CAPITAL CONSTRUCTION

Invitation for Bid
CCK-2391-19, Project #2499.0
Bid Due Date- 3/14/2019
UK RB2 Phase 2
Subcontract 23A – Plumbing, HVAC & T&B
Rebid
1. INVITATION

Sealed proposals for the following work will be received by the University of Kentucky, Capital Construction Procurement Section, Room #322 Peterson Service Building, 411 South Limestone, Lexington, Kentucky 40506-0005, in the manner and on the date hereinafter specified for the furnishing of all labor, materials, supplies, tools, appliances, equipment, services, etc., necessary for the construction of Project #2499.0 – University of Kentucky Research Building #2 Phase 2, LEXINGTON, KENTUCKY, as set forth in the specifications and as shown on the drawings as prepared by Champlin Architecture, and approved by the Capital Construction Procurement Section and the Capital Project Management Division and under the terms and conditions of this Invitation.

This Invitation for Bids is for Subcontract No. 23A Plumbing, HVAC, & T&B.

Note: Controls and the Phoenix and Aircuity Equipment are being rebid as separate bids. In addition, included within the attached Addendum 5 is a Scope Matrix to clarify the responsibilities for the Phoenix and Aircuity Systems.

2. PROJECT DESCRIPTION

The University of Kentucky received bids for Invitation for Bid CCK-2376-19 on 02/06/2019. The bids submitted pursuant to competitive sealed bidding under KRS45A.080 result in bid price in excess of the funds available for the purchases. The University of Kentucky project team determined that it is in the best interest of the project to issue this solicitation under revised specifications and scope of services, as defined in the attached Addendum No. 5 and the revised Form of Proposal.

In addition, the documents contained in the Bid Package Manual and Invitation for Bid IFB CCK-2376-19, are incorporated herein by reference including:

Addendum No. 1 – Dated 01/17/19
Addendum No. 2 – Dated 01/23/19
Addendum No. 3 – Dated 01/23/19
Addendum No. 4 – Dated 01/31/19

• Revised Form of Proposal – Subcontract 23A – Plumbing, HVAC & T & B - Rebid

Note: The successful bidder will enter into a subcontract agreement with The Whiting-Turner Contracting Company. The form of contract is included with the bid documents and will be executed without exceptions. There will be no direct contractual relationship between the successful bidder and the University of Kentucky.
3. **METHOD OF RECEIVING BIDS**

Bids will be received from Prime Contractors on a Lump Sum Amount for the total project. All phases of the work shall be bid to and through the Prime Contractors. Bids shall be submitted for Subcontract 23A in response to UK RB2 Phase 2 Bid CCK-2291-19, Plumbing, HVAC & T&B in the manner herein described above and on the official proposal form included with the conditions and specifications and shall be subject to all the conditions as set forth and described in the Bid Documents.

Bids shall be submitted only on the Official Forms supplied by the University of Kentucky, Capital Construction Procurement Section. Failure to comply with the foregoing requirements will be cause for invalidation of bid.

4. **METHOD OF AWARD**

Final award of Contract will be made on the basis of the lowest, responsive and responsible bid which offers the best value. The Whiting-Turner Contracting Company will execute all trade contracts.

5. **SCHEDULE OF PROJECT**

The time for completion as further defined in UK Research Building 2 Phase 2 (Bid Schedule) and shall be substantially completed in accordance with the project schedule contained in the project manual with final completion being thirty (30) days thereafter.

6. **BONDING**

A. All bids shall be accompanied by a bid guarantee of not less than five (5%) percent of the amount of the base bid. All Bid Bonds shall be made out to The University of Kentucky. If a Bid Bond was included in response to previous IFB, there is no need to submit another one.

7. **Offeror Communication**

To insure that IFB documentation and subsequent information (modifications, clarifications, addendum, etc.) is directed to the appropriate person’s communication with the University regarding this IFB shall only be directed to the University Purchasing Officer listed below:

- Mr. Mike Mudd.
  Purchasing Division
  University of Kentucky
  322 Peterson Service Building
  Lexington, KY  40506-0005
  Phone: (859) 257-5409
  Fax: (859) 257-1951
  E-mail: MikeMudd2@uky.edu and/or sbowlin@uky.edu
8. **OBTAINING PLANS AND SPECIFICATIONS**

To obtain a set of Plans and Documents, if required, please contact the above person who will make arrangements for Lynn Imaging to perform the duplicating and distribution services for this bid package.

In addition, key documents for this bid are available at the University of Kentucky Purchasing Web Site at the following URL: [http://www.uky.edu/Purchasing/](http://www.uky.edu/Purchasing/).

9. **BID SUBMITTAL**

Contractors must submit their bid in a sealed envelope to the University of Kentucky, Capital Construction Procurement, Room 322 Service Building, 411 South Limestone, Lexington, KY 40506-0005 and the envelope must contain the following information on the outside lower left-hand corner:

- **SEALED BID INVITATION NO.** CCK-2391-19
- **UKRB2 – Phase 2**
- **Description:** Subcontract 23A – Piping, HVAC & T&B
- **BID DATE** March 14th, 2019 at 3:00 P.M. LEXINGTON TIME

Bids, upon their receipt by the University of Kentucky, Capital Construction Procurement Section are stamped showing the hour and date received. Bids received after the scheduled closing time for reception of bids will not be considered provided legal and accepted bids have been received on said referenced Invitation.

10. **BID WITHDRAWAL**

No bidder may withdraw his bid for a period of sixty (60) days after the date set for the opening of bids. Clerical errors and omissions in the computation of the lump sum shall not be cause for withdrawal of the bid without forfeiture of bid bond. Bids may be withdrawn in person only, prior to the closing date for receipt of bids.

11. **MINORITY BUSINESS ENTERPRISE PARTICIPATION**

The University of Kentucky is committed to increasing the participation of minority business enterprises in construction and renovation projects, and encourages the use of minority subcontractors and material suppliers. All contractors should make an effort to locate and use minority business enterprises in bidding this project. For assistance in identifying minority vendors and subcontractors, the contractors may contact: The Kentucky Procurement Assistance Program, 500 Mero Street, 23rd Floor, Frankfort, Kentucky 40601, 800.838.3266, email address CED.kpap@ky.gov, and/or The Office of
Bidders using minority enterprises as subcontractors and material suppliers are requested to identify these contractors in the space provided on the Form of Proposal. The successful contractor will be asked to supply associated contract amounts rounded to the nearest $500.00 prior to the signing of a contract.

12. **RIGHT TO REJECT**

The University of Kentucky, Capital Construction Procurement Section, reserves the right to reject any and all bids and to waive all formalities and/or technicalities where the best interest of the University may be served.

13. **GENERAL INFORMATION**

A. The Listing of major subcontractors, unit prices, and material lists are to be submitted with the bid.

B. Documents from Lynn Imaging or a Form of Proposal directly from the University of Kentucky Purchasing Representative will be eligible to submit a bid for this project.

14. **PRE- BID CONFERENCE**

There will not be a Pre-Bid Conference for this solicitation

15. **WRITTEN QUESTIONS**

Anyone wishing to discuss specific items is requested to submit the items in writing to Mike Mudd, Capital Construction Procurement, no later than March 6, 2019. Written questions can be submitted by email to Mike Mudd at MikeMudd2@uky.edu and/or sbowlin@uky.edu.

16. **POST BID MEETING**

The apparent low bidder will be requested to meet with the Construction Manager, The Whiting-Turner Contracting Company, and the University to review the bid and scope of services. The time and place of this meeting will be announced at the bid opening.

**Signed:** Mike Mudd  
Procurement Officer
INVITATION FOR BIDS: CCK-2391-19
RESEARCH BUILDING #2 – PHASE 2:
CCK-2391-19, Project #2499.0
Bid Due Date- 3/14/2019
UK RB2 Phase 2
Subcontract 23A – Plumbing, HVAC & T&B
ADDENDUM # 5 Rebid 23A
March 1st, 2019

ATTENTION: This is not an order. Read all instructions, terms and conditions carefully.

IMPORTANT:
BID AND ADDENDUM MUST BE RECEIVED BY: 03/14/2019 @ 3:00 P.M. LEXINGTON, KY TIME.

