASC controller per unitary system as shown on the drawings.

C. The BAS contractor shall provide and install all B-ASC’s specified under this section.

D. All input/output signals shall be directly hardwired to the B-ASC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

E. B-ASC’s shall be in continuous, direct communication with the network which forms the facility wide building automation system. The B-ASC’s shall communicate with the B-BC at a baud rate of no less than 38,400 baud.

21. Non-Volatile Memory

A. All control sequences programmed into the B-ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the B-ASC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-ASC shall allow for the creation of unique application control sequences.

B. The B-ASC shall be provided with the ability to interface with a laptop computer. The interface port shall be provided at the wall sensor or within the unitary equipment. Connection to the wall sensor must be a standard RJ-45 or USB port.

C. The B-ASC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken.

D. Systems unable to provide the above capability shall provide for the individual input/output point trending at the B-BC. Specifics as to how each B-ASC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-ASC’s per B-BC that can be expected.

22. Controller Location

A. To simplify controls and mechanical service troubleshooting, the B-ASC shall be mounted directly in the controls compartment of the unitary system. The B-ASC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting
shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The B-ASC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

B. For compatibility to the environment of the unitary equipment, B-ASC shall have wide ambient ratings. B-ASC’s shall be rated for service from 32 DegF (Degrees Fahrenheit) to 140 DegF.

C. Contractor shall submit description of location of B-ASC’s on all mechanical and unitary equipment.

23. B-ASC Naming Convention

B-ASC devices shall be named using the following naming convention:

\[
B-ASC \text{ devices shall be named using the following format:} \\
Building\_Floor\_RoomNumber\_B-ASC\_Device\_Type
\]

\[
\text{All B-ASC points shall be named using the following format:} \\
\text{Function}
\]

Examples:

A VAV controller in the Pavilion HA room HA498 would be named as follows:

PAVHA_04_HA498_VAV

The discharge air temperature point for the above room would be named as follows:

DAT

Therefore, when this point is learned, the entire point name will be:

PAVHA_04_HA498_VAV_DAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

24. CONTROL PANELS

A. Panelboard shall contain all instruments and accessories. Provide each item of equipment with an engraved nameplate. Panelboard shall be wall-mounted or stand-mounted and shall be completely enclosed.

B. As far as is practical, the control components for each system shall be grouped. Provide each group of components with identification.

C. The entire panelboard shall be pre-wired and brought to a main terminal strip. All relays, switches, etc., shall be installed, furnished and wired on panelboard. Clearly mark each terminal strip as to which wire from which component is to be connected.
D. Fabricate panels of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color.

E. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.

F. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.

G. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

25. SENSORS

A. Electronic Sensors used in air ducts or liquid lines shall utilize non-adjustable RTD or thermostat sensing elements with + or -0.36°F, accuracy and stability of at least + or -0.05°F per year. All sensors used in liquid line shall be provided with separable stainless steel immersion wells. Averaging sensors shall be a minimum of five (5) feet in length, and shall be installed in such a manner so as to sense representative sample of the medium being controlled.

B. Equipment Operation Sensors: As follows:

Status Inputs for Fans: Differential-pressure switch with adjustable range set to 175 percent of rated fan static pressure. A hawkeye sensor should also be provided so that the owner knows if belts are lost or fans are running backwards.

Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

C. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs (preference is 4-20mA or 0-10 Volts), or continuous proportional current or voltage to 0 to 20 psi (0 to 138 kPa).

D. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent damper travel.

E. Sensor Input and Output Devices:

1. The following sensors and devices, or their equivalents, shall be considered acceptable. Other sensors and devices required for this specification are outlined in their respective subsystem.
2. Analog sensing elements for remote indication shall be independent of local pneumatic sensors used for local control loops.
3. System Accuracy: The system shall maintain an end-to-end accuracy for one year from sensor to operator’s console display for the application specified.

<table>
<thead>
<tr>
<th>STANDARD</th>
<th>Type</th>
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<tbody>
<tr>
<td></td>
<td>Temperature Sensors</td>
</tr>
<tr>
<td></td>
<td>Electronic</td>
</tr>
</tbody>
</table>

INSTRUMENTATION AND CONTROL FOR HVAC 250200 -18
<table>
<thead>
<tr>
<th><strong>APPLICATION</strong></th>
<th>BAS, HVAC, BTU, Boiler Control</th>
</tr>
</thead>
</table>
| **STANDARD**    | 100 or 1000 ohm platinum wire wound RTD element  
Standard J (3 wire) configuration  
European curve, Alpha = .00385  
Ohms/Ohm/deg.C., meets DIN SID 43760  
Wire in conduit |
| **MECHANICAL**  | 1/4" stainless steel sheath |
| **SPACE TEMPERATURE** | Sensor housing to be similar in appearance to existing thermostats except that thermometers are not required. Similarity to be Owner's decision. Locate on an outside wall if possible. |
| **DUCT TEMPERATURE** | Standard lengths -- 5.5", 11.5" and 17.5"  
Other lengths with owner's written approval.  
Locate in central area of airstream at minimum of 18" from reheat coil.  
1/2" NPT mounting thread and flange and conduit connection.  
Glass encapsulated element unless otherwise approved. |
| **THERMOWELL** | Drilled brass or stainless steel or brass fitting with stainless steel sheath built-up well with Owner approval.  
Glass encapsulated element unless otherwise approved.  
3/4" process connection with drilled wells.  
1/2" NPT process connection on built-up wells.  
Insertion into measured medium - 1" + 1/2" diameter of pipe.  
Cast iron connector head - 1/2" NPT process connection and conduit connection.  
Rated thermowell pressure = 250 psi. |
| **ELEMENT ACCURACY** | must meet .1% DIN and the DIN 43760 standard. |
| **OVERALL ACCURACY** | + 1 deg.F. General duct, space and thermowell temperatures.  
+.75 deg.F. for thermowell ele. on 4" or larger pipes.  
+.5 deg.F. for thermowell ele. on 8" or larger pipes. |
| **OVERALL RANGE** | -20% to 120% of possible operating conditions. |
GENERAL NOTE  If wires from RTD probe to DGP are to be more than 200 feet long, provide extra large cast iron connector head (nominal size 2-11/16 x 1/4) or junction box to accommodate a resistance to 4-20 mA convertor transmitter.

STANDARD

Pressure Sensor

TYPE

Electronic with LVDT element.

APPLICATION

4-20 mA Output (2 wire)
Wire in conduit
Input voltage 10-35 volts DC
Loop resistance greater than or equal to 500 ohms

MECHANICAL

Linear variable differential transformer (LVDT) element
Allowable Standard Ranges
0-30 PSI
0-100 PSI
0-200 PSI

Other ranges with Owner written approval
1/2" NPT input thread and conduit connection.
Provide differential inputs unless otherwise approved.
Provide an air filter on unused differential ports.
Provide with a NEMA 4 watertight enclosure unless otherwise approved.
Min. rate pressure - 150% FS proof and 450 PSI static.

OVERALL ACCURACY

+ 0.5% F.S. including Linearity, hysteresis and repeatability.

ACCURACY NOTE:  If pressure transducer is used to calculate flow with a pilot tube, then the accuracy of the pressure sensor should be dictated by the overall accuracy requirement of the system and would probably require a high accuracy sensor.

This section covers all new transducers provided.  All new transducers provided shall be of the following type:

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Temperature (deg.F.)</td>
<td>4-20 mA, 2 wire</td>
</tr>
<tr>
<td>Temperature (deg.F.)</td>
<td>100 ohm platinum wire RTD</td>
</tr>
<tr>
<td>2. Pressure</td>
<td>4-20 mA, 2 wire</td>
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<tr>
<td>3. Flow Instantaneous</td>
<td>4-20 mA, 2 wire</td>
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<tr>
<td>4. Flow Integrated</td>
<td>Pulse 10 PPS Max A25</td>
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<tr>
<td></td>
<td>msec open (min.) 40 msec closed (min.)</td>
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<tr>
<td>5. KW Instantaneous</td>
<td>4-20 mA, 2 wire</td>
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</tbody>
</table>
6. KWH - Integrated

Pulse – 10 PPS Max A25
msec open (min.) 40 msec
closed (min.)

Digital inputs from devices with isolated, dry type contacts (no grounds, no voltage) of either normally open (N.O.) or normally closed (N.C.) configuration. Live contact inputs, those that have voltage present, shall be provided with isolating devices to meet dry contact requirement.