Bidder must acknowledge receipt of this and any addendum as stated in the Invitation for Bids.

Bidders shall conform to the following clarifications, corrections and changes, as same shall become binding on the Contract to be issued in response to this Invitation for Bids. Bidders must acknowledge receipt of this Addendum in the space provided on the Form of Proposal. Failure to do so may subject Bidder to disqualification.

1. **Clarification to Subcontract Work Category 23A:** Please note that the bid date has been changed to March 14, 2019 for Work Category 23A at 3:00PM.

2. **Please refer to and incorporate into the Offer the Attached Addendum #05 from Champlin Architecture dated 2/28/2019, pages 1 through 54.**

3. **In addition, refer to and incorporate into the Offer the Revised Form of Proposal for Subcontract 23A Plumbing, HVAC and T&B from The Whiting –Turner Contracting Company, pages 1 through 17.**

**OFFICIAL APPROVAL**

**UNIVERSITY OF KENTUCKY**

Mike Mudd / (859) 257-5409

**SIGNATURE**

Typed or Printed Name

Attachments:

1. Addendum #5 Drawings & Specifications
2. Revised WC 23A- Plumbing, Mechanical, & T&B Bid Form.

End of Addendum #5
UNIVERSITY OF KENTUCKY – RESEARCH BUILDING #2
UK Project No. 2499.0

UNIVERSITY OF KENTUCKY
CAPITAL CONSTRUCTION PROCUREMENT SECTION
FORM OF PROPOSAL
RESEARCH BUILDING #2 - PHASE 2

Subcontract 23A – Plumbing, HVAC, & T&B - Rebid

Project No. 2499.0  Project Title: RESEARCH BUILDING #2 - PH2
Purchasing Officer: Mike Mudd

NOTE: The following Form of Proposal shall be followed exactly in submitting a proposal for this work. If this copy is lost, an additional copy will be furnished upon written request to the authority issuing Contract Documents.

This Proposal is submitted by:
(Name and Address of Bidder)

Date: ____________________________

Telephone: ________________________

TO: BID CLERK
UNIVERSITY OF KENTUCKY
CAPITAL CONSTRUCTION PROCUREMENT
RM. 322 SERVICE BUILDING
411 SOUTH LIMESTONE
LEXINGTON, KY 40506-0005

INVITATION TO BID: CCK-2391-19
BID OPENING DATES: March 14, 2019
TRADE CONTRACT DESCRIPTION: Plumbing, HVAC, & T&B Rebid
TRADE CONTRACT NO.: 23A
TIME: 3:00 P.M. E.D.T.

The Bidder, in compliance with your Invitation for Bids for the above referenced Project, having carefully examined the site of the Work, the Drawings and complete Contract Documents as defined in Article I of the General Conditions, as well as the Specifications affecting the work as prepared by the Consultant, hereby proposes to furnish all labor, materials, supplies and services required to construct the Project in accordance with the Contract Documents, within the time set forth therein, and at the price stated below without qualification.

The Bidder hereby acknowledges receipt of the following Addenda:

ADDENDUM NO. __________________ DATED __________________
ADDENDUM NO. __________________ DATED __________________
ADDENDUM NO. __________________ DATED __________________
ADDENDUM NO. __________________ DATED __________________
ADDENDUM NO. __________________ DATED __________________

(Insert the number and date of any Addenda issued and received. If none has been issued and received, the word NONE should be inserted.)
FORM OF PROPOSAL

AUTHENTICATION OF BID AND STATEMENT OF NON-COLLUSION AND NON-CONFLICT OF INTEREST

I hereby certify:

1. That I am the Bidder (if the Bidder is an individual), a partner in the Bidder (if the Bidder is a partnership), or an officer or employee of the bidding corporation having authority to sign on its behalf (if the Bidder is a corporation);

2. That the submitted Bid or Bids covering Capital Construction Procurement Section Invitation No. CCK-2391-19 have been arrived at by the Bidder independently and have been submitted without collusion with, and without any agreement, understanding or planned common course of action with, any other contractor, vendor of materials, supplies, equipment or services described in the Invitation to Bid, designed to limit independent bidding or competition; as prohibited by provision KRS 45A.325;

3. That the contents of the Bid or Bids have not been communicated by the Bidder or its employees or agents to any person not an employee or agent of the Bidder or its surety on any bond furnished with the Bid or Bids and will not be communicated to any such person prior to the official opening of the Bid or Bids;

4. That the Bidder is legally entitled to enter into the contracts with the University of Kentucky and is not in violation of any prohibited conflict of interest, including those prohibited by the provisions of KRS 164.390, and 45A.330 to 45A.340 and 45A.455;

5. This offer is good for 60 calendar days from the date this Bid is opened. In submitting the above, it is expressly agreed that upon proper acceptance by the Capital Construction Procurement Section of any or all items Bid above, a contract shall thereby be created with respect to the items accepted;

6. That I have fully informed myself regarding and affirm the accuracy of all statements made in this Form of Proposal including Bid Amount.

7. Unless otherwise exempted by KRS 45.590, the Bidder intends to comply in full with all requirements of the Kentucky Civil Rights Act and to submit data required by the Kentucky Equal Employment Act upon being designated the successful contractor.

8. That the bidding contractor and all subcontractors to be employed do not and will not maintain any facilities they provide for employees in a segregated manner and they are in full compliance with provisions of 41 CFR 60-1.8 that prohibits the maintaining of segregated facilities.

9. In accordance with KRS 45A.110(2), the undersigned hereby swears under penalty of perjury that he/she has not knowingly violated any provision of the campaign finance laws of the Commonwealth of Kentucky and that the award of a contract to the bidder will not violate any provision of the campaign finance laws of the Commonwealth of Kentucky.

READ CAREFULLY - SIGN IN SPACE BELOW – FAILURE TO SIGN INVALIDATES BID

SIGNED BY _______________________________ TITLE _______________________________

PRINT NAME _______________________________ FIRM _______________________________

ADDRESS _______________________________ PHONE ( ) _______________________________

CITY ___________________ STATE ___________ ZIP CODE ___________________

FAX ( ) _______________________________ DATE _______________________________

Work Category – 23A Page 2 of 17
Contractor Report of Prior Violations of
Chapters 136, 139, 141, 337, 338, 341, and 342

Pursuant to KRS 45A.485, the Contractor shall, prior to the award of a Contract, reveal
final determinations of any violations of the provisions of KRS Chapters 136, 139, 141,
337, 338, 341, and 342 by the Contractor that have occurred in the previous five (5)
year period.

This statute also requires for the duration of the Contract established, the Contractor be
in continuous compliance with the provisions of Chapters 136, 139, 141, 337, 338, 341,
and 342 that apply to the Contractor’s operations. The Contractor’s failure to reveal a
final determination of a violation of KRS Chapters 136, 139, 141, 337, 338, 341, and
342, or failure to comply with any of the above cited statutes for the duration of the
Contract shall be grounds for the cancellation of the Contract, and the disqualification
from eligibility for future contracts for a period of two (2) years.

The Contractor, by signing and submitting a Bid on this Invitation, agrees as required by
KRS 45A.485 to submit final determinations of any violations of the provisions of KRS
Chapters 136, 139, 141, 337, 338, 341, and 342 that have occurred in the previous five
(5) years prior to the award of a Contract and agrees to remain in continuous
compliance with the provisions of these statutes during the duration of any contract that
may be established. Final determinations of any violations of these statutes, must be
provided to the University by the successful Contractor prior to the award of a Contract.
LUMP SUM PROPOSAL

The Bidder, in compliance with the Invitation to Bid CCK-2391-19 having examined the drawings, specifications, related documents and having visited the site of the proposed work, and being familiar with all the conditions surrounding the construction of the proposed project including the availability of materials and labor, hereby submits the following bid to furnish all labor, materials, and supplies and to construct the project in accordance with the Bid Documents within the time set forth therein and at the prices stated below. These prices are to cover all expenses incurred in performing the work required under the Contract Documents, of which this Bid is a part.

The Bidder agrees to furnish all labor, materials, supplies and services required to complete the Work, for the above referenced Project, for the Capital Construction Procurement Section, University of Kentucky, as described in the Specifications and Contract Documents and shown on the Drawings enumerated below and as modified by the Addenda listed above.