26. THERMOSTATS

A. Room Thermostats: Provide room thermostats that work in conjunction with the B-AAC and B-ASC terminal unit controllers. Thermostats shall have visible thermometers, setpoint indication and exposed setpoint adjustment in all areas except public spaces. Thermostats are to have push buttons on the front face for adjusting the temperature setpoints. Thermostats are to have no doors.

B. In cases where a single room sensor is to be shared by multiple controllers the slave box reheat control valves and dampers shall be individually controlled to track the discharge temperature of the master unit. The Master shall be identified locally and on the FMS.

C. An RJ-11 type connection to serial port shall allow a local portable operator or programmer’s terminal to access all program blocks and attributes for complete programmability.

D. Room Thermostat Accessories: As follows:

E. Insulating Bases: For all thermostat installations.

F. Thermostat Guards: Locking transparent-plastic mounted on separate base.

G. Adjusting Key: As required for device.

H. Aspirating Boxes: Where indicated for thermostats requiring flush installation.

27. DAMPERS:

A. Provide automatic control dampers as indicated, with damper frames not less than 13-gage galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-gage galvanized steel, with maximum blade width of 8”.

B. Secure blades to 1/2” diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.

C. Do not exceed maximum 48”x48” damper size. For sizes larger then this maximum in either dimension, use multiple dampers with a separate operator for each damper. Do not link separate dampers together.
D. Operating Temperature Range: From -20 degrees to 200 degrees F. (-29 degrees to 93 degrees C.). The occupant shall have an operation local range of 68 degrees and 74 degrees on rooms with Occupancy sensors.

E. For standard applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable steel blade edging, or replaceable rubber seals, rated for leakage less than 10 CFM/sq.ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.

F. Smoke Dampers: Provide smoke and combination fire/smoke dampers in accordance with applicable requirements of Specification Section "Ductwork Accessories".

28. ACTUATORS:

A. Electric Valve and Damper Motors: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified.

B. For reheat coils in branch ductwork and heating coils for air terminal units and fan terminal units, provide non-spring return, fully proportional, floating valve actuators.

C. For all other applications, provide permanent split-capacitor or shaded pole type motors with gear trains completely oil-immersed and sealed. Equip spring-return motors, with integral spiral-spring mechanism. Furnish entire spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

D. Equip motors for outdoor locations and for outside air intakes with "O ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at -40 degrees F. (-40 degrees C.)

E. Provide separate motor for each outside air, return air and exhaust air damper. Do not link dampers with different functions together on one damper motor.

F. Provide separate motor for each damper when overall damper size exceeds 48" in either dimension. Do not link different dampers together on one damper motor.

G. Binary backed-up motors are not acceptable.

29. MISCELLANEOUS:

A. Wells for Pipe Mounted Sensor: Wells shall have minimum working pressure of 150 WOG psig. Wells shall be brass or stainless steel.

B. Lightning Protection: All electric/electronic equipment supplied must be internally or externally lightning/transient surge voltage protected on all external power feeder and input/output connections which are subject to surge voltage transients. Provide high speed clamping elements which meet IEEE. STD. 472 (SWC) on all digital or analog date channels.

C. Pressure Instruments:
1. Differential Pressure and Pressure Sensors: Sensors shall have 4-20 mA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging device. Accuracy shall be within 2% of full scale.

2. Pressure Switches: Pressure switches shall have repetitive accuracy of ±2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over operating pressure range. Switch shall have application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy or gold plating.

D. Current Sensing Relays: Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for application. Setpoint of contact operation shall be field adjustable.

E. Low Voltage Wiring: Control wiring for analog functions shall be 18 AWG minimum with 600 volt insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

F. Low Voltage Wiring: Wiring for electric or electronic circuits less than 25 volts shall be cabling manufactured for express use in air plenums. The plenum cable shall be 24 gauge or larger as required, tinned copper, Teflon insulated, twisted pairs, shielded or unshielded, as required, a color coded, overall tape wrap, with transparent Teflon jacket, 150V., NEC725, Class 2 classified for use in air plenum non-conduit signaling application.

G. Manual Override Switches: In case of failure of the DDC system, provide override switches to operate fans, pumps, air handling units, cooling tower, heat exchangers, etc., manually in local interface control panel. Also for temperature and pressure control provide switches to allow supply temperatures, water temperatures, supply air pressure and fans to be manually regulated. All switches shall be located in locked panel to prevent unauthorized use of the manual override switches.