Bidder hereby agrees that all escalation cost associated with materials and/or labor have been included in the stated unit cost, through the projected duration dates as stated in the preliminary project construction schedule.

FOR THE LUMP SUM OF __________________________ (USE WORDS)

_________________________ DOLLARS AND ___________________ CENTS. (USE WORDS)

($____________________) (USE FIGURES)

BID ALTERNATES

None
BUSINESS CLASSIFICATION

Please complete this form which is necessary for the University of Kentucky vendor database. Mark only one classification. Refer to "Definitions" for assistance in determining correct classification.

(01) ___ Small Business    (06) ___ Woman-Owned Large Business

(02) ___ Large Business    (07) ___ Disadvantaged Woman-Owned Small Business

(03) ___ Disadvantaged Small Business

(04) ___ Disadvantaged Large Business

(05) ___ Woman-Owned Small Business

(07) ___ Disadvantaged Woman-Owned Large Business

(08) ___ Disadvantaged Woman-Owned Large Business

(09) ___ Other

DEFINITIONS

(01) SMALL BUSINESS: A business concern that is organized for profit, is independently owned and operated, is not dominant in the field of operations in which it is bidding and meets the size standards as prescribed in the Code of Federal Regulations, Title 13, Part 121. Consult your local or district Small Business Administration (SBA) office if further clarification is needed.

(02) LARGE BUSINESS: A business concern that exceeds the small business size code standards established by SBA.

(03) DISADVANTAGED SMALL BUSINESS: A business concern (a) that is at least 51 percent owned by one or more socially and economically disadvantaged individuals (as defined below), or a publicly owned business, having at least 51 percent of its stock owned by one or more socially and economically disadvantaged individuals; and (b) has its management and daily business operations controlled by one or more such individuals. Socially and economically disadvantaged individuals include Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans and other minorities or individuals found to be disadvantaged by the SBA.

(04) DISADVANTAGED LARGE BUSINESS: A concern that meets the definition of socially and economically disadvantaged individuals, but which is not a small business by the SBA's size standards.

(05) WOMAN-OWNED SMALL BUSINESS: A small business that is at least 51 percent owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" means actively involved in the day to day management.

(06) WOMAN-OWNED LARGE BUSINESS: A concern that meets the definition of woman owned and operated, but which is not a small business by the SBA's standards.

(07) DISADVANTAGED, WOMAN-OWNED SMALL BUSINESS: A concern that meets the definition of both (03) and (05) above.

(08) DISADVANTAGED, WOMAN OWNED LARGE BUSINESS: A concern that meets the definition of both (04) and (06) above.

(09) OTHER: A concern that does not meet any of the above definitions.
THE FOLLOWING ITEMS ARE HEREWITH ENCLOSED AS REQUIRED BY KRS 45A.185

1. Bid Bond or Certified Check in an amount not less than five percent (5%) of total Bid.

2. List of Proposed Subcontractors and Unit Prices. (if required)

3. Authentication of Bid and Statement of Non-Collusion and Non-Conflict of Interest.

4. List of Materials and Equipment.

5. VENDOR NUMBER: It is imperative that you furnish your Federal Employer Identification Number in the space provided below. Failure to do so may delay the processing of purchase orders issued to your firm.

(Nine Digit Number)

BIDDER'S QUALIFICATIONS

The Commonwealth of Kentucky Model Procurement Code (KRS 45A.080) requires contracts to be awarded, "to the responsive and responsible bidder whose bid offers the best value" to the University of Kentucky. In order to determine if the Bidder has the experience, qualifications, resources and necessary attributes to provide the quality workmanship, materials and management required by the plans and specifications, the Bidder may be required to complete and submit the information requested on the University of Kentucky Contractor Bidder Determination of Responsibility questionnaire. Failure to provide the information requested on the questionnaire or failure to provide any additional submittals or information that may be requested to make this determination may be grounds for a declaration of non-responsibility with respect to the Bidder. A copy of the Contractor Determination of Responsibility questionnaire is available upon request to all Bidders.

TIME LIMIT FOR EXECUTION OF CONTRACT DOCUMENTS

It is further agreed, that in the event this Proposal is accepted by the Owner and the undersigned shall fail to execute the Contract and furnish satisfactory Payment and Performance Bond within ten (10) consecutive calendar days from the date of notification of the award of the Contract, the Owner may at his option, determine that the undersigned has abandoned the Contract and thereupon, the Proposal shall become null and void and the Bid guarantee, check or Bid bond which accompanied it shall be forfeited and become the property of the Owner as liquidated damages for each failure and no protest pursuant to such action will be made. If the Undersigned shall execute the Contract, and furnish satisfactory Payment Bond and Performance Bond, it is understood that the Bid Guarantee or Bid Bond will be returned to the undersigned by the Owner.
UNIT PRICES

NOTE: Unit Prices shall include the furnishing of all labor, materials, supplies and services and shall include all items of cost, overhead and profit for the Contractor and any subcontractor involved, and shall be used uniformly without modifications for either additions or deductions. The Unit Prices as established shall be used to determine the equitable adjustment of the Contract Price in connection with changes, deletions or extra work performed under the Contract and the "Rules of Measurement" set forth in the General Conditions shall govern.

All Bidders are required to complete and submit the following information with their bid.

The apparent low bidder is requested to attend a post bid meeting which will be scheduled at a later date.

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<th>ITEM</th>
<th>UNIT</th>
<th>COST PER UNIT</th>
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<td>Journeyman</td>
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<td>Foreman</td>
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PRIMARY LIST OF PROPOSED SUBCONTRACTORS

All subcontractors are subject to the approval of the Capital Construction Procurement Section and Capital Project Management Division, University of Kentucky, Lexington, KY.

If certain branches of the Work are to be done by the Prime Contractor, so state.

_The apparent low bidder will be required to complete and submit to the University the following information by twelve (12) noon of the first working day following the bid opening. The information requested in this submittal is required to assist the University in determining contractor responsibility to complete the project being bid._

_The apparent low bidder is requested to attend a post bid meeting which will be scheduled at a later date._

Provide the address, phone number and contact information for the following subcontractor/suppliers:

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<tr>
<th>DIVISION OF WORK</th>
<th>NAME AND ADDRESS OF SUBCONTRACTOR</th>
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LIST OF MATERIALS AND EQUIPMENT

Each item listed under the different phases of construction must be clearly identified so that the Owner will know what the Bidder proposes to furnish.

The use of a manufacturer's or dealer's name only, or stating "as per Plans and Specifications," will not be considered as sufficient identification.

Where more than one "Make" or "Brand" is listed for any one item, the Owner has the right to select the one to be used.

*The apparent low bidder will be required to complete and submit to the University the following information by twelve (12) noon of the first working day following the bid opening. The information requested in this submittal is required to assist the University in determining contractor responsibility to complete the project being bid.*

*The apparent low bidder is requested to attend a post bid meeting which will be scheduled at a later date.*

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<th>ITEM DESCRIPTION</th>
<th>MANUFACTURER/SUPPLIER</th>
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IDENTIFICATION OF MINORITY SUBCONTRACTORS AND MATERIAL SUPPLIERS

Participation of Minority and Women owned Contractors and businesses.

The University of Kentucky encourages and supports the participation of minority and women owned businesses.

1. Minority and Women Subcontractors

2. Minority and Women Material Suppliers

SUPERINTENDENT

In accordance with Article 17 of the General Conditions a full-time superintendent will be required on this project. Below, please list the superintendent your firm will employ on this project. The successful Bidder will be required to furnish a resume of the superintendents’ qualifications and or past projects.

List the Superintendent’s Name

Revised 3/22/06
TRADE CONTRACT – 23A – Plumbing, HVAC, & T&B

This section defines in summary, without limitations by the descriptions, significant items of the scope of work to be performed by the Subcontractor and any special provision related to the Subcontractor’s execution of the Work and the Project. The details of the scope of work are further defined in Drawings, Specifications, and other provisions contained in the Project Documents.