PART 3 - EXECUTION

1. INSPECTION:

Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

2. INSTALLATION OF AUTOMATIC TEMPERATURE CONTROLS

General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on the Drawings.

3. CONTROL WIRING:

A. Contact the project manager for all required Ethernet connections for this project.

B. Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code. Install wiring in electrical conduit in all areas. All controls conduit shall be green in color.
C. Conceal conduit, except in mechanical rooms and areas where other conduit and piping are exposed.

D. Install all control wiring with color-coded wire in ¾” minimum size conduit. Wire gauge to be in accordance with National Electrical Code.

F. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

4. POWER WIRING:

A. Provide power wiring and conduit to air terminal units (if required) and to smoke dampers and combination fire/smoke dampers and their damper motors.

B. Furnish and install power cabling and conduit for temperature controls panels and equipment from emergency power panels. Each temperature control panel shall be connected to a separate circuit. Conduits shall connect to panels at the locations directed by the Contractor under Division 26. Final connection in the power panels shall be by Temperature Control Contractor in coordination with Division 26 Contractor.

C. Every controller and control panel shall be labeled with a lamacoid plate permanently secured to the device. Sticky tape or glued labels are not acceptable. The labeling shall describe device and include all pertinent information such as MAC address, IP address, instance # etc. All power feeds shall be clearly identified and shall include panel number and electrical panel location if not in the same room. The tag labeling shall match the following image.

D. The TCC shall install all temperature control interlock wiring required.

E. 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.

F. Provide a 110 VAC emergency power duplex receptacle for all temperature control and master control panels. Provide a ups power supply for the main building control unit.
G. STANDARDS

NFPA Compliance: Comply with requirements where applicable for controls.

Kentucky Building Code (includes energy code requirements): Comply with requirements where applicable for controls.


Provide products of the temperature control system with the following agency approvals:

- UL-873 – Temperature Indication and Regulating Equipment.
- UL-864 – Subcategories UUKL, OUXX, UDTZ, Fire Signaling and Smoke Control Systems.

All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, NEC, Local and National Codes.

SENSORS

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 0.75 degrees F. Outside air, water and duct sensors must be tested and accurate to within 1.0 degree F.

SPACE SENSORS: Wireless thermostats for unitary/terminal equipment are acceptable in lieu of conduit and wire. All thermostat/sensor's must be provided with temperature indication. Programmed set-point shall be locally adjustable limited to 5 degrees above set-point and 5 degrees below set-point (in one degree increments) for supervised areas. Unsupervised areas shall have non-adjustable set-point. Doors will not be allowed on sensors. All thermostats shall include a push-button override feature.

All analog input devices shall utilize the 1000 ohm platinum standard.

Thermostats shall be installed 48" 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. Proper ADA heights must be maintained at all times and shall set precedent over any stated mounting height. All thermostats shall be labeled on the inside cover with the name of the controller and room location.

Temperature sensors in public areas ie. Corridors lobbies etc shall be installed at 84" AFF.

HUMIDITY SENSORS: These devices shall be 100% solid state, linear and temperature compensated with scaling 0-100% RH range with LED or LCD Display. Accuracy at 25°C from 10-80% RH* ±2%, operating Humidity Range 0 to 100% RH (non-condensing), Stability ±1% @ 20°C (68°F) annually, for two years, Hysteresis 1.5% typical, Temperature Effect ±0.1% RH/°C above or below 25°C (typical), 1% accuracy between 0% - 90% RH, Operating Temperature Range -40° to 50°C (-40° to 122°F) +/ - 1%.-Do not submit products that do not meet this range.

The output of the device shall utilize an analog output 4-20 mA, 2-wire, polarity insensitive, (clipped and capped), The device shall use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the
temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.

5. MISCELLANEOUS:

A. Software Programming: All software programs shall be programmed by this Contractor.

B. Installation of Mechanical Devices: Refer to Mechanical Division sections for installation of valve bodies, control wells and dampers; not work of this section.

6. ADJUSTMENT AND SERVICE:

A. After completion of the installation, the automatic temperature control manufacturer shall regulate and adjust all thermostats, control valves, motors, and other equipment provided under his contract and shall place them in complete operating condition, subject to approval by the Engineer and Owner.