The work covered under this Contract includes but is not limited to the following specific work items:

**Unit 23 – Plumbing, HVAC, & T&B**

The work covered under this Contract includes but is not limited to the following specific work items:

This work shall include all items indicated in Section A: General Scope of Work, as such items apply to this work unless specifically noted otherwise herein.

This work primarily includes, but is not limited to the following specification sections as well as related work specified or shown elsewhere in the Contract Documents:

- Plumbing, HVAC, Controls, and Testing and Balancing as specified in contract documents

***Note: This Subcontractor is responsible for the requirements of the complete Contract Documents as they pertain to this Unit of Work.***

1. **Scope of Work** – It is the intent for this project that this Subcontractor perform all work scoped herein and as specified in the Project Manual and Contract Drawings. This subcontract includes the Mechanical, Plumbing, and Testing and Balancing of all systems for the RB2 Phase 2 project, including engineering, testing and modifications required to existing active systems. Coordinate Fit Out with Core and Shell drawings and installation.

2. **Building Information Modeling (BIM)** – Coordination shall be 3-D VDC, based on the Construction Manager BIM Implementation Plan. Lay out work using 3-D surveying technology (Trimble or other). 23A shall provide 3D scans of the Lower Level, Level 4 and Level 5 and use as a background model for coordination. 23A is responsible for creating a 3D model form the scans data and converting it to a file type compatible with Naviworks. 23A shall be the gatekeeper of all 3D coordination. 23A is responsible for drawing out all access zones for FSD’s & Valves at shafts. Refer to BIM Implementation Plan for details.

3. **Laser Scanning** – This Subcontractor will laser scan the Level 4, 5, and Basement Vivarium shell spaces and convert it to a 3D model to be used as the baseline for all previously installed MEP systems. This model will be the base line for 3D coordination in these spaces and will be completed immediately after execution of Subcontract.

4. **PlanGrid License** – This Subcontractor has included the necessary license(s) to PlanGrid for their office and field staff for field reference and notifications. Please note that drawings posted on PlanGrid do not supersede the Contract Documents and should only be used for reference and notifications. All submittals, RFIs, and installation work should conform to the Contract Documents.

5. **BBSRB Tie-in** – This project includes connection to the existing BBSRB building at four levels. This Subcontractor shall carry an allowance of $10,000 for plumbing work associated with these tie-ins, including but not limited to exploratory work to determine isolation points, coordination of shutdowns, draining and demolition of sprinkler system, piping, relocation of fixtures, testing, and any other work associated with interface between existing Plumbing system and RB2. Any unused funds of the allowance will be returned to UK via deductive change order.
6. **Sleeves** – Furnish and set plumbing sleeves in concrete, masonry and drywall walls. Furnish wall sleeves for installation into walls by masonry contractor or drywall contractor. Provide shop drawings to installing contractor identifying height and locations of wall sleeves.

7. Provide cutting and patching, saw cutting and core drilling for any penetrations required for this scope of work. No core drilling will take place without the Structural Engineer's written approval.

8. Provide drawings showing all required in-wall blocking. Blocking to be provided by others. If blocking is not indicated in drawings and missed, this Subcontractor will be responsible for its installation.

9. **Access Doors** – Furnish all access doors required for access to plumbing and HVAC systems. Access doors to be installed by others.

10. **Fire Stopping** – Provide fire stopping at all plumbing and HVAC penetrations in floors, ceilings, and walls.

11. **Caulking and Sealing** – Provide caulking for all piping installed in this subcontract. Coordinate with Division 13A for sealing of Plumbing penetrations into Environmental Rooms. Subcontractor shall seal all penetrations where fire protection piping penetrates interior or exterior partitions. Subcontractor shall seal all penetrations where HVAC piping, ductwork and equipment penetrates interior or exterior partitions. Ensure that all penetrations through exterior walls to receive waterproofing have been properly sealed according to the requirements of the Contract Documents and manufacturer’s recommendations before waterproofing is installed.

12. **Patching of Fire Proofing** – This Subcontractor is responsible for removal and patching back of all fire proofing related to completing this Subcontract’s scope of work. This includes, but is not limited to, all removal, primers, patching, fire proofing materials, mixing, access, lifts, inspections, protection, cleanup, etc. necessary to patch back fire proofing as it relates to this Subcontractor’s work. This Subcontractor is responsible for cleaning up any and all adjacent surfaces where patching is dropped or sprayed. This Subcontractor will patch any fireproofing inadvertently removed or flaked off due to this Subcontractor’s work. This Subcontract will coordinate with the Construction Manager to confirm the proper fire proofing material and density is used at the proper locations and installed to the proper thicknesses.

13. **Fire Proofing Allowance** – This Subcontractor has included a patching allowance of $15,000 to be used at the discretion of the Construction Manager. This allowance is over and above the patching this Subcontractor has already included per the previous Patching of Fire Proofing requirement. This allowance will not be used without the express written consent of the Construction Manager. Any and all unused portions of this allowance will be returned, at any time, as directed by the Construction Manager.

14. **Protection** – This Subcontractor shall be responsible for identification and protection of all work that will remain exposed after installation. Costs to repair or replace inadequately protected work that becomes damaged shall be borne by this Subcontractor.

15. **Roof Patching** - Provide equipment curbs, roofing, roof patching, and sealants required for plumbing and HVAC penetrations through the roof. Include all supports, angles, clips, all thread, bolts and connections to support and mount new work.

16. This Subcontractor has included the Vivarium trench drain grates. This Subcontractor will coordinate with the General Requirements Subcontractor to confirm dimensions and layout, including squareness, prior to pouring the trench drains. This Subcontractor has also included chipping and adjusting of piping to fit within the trench drain.

17. Furnish and install supplemental steel for HVAC equipment, ductwork and piping per contract documents for this scope of work. Prime paint all steel supports installed for this scope of work. Provide openings in mechanical corridor grating as needed for mechanical penetrations and provide additional reinforcing. Provide engineering and calculations for additional reinforcing. Provide coating on added steel to match existing grating, and patch and repair coatings on steel modified by this Subcontractor.
18. Provide extended warranties for period of temporary use of equipment during construction. Provide maintenance of all equipment used during the temporary power and heating periods according to manufacturer’s recommendations. Maintain a log of all maintenance performed through the temporary construction period until substantial completion. Submit a sample log to The Construction Manager for approval before the start of temporary use.

19. This Subcontractor will provide temporary duct detectors for the temp use of the units, as necessary to provide adequate coverage. Duct detector shall be interlocked to the AHU and shut off AHU in case of smoke detection in the duct.

20. Furnish and install labels and signage which meet contract documents along with the governing code for plumbing, HVAC, and Mechanical Systems.

21. Furnish and install all insulation and jacketing required by specification, drawings and governing energy codes for this scope of work.

22. Subcontractor shall be responsible for flushing, cleaning and certification of plumbing systems as required by contract documents and codes. This Subcontractor shall be responsible for final testing, cleaning and certification of RO and acid waste systems, including piping installed under core and shell contract.

23. Subcontractor shall be responsible for flushing, cleaning and certification of HVAC piping and duct systems as required by contract documents and codes. If any ductwork installed under Core and Shell scope is dirtied through the actions of this Subcontractor, this Subcontractor shall be responsible for cleaning of entire duct system.

24. Subcontractor is responsible for Coordination of HVAC, Plumbing, and electrical Contractor for interface between these systems and Building Automation System.

25. Coordinate with the Electrical Subcontractor the locations and requirements of power feeds and/or receptacles needed for all equipment provided by this scope of work. Provide electrical interconnect wiring for plumbing equipment to provide a single point electrical connection.

26. Coordinate any and all shut downs or tie-in work with The Construction Manager and the Owner's Representative 2 weeks prior to performing this work.

27. **Material Hoist** – Provide $250,000 allowance for material hoist design, set up, testing, inspection, foundation, rental, maintenance, teardown, and labor for operators. Hoist shall be a single carriage type. Provide 16’x8’ single carriage material hoist, including installation, maintenance and teardown. Include all costs for rental and inspections. Hoist to include minimum 12’ x 5’ car with speed of at least 120 fpm. Coordinate hoist location with The Construction Manager. This Subcontractor shall size and provide concrete foundation for hoist and provide removal of foundation when lift is removed. Provide 1 fulltime operators for hoist. Coordinate power and disconnect with Division 26. Assume that hoist will remain in place for 12 to 14 months. Submit pricing, invoices and backup for all costs related to hoist allowance to The Construction Manager before issuing a purchase order. Any credit for unused funds if lift is removed before 12 to 14 months have elapsed will be returned to the Owner.

28. **Lower Level** – Plumbing piping in basement mechanical rooms including branch piping was installed in a previous bid package. This Subcontractor shall furnish and install main and branch piping serving fit out areas. Provide gas piping and manifolds. This Subcontractor shall be responsible for installing gas outlets, to be furnished by Division 12A. Provide all testing, cleaning and certification of gas piping.

29. **Fit Out Plumbing** – Plumbing risers for all floors were installed in a previous Phase. Provide plumbing in walls, overhead and drops to future equipment. Coordinate with plumbing piping and equipment installed in core and shell bid package. Provide lab gas branch piping and install outlets provided by Division 12A. This Subcontractor shall be responsible for testing, purging and certification of complete lab gas piping, including
piping installed under Core and Shell contract. Provide balancing valves on hot water recirc mains. Subcontractor is responsible for any reconfiguration of existing rain leader piping for phase II architectural fit out and MEP overhead fit out.

30. **Fixtures** – Furnish and install all plumbing fixtures excepting fixtures in lab furniture. Casework faucets and tailpieces furnished by others. Install all plumbing fixtures in lab furniture furnished by others, coordinate with Division 12A. Furnish and install connections at ceiling service panels, hoses. Provide trap primers and other specialties indicated on fit out drawings. Furnish electronic faucet and flush valves and turn over to Division 26C for installation.

31. **Elevators** – This Subcontractor is required to expedite all items related to the Elevator scope. This includes but is not limited to all Submittals, Shop Drawings, Product Data, Material and Labor by March 30th, 2019. This Subcontractor shall provide and install all Elevator sump pumps for Phase 2 fit-out. Power will be provided by 26A.

32. **Spline Sump Pump** – This Subcontractor has included the sump pumps indicated in the spline manholes adjacent to South Limestone. This includes, but is not limited to, all piping, conduit, pumps, brackets, fasteners, sealants, floats, levels, power cabling, power terminations, controls, controls terminations, etc. necessary for a complete system. Discharge line and power conduit have been run to the manhole by others.

**HVAC**

33. **HVAC Equipment** – This Subcontractor shall provide HVAC equipment including but not limited to:
   a. Exhaust Fans
   b. Volume/balancing Dampers
   c. AHU smoke/isolation dampers
   d. Heat Recovery System including coils for AHU-2/4/7/8 – Coordinate coil delivery to AHU manufacturers
   e. Evaporative Cooling System
   f. Humidifiers
   g. Duct Mounted Coils
   h. Air Terminal Devices
   i. Chilled Beams
   j. Radiant Ceiling Panels
   k. Fintube Radiant Heating
   l. Filters
   m. Equipment should be purchased in packaged assemblies with all components pre-wired and plumbed where possible. Equipment assemblies should be fully functional from the factory where possible
   n. Provide startup for all equipment provided under this scope of work. Provide multiple mobilizations as required for each system.
   o. **Furnish and install VFD’s for all HVAC equipment. (Including AHUs furnished by others.) Connection and wiring will be by 26A coordinate installation with 26A.**

34. **Responsibility Matrix** – This Subcontractor has reviewed and understands the Responsibility Matrix, included in the Contract Documents. This Subcontractor will provide, receive, install, test, etc. as noted and indicated.

35. The following equipment shall be furnished by others and installed by this Subcontractor including but not limited to hoisting, unloading, inventory, storing and protection:
   a. Air Handling Units
   b. Venturi Air Terminal Devices
   c. Control Valves

36. **AHU Handling** – This Subcontractor shall receive, unload, store, hoist, set and assemble all air handling units including any required field welding. This Subcontractor shall coordinate with and provide support for AHU manufacturer for startup and field testing of AHU’s/EAHU’s. Provide duct and piping connections, startup and maintenance of AHU’s/EAHU’s during temporary use. Also coordinate the Konvekta and Meefog coils with
the AHU manufacturer for offsite installation. Subcontractor is responsible for the full coordination and planning with Konvekta for the reconfiguration and commissioning of the Heat Recovery System for the full fit-out scope.

37. Subcontractor is responsible for the removal, storage, reinstallation, touch up, and new sealant of the louvers and steel cross support beams for AHU install and removal, storage and reinstallation of tube steel associated with louvers.

38. Subcontractor is responsible for the removal, reinstallation, and rework of plenums for AHU install.

39. For all packaged equipment provided under this scope of work, install and pre-wire all electrical outlets, lights, fans, disconnects, etc. as indicated in the electrical drawings. Comply with all electrical specifications. Coordinate single point connections with division 26. Provide all accessories required to make final connections.

40. This Subcontractor has included the demo of the Level 4, 5, and Vivarium shell space unit heaters and associated controls. Unit heaters are to be turned over to the Owner.

41. HVAC risers were installed under the Core and Shell contract. Valves were provided on pipe risers, connect to valves. This Subcontractor shall be responsible for any additional condensate risers required in addition to those installed under Core and Shell package.

42. HVAC piping for lower level mechanical rooms and penthouse was provided under a previous contract. This scope of work includes all piping shown on fit out documents. Refer to MF drawings for rework and revision to penthouse piping for new AHU’s.

43. Duct risers and dampers for all floors were installed under a previous contract. Extend ductwork and dampers as required by the contract documents and patch and maintain all fire wrap and/or fire rated coatings for risers damaged during installation of fit out duct.

44. Provide ductwork to fit out equipment including branch duct to reheat coils, and chilled beams. Ductwork for lower level mechanical rooms, fan coil units, air floor system and penthouse were installed under a previous contract. This Subcontractor is responsible for dampers and thimble connections at cage racks – coordinate with owner and The Construction Manager for locations. Refer to MF drawings for rework and revision to penthouse piping for new AHU’s.

45. GRD’s/ Duct – Provide all registers, grilles and diffusers. Provide colors as specified on architectural documents, including custom colors. Provide aluminum duct at sterilizer exhaust as indicated in specification. Provide all steam piping for autoclave systems on Level 4 and Level 5.

46. Filters – This Subcontractor will provide 5 sets of filters (pre-filters and final filters) for the AHU’s included in this scope of work. As directed by the Construction Manager, 2 sets will be used during construction use, 1 set for building flush out, 1 set for building turn over, and 1 set for attic stock. This Subcontractor has also included 2 sets of filters (pre-filters and final filters) for the existing AHU’s in the building, to be used as directed by the Construction Manager during construction. This Subcontractor has included in this cost all removal, swapping, after hours shut downs, etc. necessary to make the filter changes. In addition to the filter sets noted above, this Subcontractor has included, and will maintain, rolled filter media over all pre-filters and return air filters for the duration of construction. This filter media will be changed out frequently, and or at the direction of the Construction Manager, in order to prolong the life of the filters being used.

47. Air Quality Sampling – This Subcontractor has included 5 air sampling tests in occupied spaces, to be used at the direction of the Construction Manager, to help monitor air quality for the occupied portions of the building.

TESTING AND BALANCING

48. Subcontractor shall review shop drawings to confirm that quantities and locations of balancing valves,
dampers, access doors and other means of access are acceptable. Notify the Construction Manager immediately of any conditions which prohibits or delays proper adjusting and balancing of systems.

49. Subcontractor shall perform four (4) site inspections during the construction phase of project. Verify field conditions before starting any testing and balancing. Notify the Construction Manager immediately in writing of any unacceptable or incomplete items.

50. Coordinate all testing and balancing with Authority Having Jurisdiction, owner’s Commissioning Agent and The Construction Manager.

51. Provide remobilizations as required to meet contract schedule

52. Provide additional testing to verify settings and system capacity during near-peak conditions. This will include equipment previously installed and balanced in Phase I.