B. This shall include but not be limited to “tuning” of all control systems. Systems shall be tuned for decaying wave response and minimal overshoot of setpoint. Contractor is to not leave any system in an Auto Tune mode.

C. Room temperature controls shall have one temperature setpoint with less than a 0.5˚F between calculated heating and cooling temperatures.

D. This Contractor shall work with Balancing Contractor to provide verification of CFM reading from the DDC terminal unit controllers.

E. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

F. After completion of installation, perform the following:

1. Installation.
   Check proper installation and connection of each control device.
   Verify electric power.
   Verify each sensor and actuator connection to field computer.

2. Field Computer Operation.
   Point Test.
   - check of wiring of each sensor and actuator end-to-end
   - verify calibration of each sensor.
   - verify manual operation of each actuator.

   Local loop control.
   - bring each local loop under control.
   - check response to upset, change in setpoint.
   - check full and partial load operation.

3. Supervisory functions.
   - verify time clock schedules.
   - verify reset control.
4. Verify communication with each field device.
   - perform end-to-end sensor and actuator checks.
   - verify that the database is correct.

5. Test other software.
   Trend Logging.
   Report Generation.
   Remote Access.
   System Documentation.

6. Verify proper operation of every control point in the presence of the Engineer.
   Include point-by-point checkout.

7. The control manufacturer shall provide a period of free service extending through one complete heating season and one complete cooling season, after acceptance of the control system, and shall report the condition of the control equipment to the Owner and the Architect.

PART 4 - SEQUENCE OF OPERATION:

A. Refer to the IC and Mechanical Drawings for the sequences of operation as well as necessary system components.

PART 5 - WARRANTY/DELIVERY/ STORAGE

1. Labor and Material Warranty - The Control System shall be free from defects in material and workmanship under normal use and service. If within twenty four (24) months from the date of ACCEPTED COMMISSIONING AND FUNCTIONING DATE - NOT SUBSTANTIAL COMPLETION DATE, any of the manufacturers equipment herein described is defective in operation, workmanship or materials, it will be replaced, repaired or adjusted by the TCC Contractor free of charge.

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.

3. Delivery, Storage and Handling - Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

PART 6 - SYSTEM START-UP AND ACCEPTANCE

1. Commissioning: This section specifies a system or a component of a system being commissioned as defined in Section 01 91 13 Commissioning. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Section 01 91 13 Commissioning for detailed commissioning requirements.

2. The CONTROL SYSTEM CHECKOUT AND TESTING - PRIOR TO COMMISSIONING
A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any of all startup testing.

- Calibrate and prepare for service each instrument, control, and accessory equipment furnished.
- Verify that control wiring is properly connected and free of shorts and ground faults.
- Enable control systems and verify each input device’s calibration. Calibrate each device according to manufacturer’s recommendations.
- Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, starters, operate properly and that normal positions are correct.
- Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
- Prepare a log documenting startup testing of each input and output device, with technician’s initials certifying each device has been tested and calibrated. Submit log to Engineer for review.
- Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
  - Alarms and Interlocks.
  - Check each alarm with an appropriate signal at a value that will trip the alarm.
  - Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
  - Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3. CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration: Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Control System Checkout and Testing. Provide Engineer with log documenting completion of startup tests. Refer to Section 230200 HVAC Equipment for other start-up requirements.

- Engineer will be present to observe and review system demonstration. Notify Engineer at least 14 days before system demonstration begins. Systems balancing shall be complete prior to demonstration, coordinate scheduling with TAB agency accordingly.
- Demonstrate actual field operation of each sequence of operation as specified in these specifications. Provide at least two persons to demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.
- Demonstrate complete operation of operator interface.
- Demonstrate all alarms, including external alarms to Owner selected pagers, phones, e-mail accounts, etc.
- Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
• Provide all required tools to perform demonstration (drills, duct plugs, thermometers, hygrometers, carbon dioxide sensors, smoke test aerosol smoke, 2-way radios, water probes, etc.)