53. Subcontractor shall be responsible for testing, balancing and adjusting air and water systems which includes but is not limited to AHU’s, EAHU’s, supply air, return air, exhaust air, outside air, exhaust fans, supply fans, chilled water, heating water system, heat recovery systems pumps, fan coil units, unit heaters, VAV boxes, chilled beams, radiant heating panels, radiant floor heating, Phoenix valves, grills, registers, diffusers, etc. Subcontractor shall perform coil temperature/performance testing of all heating and chilled water coils.

54. This Subcontractor shall provide testing and balancing as required for packaged systems provided by others under Fit Out, including but not limited to RO system, domestic water system, Konvekta and MeeFog.

55. Subcontractor shall perform room pressure testing/verification.

56. Provide duct leakage testing as directed by mechanical engineer. Testing equipment will be provided by this Subcontractor. Coordinate with owner’s commissioning agent, The Construction Manager, and authority having jurisdiction.

57. Subcontractor shall provide velocity and airflow testing at fume hoods. Coordinate with Division 12A. ASHRAE 110 testing is by others.

58. Hand written copy of reports shall be submitted to The Construction Manager immediately upon completion of adjusting and balancing of a system or portion of a system. Final adjusting and balancing report shall be submitted within 2 weeks of completing work.

59. All valve/damper position indications shall be indelibly and clearly marked and shall be defined in the TAB report. Provide all test plugs required for testing and balancing.

60. Final adjustment of sheaves will be by this contractor. Sheave change out will be on a Time and Material basis if required.

61. Testing – This Subcontractor shall be responsible for all testing of systems installed under this scope of work. Provide factory testing and third-party testing as required. Coordinate all testing and inspections with Authority Having Jurisdiction and The Construction Manager. Provide multiple testing of installations as required to meet the project schedule. Extent of all testing is to be reviewed with The Construction Manager within one month of contract award to establish limits of testing and methods.

62. Training – Subcontractor shall provide training and demonstrations per contract documents. Include videotaped records of training sessions. Coordinate training with W-T and owner.

63. Commissioning – Provide commissioning support including but not limited to the following:
   a) Provide third party Indoor Air Quality Testing for LEED certification. Schedule Air Quality testing with The Construction Manager to ensure that all requirements are met before testing takes place.
   b) Completion of commissioning documentation
c) Attendance in commissioning meetings when directed by The Construction Manager  
d) Onsite support during functional testing  
e) Onsite support to resolve any commissioning issues with installed work Controls  
f) Ladders, lifts, tools and any other equipment required to allow Cx agent to complete their work.  
g) Onsite support to resolve any commissioning issues with installed work  
h) Provide an additional allowance of 200 hours of onsite labor for Cx support. Any unused funds of the allowance will be returned to UK via deductive change order.

64. **Site Conditions** – All existing site conditions are to be verified prior to start of construction. Any variances in conditions must be documented prior to construction. If the Construction Manager is not notified in writing, it shall be the responsibility of this Subcontractor to make any corrections or remediation necessary at no additional cost. In addition, this Subcontractor shall protect all existing conditions and surroundings as so not to damage during construction. This includes any damage that could result from surface water. If any existing items, which are to be left undisturbed, are damaged by this Subcontractor it shall be its responsibility to repair.

65. **Traffic Control** – This Subcontractor is fully aware that the construction site is within a high traffic campus corridor with continuing operations throughout the construction process. To that end, this Subcontractor will work hand in hand with the Construction Manager to ensure deliveries, manpower, and general construction traffic are conducted in such a manner as to provide a safe and undisturbed environment for the pedestrian and vehicular traffic, which includes but is not limited to: cleanup of all vehicle debris, mud, materials, adjusting haul routes and hours, adjusting exit routes, parking in designated areas, deferring to campus traffic, etc.

66. **Overtime Outages** – This Subcontractor has accounted for all outages, rework, or new work on existing floors to be performed during off hours or on weekends, and as a result, has accounted for all associated overtime.

**END OF SPECIFIC SCOPE**
Addendum #05

Client  University of Kentucky  Date  2/28/2019
Project RB2 Phase 2  Champlin Project # 514-5350

This addendum provides information to clarify or adjust construction items which may affect any or all trade contractors. The original documents for the referenced project are amended as noted in this addendum and made part of said documents and shall govern the work covered by the Form of Proposal. All work to be in strict accordance with the terms, stipulations and conditions of contract documents.

SUMMARY OF ATTACHMENTS

PART A - DRAWINGS:

AG-001 – DRAWING INDEX
  1. Plumbing sheet P-251A added to drawing set.

AI-354A – FINISH FLOOR PLAN – LEVEL FOUR AREA ‘A’
  1. Keynotes 1 & 2 added to clarify detail reference.

AI-354B – FINISH FLOOR PLAN – LEVEL FOUR AREA ‘B’
  1. Keynotes 1 & 2 added to clarify detail reference.

AI-354C – FINISH FLOOR PLAN – LEVEL FOUR AREA ‘C’
  1. Keynotes 1 & 2 added to clarify detail reference.

AI-454A – RCP - LEVEL FOUR AREA ‘A’
  1. Four additional SH-1 manual shade tags added.

AI-669 – Details – Interiors at Windows
  1. Updated description for details 4 & 5 to clarify floor level locations.

P-250B – Basement Phase 2 Fitout Area ‘B’ Plumbing Plan
  1. Provide new pressure reducing valve in the existing domestic water pipes.

P-251A – Level 01 Phase 2 Fitout Area ‘A’ – Plumbing Plan
  1. Sheet added; Provide new pressure reducing valve in the existing domestic water pipes.

P-251B – Level 01 Phase 2 Fitout Area ‘B’ – Plumbing Plan
  1. Provide new pressure reducing valve in the existing domestic water pipes.

MF-950 – Mechanical Schedules
  1. Added scope matrix to clarify scope for Phoenix and Aircuity systems.

IC-753 – Terminal Units
  1. Clarification for wiring intent to terminal unit controllers.
IC-754 – Terminal Units
  1. Clarification for wiring intent to terminal unit controllers.

IC-755 – Terminal Units
  1. Clarification for wiring intent to terminal unit controllers.

IC-756 – Terminal Units
  1. Clarification for wiring intent to terminal unit controllers.

IC-757 – Terminal Units
  1. Clarification for wiring intent to terminal unit controllers.

IC-950 – Instrumentation Equipment Schedules
  1. Added scope matrix to clarify scope for Phoenix and Aircuity systems.

PART B - SPECIFICATIONS:

Section 230993 Control Sequences
  1. Section revised.
  2. Added AHU switchover to be controlled by Tridium for lead-lag-standby sequences for AHUs 5-8.
  3. AHU 5-8 Static Pressure control average signal is to be sent from Tridium to Phase 2 BAS.
  4. Added AHUs 1-4 are to be enabled through Tridium.
  5. AHU 1-4 Static Pressure control average signal is to be sent from Tridium to Phase 2 BAS (for each set/area of transmitters).

End of Addendum
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<td>ES-150D BASEMENT PHASE 2 FITOUT OVERALL - ESS</td>
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<td>ES-151 LEVEL 01 PHASE 2 FITOUT OVERALL - ESS</td>
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<td>QL-200D FLOOR PLAN LOWER LEVEL AREA &quot;D&quot;</td>
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<td>QL-204A FLOOR PLAN LEVEL 04 AREA &quot;A&quot;</td>
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<td>EL-154C LEVEL 04 PHASE 2 FITOUT AREA 'C' - LIGHTING PLAN</td>
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<td>EL-155B LEVEL 05 PHASE 2 FITOUT AREA 'B' - LIGHTING PLAN</td>
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<td>P2-VT-03 PLANS AND HOISTWAY SECTION ELEVATOR KITCHEN</td>
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<td>EL-350 PHASE 2 LIGHTING SYMBOLS AND FIXTURES</td>
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<td>EL-155B LEVEL 05 PHASE 2 FITOUT AREA 'B' - LIGHTING PLAN</td>
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<td>P2-VT-03 PLANS AND HOISTWAY SECTION ELEVATOR KITCHEN</td>
</tr>
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</table>
GENERAL NOTES - FINISH PLANS

SEE FLOOR PLANS FOR WALL TYPES.