B. Acceptance: After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor’s control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
• System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in these specifications. Warrantee will not start until acceptance by Owner, Engineer and Commissioning Agent if applicable.
• Upon completion of the installation, the Controls Contractor and a factory authorized representative shall start-up the system and perform all necessary testing and debugging operations. An acceptance test in the presence of the Owner’s representative shall be performed. The vendor shall check all sensors that exhibit any problems or faulty reading. When the system performance is deemed satisfactory in whole, the system parts will be accepted for beneficial use and placed under warranty.
• This Contractor shall work with the Owner, who is developing the graphics, to ensure that all point report, function and alarm as required on the BACnet head-in system. The Contractor will also work with the Project Manager or CNS/MCIS to obtain all necessary IP’s and Ethernet drops needed for BACnet panel. The Contractor shall contact UK Delta Room for BACnet instance number prior to connecting to existing BACnet network. No exceptions.

4. DELTA ROOM COMMISSIONING

A. PPD will be performing their own complete point by point evaluation as part of this project independently of the commissioning activity. This will occur during the warranty period of the project. The controls contractor shall be a part of this process and shall include in their bid to have a controls technician in the Delta Room to adjust and modify the control system as part of the point by point evaluation. Include 40 hours of technician time to be performed after 5:00 PM. This will be coordinated by the Delta Room.

PART 7 - BACnet Protocol Implementation Conformance Statement:

A. The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for their BACnet Interface with their shop drawings. The interface shall comply with the following as a minimum.

B. Vendor Name: Tridum, Inc.
Product Family: Niagara Framework, including N4Web Supervisor, JACE 6XX at Release 3.8 JACE 8XXX at release 4.6 or greater using the most current version of JAVA or HTML 5. All control work associated with this project must be fully compatible with this version of Tridium such that all alarms, points, etc. communicate and clear alarms seamlessly with the existing system.
C. Description: This product family provides bi-directional communication between Tridium Niagara Framework and a BACnet system operating at BACnet Conformance Class 3, over Ethernet media.

BACnet Protocols are documented in Appendices A, B & C.

D. REQUIRED SUBMITTALS:

The following chart is supplied for the benefit of the Owner, Architect, Engineer and contractor to assure a complete submission of required information. It is a reference listing of documents required by the Specifications under this Section. Refer to Specifications Section - General Provisions for the general requirements of submittals.

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<thead>
<tr>
<th>ITEM</th>
<th>SHOP DRAWING</th>
<th>M&amp;O MANUAL</th>
<th>PARTS LIST</th>
<th>WRITTEN DESCRIPTION</th>
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Print and Save Excel I/O Summary Sheet in Spec Directory (*Add general IO Point list*)
Appendix A – Vykon Niagara Compatibility Statement (NiCS)

**VYKON NiagaraAX Compatibility Statement (NiCS)**

Includes all VYKON branded JACE and Software Products

The following information describes Tridium’s VYKON branded NiagaraAX product licensing:

Tridium’s VYKON AX branded products utilize an open access licensing procedure. VYKON AX branded products can be connected to and managed by any Niagara based tools or systems without the need to modify the license. This means the end user does not have to authorize changes to a VYKON AX license for another systems integrator to gain access to the system. The end user does need to have the necessary user names and passwords installed by the original system integrator so they can be used by another Niagara trained system integrator.

The following is an explanation of the VYKON licensing schema:

**BrandID**

Every licensed station and tool has a Brand Identifier (BrandID). This field holds a text descriptor that the OEM chooses as the identifier for its product line. Each station or tool can have only one BrandID entry.

Tridium’s VYKON products have the following:

**BrandID = VYKON**

**Station Compatibility In**

This field is a list of brands that this local station will allow Niagara AX data to come in from. Simply stated from the point of view of a JACE, “this is the list of brands that can I accept data from.”

Tridium’s VYKON products contain:

Station Compatibility In = All (in the actual license ALL is defined by an “*)

Note: The compatibility fields can contain a single brand “ABC”, a list of multiple brands “ABC, XYZ”, no brand “None” or all brands “All”.

**Station Compatibility Out**

This field is a list of brands that this local station will allow Niagara AX data to be shared with. Simply stated: “This is the list of brands that I can share data with.”

Tridium’s VYKON products contain:

Station Compatibility Out = All
Tool Compatibility In
This field is a list of brands that this station will allow to be connected to it for engineering of its application. Simply stated, “This is the list of brands that I can engineer”. Tridium’s VYKON products contain:

Tool Compatibility In – All

Tool Compatibility Out
This field is a list of brands that this tool is allowed to connect to and engineer. Simply stated, “This is the list of brands that I can engineer”. Tridium’s VYKON products contain:

Tool Compatibility Out – All

As long as VYKON branded products are purchased by the end user any Tridium Certified (TCP) system integrator can provide support for the end user without the need for the owner to be involved in the licensing process. For more information on Niagara Connectivity and Security visit our website library at: http://www.vykon.com/cu/library/white_papers

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Suite 350
Richmond, VA 23233
804.777.4771
Appendix B – Tridium Niagara 3.8 BACnet PICS

TRIDIUM NIAGARA AX 3.8
BACnet PICS

BACnet Protocol Implementation Conformance Statement

Date: August 31, 2016
Vendor Name: Tridium
Product Name: Niagara AX BACnet Integration
Product Model Number: Tridium JACE models
Application Software Version: 3.8.112 or higher
Firmware Revision: 3.8.112.1 or higher
BACnet Protocol Revision: 7

Product Description:
Niagara AX provides the ability to view, monitor, and control BACnet devices over IP, raw Ethernet, or MS/TP media. Devices, points, schedules, alarms, and logs can be learned and managed from Niagara AX. In addition, Niagara points, schedules, histories, and alarming can be exposed to BACnet for monitor and control by foreign BACnet clients.

BACnet Standardized Device Profile (Aanen L):

- BACnet Advanced Operator Workstation (B-AWS)
- BACnet Operator Workstation (B-OWS)
- BACnet Operator Display (B-OD)
- BACnet Building Controller (B-BC)
- BACnet Advanced Application Controller (B-AAC)
- BACnet Application Specific Controller (B-ASC)
- BACnet Smart Sensor (B-SS)
- BACnet Smart Actuator (B-SA)
**Additional BACnet Interoperability Building Blocks Supported (Annex K):**

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Standard Object Types Supported:
- The CreateObject and DeleteObject services are not supported, so no objects are dynamically creatable or deletable through BACnet service requests, although these objects are dynamically creatable and deletable through Niagara.
- No general range restrictions exist, however, certain specific applications may have specific range restrictions.
- All potentially available properties are listed for each object type.
- Optional properties are listed in italics. Not all instances support all optional properties.
- Writable properties are listed in bold. Any range limitations are expressed in parentheses following the property name.

Notes from Table
1. The File_Size property of File objects is only writable if the underlying system file is changeable.
2. The Setpoint property of Loop objects is writable only if the setpoint is not linked from within Niagara.
3. The Recipient_List property of the Notification Class object will maintain entries that are internally configured within Niagara.
4. The List_Of_Object_Property_References property of the Schedule object will maintain entries that are internally configured within Niagara.
5. The Priority_For_Writing property of Schedule objects is not important for internal Niagara operation, as the priority at which a point is commanded is determined by the input to which the Schedule output is linked.
6. These Trend Log object properties are not writable if the backing history for the exported Trend Log is a Niagara-generated history. If the history is created as a BACnet Trend Log, then they are writable.
7. Trend Logs in Niagara use internal triggering and are either COV or Interval. So the Log_Interval property cannot be written from BACnet.
<table>
<thead>
<tr>
<th>Object Type</th>
<th>Properties</th>
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|                     |     | Notify_type  
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|                     | Status_Flags  
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|                     | Event_State  
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|                     | Polarity  
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BACnet PICS  
August 31, 2016
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| Multi-state input | Object-Identifier | Number_of_States |
|                  | Object_Name | State_Text |
|                  | Object_Type | Time_Delay |
|                  | Present_Value | Notification_Class |
|                  | Description | Alarm_Value |
|                  | Device_Type | Fault_Value |
|                  | Status_Flags | Event_Enable |
|                  | Event_State | Acked_Transitions |
|                  | Reliability | Notify_Type |
|                  | Out_of_Service | Event_Time_Stamp |

| Multi-state Output | Object-Identifier | State_Text |
|                   | Object_Name | Priority_Acency |
|                   | Object_Type | Relinquish_Default |
|                   | Present_Value | Time_Delay |
|                   | Description | Notification_Class |
|                   | Device_Type | Feedback_Value |
|                   | Status_Flags | Event_Enable |
|                   | Event_State | Acked_Transitions |
|                   | Reliability | Notify_Type |
|                   | Out_of_Service | Event_Time_Stamp |
|                   | Number_of_States |
## Object Type