3. REFER TO AI-723 FINISH LEGEND FOR MATERIAL DESIGNATIONS AND BASIS OF DESIGN PRODUCT INFORMATION.

4. PAINT HOLLOW METAL DOOR & FRAMES TO MATCH THE COLOR OF THE DOOR PANEL, UNO.

6. ALL MISCELLANEOUS PANELS, FIRE EXTINGUISHER CABINETS, EXPOSED DUCTING PARTS, CONDUIT, PIPES, LOUVERS, VENTILATION COVERS AND ANY EQUIPMENT FACTORY FINISHED, INCLUDING ALL WALLS TO RECEIVE Pt-672. ACCENT WALLS TO RECEIVE C-ThinChamplin.com.

10. ALL SHELL SPACES SHALL BE LEFT UNFINISHED. FLOORS SHOULD BE RSF-3 TO BE USED AS ACCENT FLOORING AT ALL EMERGENCY EYE LEVELS BASEMENT THROUGH LEVEL 4, UNO.; ALL LANDINGS IN WET LAB. SEE 15/AI.

12. CLEAR FLOOR AREAS AT LOWER LEVEL: REVIEW MARKINGS INDICATED ON PLAN WITH OWNER AFTER ALL FIXED EQUIPMENT HAS BEEN INSTALLED. FLOOR MARKING MATERIAL TO BE DETERMINED. ELEVATOR CAB FLOORING (NOT SHOWN ON PLAN) TO BE TZO-1.

15. ALL CTW CORNER TRANSITIONS TO RECEIVE CTA-3 FOR RES-2 FLOORING, UNO.

17. CORRIDOR LEVELS BASEMENT THROUGH LEVEL 4, UNO.; ALL LANDINGS IN FACULTY OFFICE.

18. CODE IN STAIRS E; REFER TO FINISH LEGEND AI.

19. DECORATIVE FILM-1; REFER TO FINISH LEGEND.

25. CONTRACTOR TO INCLUDE ALL PHOTOLUMINESCENT ITEMS PER CODE IN STAIRS E; REFER TO FINISH LEGEND AI-724 FOR ALL ITEMS.

26. NO WORK IN THIS AREA.
1. SEE ROOM FINISH SCHEDULE, INTERIOR ELEVATIONS, INTERIOR REFER TO AI

PAINT HOLLOW METAL DOOR & FRAMES TO MATCH THE COLOR OF THE DOOR PANEL, UNO.

6. COVERS AND ANY EQUIPMENT FACTORY FINISHED, INCLUDING ASSOCIATED HARDWARE, SHALL BE PAINTED TO MATCH THE SURFACE ON WHICH IT OCCURS, UNO.

7. ACCENT WALL BASE.

9. ALL COLLABORATION CASEWORK WALLS TO RECEIVE HIGH GLOSS FINISH WITHIN ALCOVE.

10. ALL SHELL SPACES SHALL BE LEFT UNFINISHED. FLOORS SHOULD BE PREPPED FOR FUTURE INSTALL.

11. RSF-WASH AND SAFETY SHOWER FIXTURES. SEE 12/AI-672.

12. TO BE USED AS ACCENT FLOORING AT LADDER STATIONS IN CLEAR FLOOR AREAS AT LOWER LEVEL: REVIEW MARKINGS INDICATED ON PLAN WITH OWNER AFTER ALL FIXED EQUIPMENT HAS ELEVATOR CAB FLOORING (NOT SHOWN ON PLAN) TO BE Tzo-1.

13. STAIRS E TO RECEIVE INTEGRATED LUMINOUS STAIR TREAD FOR ALL LEVELS BASEMENT THROUGH LEVEL 4, UNO.; ALL LANDINGS IN CONCEPT TO INCLUDE ALL PHOTOLUMINESCENT ITEMS PER CPT-52.

14. RSF-1
1. SEE FLOOR PLANS FOR WALL TYPES.
2. SEE ROOM FINISH SCHEDULE, INTERIOR ELEVATIONS, INTERIOR DETAILS, & CASEWORK DETAILS FOR ADDITIONAL INFORMATION.
3. REFER TO AI-723 FINISH LEGEND FOR MATERIAL DESIGNATIONS AND BASIS OF DESIGN PRODUCT INFORMATION.
4. PAINT HOLLOW METAL DOOR & FRAMES TO MATCH THE COLOR OF HOST WALL, UNO.
5. THE DOOR PANEL, UNO.
6. ALL MISCELLANEOUS PANELS, FIRE EXTINGUISHER CABINETS, ASSOCIATED HARDWARE, SHALL BE PAINTED TO MATCH THE
7. ALL WALLS TO RECEIVE PT-1, UNO.
8. ALL WALLS TO RECEIVE RB-1, UNO. ACCENT WALLS TO RECEIVE ACCENT WALL BASE.
9. FINISH WITHIN ALCOVE.
10. ALL SHELL SPACES SHALL BE LEFT UNFINISHED. FLOORS SHOULD BE
11. <RSF-3> TO BE USED AS ACCENT FLOORING AT ALL EMERGENCY EYE WASH AND SAFETY SHOWER FIXTURES. SEE 12/AI...
12. <RSF-3> TO BE USED AS ACCENT FLOORING AT LADDER STATIONS IN WET LAB. SEE 15/AI-672.
13. CLEAR FLOOR AREAS AT LOWER LEVEL: REVIEW MARKINGS INDICATED ON PLAN WITH OWNER AFTER ALL FIXED EQUIPMENT HAS
14. ELEVATOR CAB FLOORING (NOT SHOWN ON PLAN) TO BE TZO-1
15. ALL CTW CORNER TRANSITIONS TO RECEIVE CTA-2.
16. REFER TO 11&14/AI-672 FOR RES-1 COVE BASE DETAIL; TO BE USED AT ALL LOCATIONS RECEIVING RES-1 FLOORING, UNO.
17. STAIRS E TO RECEIVE INTEGRATED LUMINOUS STAIR TREAD FOR ALL LEVELS BASEMENT THROUGH LEVEL 4, UNO.; ALL LANDINGS IN
18. CONTRACTOR TO INCLUDE ALL PHOTOLUMINESCENT ITEMS PER CODE IN STAIRS E; REFER TO FINISH LEGEND AI-724 FOR ALL ITEMS TO BE APPLIED.
19. PROTECT EXISTING INSTALLED EQUIPMENT WHEN APPLYING VCT FLOOR FINISH.
20. ACCENT PLAM
21. PT-1 W/ RB-1
22. PAINT DOOR AND DOOR FRAME, PT-6
23. PAINT DOOR FRAME, PT-6
24. RSF-3 ACCENT FLOOR AT FLOOR DRAIN; REFER TO 12/AI-672
25. RSF-3 ACCENT FLOOR AT LADDER STATION; REFER TO 15/AI-672
26. TRANSITION STRIP BETWEEN VCT AND SEALED CONCRETE FLOOR
27. STAIR RISERS TO BE PAINTED BLACK IN STAIRS A, B, C THROUGH
28. 2" WIDE CONTINUOUS FILM-3 APPLIED TO GLASS; SIGN ADJ. TO FILM-2
29. REPAIR AND REPAINT WALLS
30. FRP BACK SPLASH
31. CTA-3
32. REFINISH PHASE 1 WALLS TO 9'-0" AFF WITH PT-4
33. TERRAZZO FLOORING
34. AREA
35. 400S
36. TBD
37. 2" WIDE CONTINUOUS FILM-3 APPLIED TO GLASS; SIGN ADJ. TO FILM-2
38. REPAIR AND REPAINT WALLS
39. FRP BACK SPLASH
40. CTA-3
41. REFINISH PHASE 1 WALLS TO 9'-0" AFF WITH PT-4
42. TERRAZZO FLOORING
43. AREA
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51. TERRAZZO FLOORING
52. AREA
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55. 2" WIDE CONTINUOUS FILM-3 APPLIED TO GLASS; SIGN ADJ. TO FILM-2
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62. 400S
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66. FRP BACK SPLASH
67. CTA-3
68. REFINISH PHASE 1 WALLS TO 9'-0" AFF WITH PT-4
69. TERRAZZO FLOORING
70. AREA
71.
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**PHOENIX RESPONSIBILITY MATRIX**

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<thead>
<tr>
<th>No.</th>
<th>Project</th>
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<th>Location</th>
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**BEARING RESPONSIBILITY MATRIX**

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<td>0810-RSC</td>
<td>ENH-0014</td>
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<td>ENH-0014</td>
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**ENERGY RECOVERY HEATING COILS IN AIR HANDLING UNITS**

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<th>No.</th>
<th>Description</th>
<th>Type</th>
<th>Size</th>
<th>Efficiency</th>
<th>EWT</th>
<th>LWT</th>
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**REHEAT COILS IN AIR HANDLING UNITS**

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**ATOMIZING TYPE HUMIDIFIERS**

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</table>
1. **SEQUENCE A: OFFICE WITH EXTERIOR EXPOSURE**

   - The control/flow diagram is only intended to provide control and instrumentation related information. Refer to mechanical details for valving, dampering and associated specialties' installation requirements.