### Multi-state Value
- **Object-Identifier**
- **Object_Name**
- **Object_Type**
- **Present_Value**
- **Description**
- **Status_Flags**
- **Event_State**
- **Reliability**
- **Out_Of_Service**
- **Number_Of_States**

### Notification Class
- **Object-Identifier**
- **Object_Name**
- **Object_Type**
- **Description**

### Schedule
- **Object-Identifier**
- **Object_Name**
- **Object_Type**
- **Description**
- **Effective_Period**
- **Weekly_Schedule**
- **Exception_Schedule**

### Trend Log
- **Object-Identifier**
- **Object_Name**
- **Object_Type**
- **Description**
- **Log_Enable**
- **Start_Time**
- **Stop_Time**
- **Log_DeviceObjectProperty**
- **Log_INTERVAL**
- **COV_RecursionInterval**
- **Client_COV_Increment**
- **Stop_When_Full**
- **Buffer_Size**

### Properties
- **State_Text**
- **Priority_Array**
- **Relinquish_Default**
- **Time_Delay**
- **Notification_Class**
- **Alarm_Values**
- **Fault_Values**
- **Event_Enable**
- **Acked_Transactions**
- **Notify_Type**
- **Event_Time_Stamps**
- **Notification_Class**
- **Priority**
- **Ack_Required**
- **Recipient_List**
- **Schedule_Default**
- **List_Of_Object_Property_References**
- **Priority_For_Writing**
- **Status_Flags**
- **Reliability**
- **Out_Of_Service**
- **Log_Buffer**
- **Record_Count**
- **Total_Record_Count**
- **Notification_Threshold**
- **Records_Since_Notification**
- **Last_Notify_Record**
- **Event_States**
- **Notification_Class**
- **Event_Enable**
- **Acked_Transactions**
- **Notify_Type**
- **Event_Time_Stamps**
Data Link Layer Options:

- BACnet IP, (Annex J)
- BACnet IP, (Annex J), Foreign Device
- ISO 8802-3, Ethernet (Clause 7)
- ANSI/ATA 878.1, 2.5 Mb, ARCNET (Clause 8)
- ANSI/ATA 878.1, RS-485 ARCNET (Clause 8), baud rate(s) __________
- MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400, 76800
- MS/TP slave (Clause 9), baud rate(s) __________
- Point-To-Point, EIA 232 (Clause 10), baud rate(s): __________
- Point-To-Point, modem (Clause 10), baud rate(s): __________
- LonTalk, (Clause 11), medium: __________
- Other: __________

Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☐ Yes  ☐ No

Networking Options:

- Router, Clause 6 – Routing configurations: Ethernet-IP, Ethernet-MS/TP, IP-MS/TP
- Annex H, BACnet Tunneling Router over IP
- BACnet/IP Broadcast Management Device (BBMD)
  Does the BBMD support registrations by Foreign Devices? ☐ Yes  ☐ No

Character Set: Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

- ANSI X3.4
- IBM®/Microsoft® DBCS
- ISO 8859-1
- ISO 10646 (UCS-2)
- ISO 10646 (UCS-4)
- JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:

This product supports communications between BACnet and any third-party system to which Niagara can connect. Contact Tridium for a list of supported protocols.

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BACnet PICS
BACnet Testing Laboratories
Product Listing

This product has been tested at a qualified BACnet Testing Laboratory and found to comply with all the necessary interoperability requirements in place on the published test date. This listing represents the tested capability of the Listed Product. For information on additional functionality that was not covered in the test process, refer to the Manufacturer's PICS statement on the BTL website.

### Listing Information

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<td>3951 Westmore Parkway, Suite 350</td>
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<td>Richmond, VA 22333 USA</td>
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### Device Profiles

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### BIBBs Supported

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### Instrumentation and Control for HVAC

#### Alarm and Event Management

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<td>Alarm and Event-Notification-A</td>
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<td>AE-ELVM-A</td>
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#### Scheduling

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<td>Scheduling-Advanced View and Modify-A</td>
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<td>Scheduling-Weekly Schedule-A</td>
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<td>Dynamic Object Binding-A</td>
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<td>Automatic Device Mapping-A</td>
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<td>Automatic Network Mapping-A</td>
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<td>Time Synchronization-A</td>
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<td>DCC-A</td>
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<td>ODCA-A</td>
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#### Object Type Support

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### Character Set Support

- ANSI X3.4
- ISO 10646 (UCS-2)