   - Control/flow diagram includes general arrangement of system components. Refer to floor plans and equipment schedules for component quantities.

2. **SEQUENCE B: HALLWAYS ASSOCIATED WITH OFFICES**

   - General notes:
     - Sheet keynotes:
       - Sensor where indicated on mechanical drawings.

3. **SEQUENCE C: LOBBY AREAS**

4. **SEQUENCE D: MAIN HALLWAYS**
THE CONTROL/FLOW DIAGRAM IS ONLY INTENDED TO PROVIDE CONTROL AND INSTRUMENTATION RELATED INFORMATION. REFER TO MECHANICAL DETAILS FOR VALVING, DAMPERING AND ASSOCIATED SPECIALTIES' INSTALLATION REQUIREMENTS.

CONTROL/FLOW DIAGRAM INCLUDES GENERAL ARRANGEMENT OF SYSTEM COMPONENTS. REFER TO FLOOR PLANS AND EQUIPMENT SCHEDULES FOR COMPONENT QUANTITIES.

1. THE CONTROL/FLOW DIAGRAM IS ONLY INTENDED TO PROVIDE CONTROL AND INSTRUMENTATION RELATED INFORMATION. REFER TO MECHANICAL DETAILS FOR VALVING, DAMPERING AND ASSOCIATED SPECIALTIES' INSTALLATION REQUIREMENTS.

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CONTROL/FLOW DIAGRAM INCLUDES GENERAL ARRANGEMENT OF SYSTEM COMPONENTS. REFER TO FLOOR PLANS AND EQUIPMENT SCHEDULES FOR COMPONENT QUANTITIES.

1. OCCUPANCY SENSOR PROVIDED BY CONTROL CONTRACTOR.

GENERAL NOTES:

MULTIPLE UNITS PER ZONE.

1. OCCUPANCY SENSOR PROVIDED BY CONTROL CONTRACTOR.
GENERAL NOTES:

1. THE CONTROL/FLOW DIAGRAM IS ONLY INTENDED TO PROVIDE CONTROL AND INSTRUMENTATION RELATED INFORMATION. REFER TO MECHANICAL DETAILS FOR VALVING, DAMPERING AND ASSOCIATED SPECIALTIES' INSTALLATION REQUIREMENTS.

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### ARBITRARY RESPONSIBILITY MATRIX

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### PHOENIX RESPONSIBILITY MATRIX

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### AIR FLOW METERS

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### CONTROL VALUES

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### REMARKS

- Smoke damper and fail actuators shall be provided with the AHU.
- AHU smoke damper & actuators shall be provided with the AHU.
- AHU manufacture to provide unit dampers. TCC to provide actuators.
- Refer to system diagrams if fail position are not indicated in schedule.
- Pressure drop in Main Return 2 to 1.1/4 in. Schedule 40 Pvc. 36x72 Max.
- Airflow (gpm) / Flow

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<th>Type</th>
<th>Size</th>
<th>Remarks</th>
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### EQUIPMENT SERVED

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</table>

### DRAWN BY

- Drawn By: T 513.241.4474    F 513.241.0081

### PHASE 2 DD 100%

- RB2

### PROJECT NO.

- Project No. 03-59

### SHEET NO.

- SHEET NO. IC950

### MATERIALS

- CHAMPLIN

### ROBESON

- ROBESON COMMISSIONING INSTRUMENTATION EQUIPMENT SCHEDULES

### DATE

- 08/15/2018
SECTION 23 0993 CONTROL SEQUENCES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control System Integration, applies to the work of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to sections stated under related work.

PART 3 - EXECUTION

3.1 CONTROL SEQUENCE

A. Systems shall perform in accordance with the following.

B. Refer to Control/Flow Diagrams and Control Points List for additional information.

C. Alarms

1. All Control and alarm setpoints shall be adjustable from the operator’s workstation for the Tridium Enterprise System or at local controllers via laptop software unless otherwise noted.

2. BAS shall annunciate alarm conditions when analog input values exceed their programmed ranges.

   a. Unless otherwise noted, alarm ranges shall be:

      1). Air Temperature: +/-5°F from setpoint
      2). Water Temperature: +/-10°F from setpoint
      3). Humidity: +/-10% RH from setpoint
      4). Air Pressure: +/-0.5" W.C. from setpoint
      5). Water Pressure: +/- 5 psig from setpoint
      6). Flow: +/-25% of maximum flow range
      7). Level or Value: +/-5% of maximum level or value from setpoint

3. All references to alarms, alarm setup, and alarm enunciation are to be programmed in the UK Tridium system and shall not be programmed in the BAS to annunciate at a non-Tridium workstation. Controls contractor shall coordinate all alarming with UK staff for required alarms.

   a. The contractor is 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 PPDMC. PPDMC will be responsible for doing the alarm names, alarm texts and enabling the alarm points provided on the list.

4. Program alarm levels as indicated in sequences, based on the following levels.

   a. Urgent
   b. High Priority
   c. General Maintenance
5. All Input/Output points and BAS data objects shall have alarm parameters available for defining alarms.
6. Alarm monitoring and programming functions shall be restricted by password protection.
7. Coordinate alarm action requirements (printing, automatic dialing, etc.) with Owner.
8. Alarms shall remain active until alarm condition has cleared and alarm is reset manually.

D. Setpoints
1. All controlling setpoints shall be field-adjustable. The Control Contractor shall work in conjunction with the owner, commissioning agent, and Testing and Balancing Contractor to field adjust all final set points.
2. Control Contractor shall verify setpoints, time intervals, and limits based on actual field conditions. All setpoints, time intervals, and limits shall be optimized to achieve stable system operation, prevent damage to equipment, minimize maintenance requirements, and eliminate nuisance alarms (such as premature filter loading, false tripping of freezestats, and other similar conditions).
3. The terms ‘Adjustable Temperature Sensor’ and ‘Non-adjustable Temperature Sensor’ are used to describe space temperature sensors.
   a. Adjustable/User-Adjustable Temperature Sensor – space temperature sensor is provided with a slide or buttons that allow the space occupant to locally adjust the setpoint. All Adjustable Sensors shall be programmed with a locked/limited range. The range shall be displayed on the BAS graphic for each space and shall be adjustable from the graphic.
   b. Non-Adjustable Temperature Sensor – Flat plate type or plastic with no local adjustment. Setpoints are programmed at the BAS and shall be adjustable from the graphic for each room.

E. Switch Point Actuation
1. Provide each switch/alarm trip point with an adjustable time delay to prevent nuisance tripping. These time delays apply to all switch points whether hardware or software and for normal operation. Additional or longer delays may be necessary during start-up or shut down as noted herein.
2. Unless otherwise specified, the time delay shall be as follows:
   
<table>
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<tr>
<th>Process or operation</th>
<th>Time Delay</th>
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<tbody>
<tr>
<td>Flow</td>
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</tr>
<tr>
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<td>Gas pressure</td>
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</tr>
<tr>
<td>Pressure differential</td>
<td>1 minute</td>
</tr>
<tr>
<td>Level</td>
<td>30 seconds</td>
</tr>
<tr>
<td>Valve limit switch</td>
<td>2 minutes</td>
</tr>
<tr>
<td>Temperature indoor</td>
<td>5 minutes</td>
</tr>
<tr>
<td>High/Low Pressure Switch</td>
<td>5 second</td>
</tr>
<tr>
<td>High/Low Temperature Switch</td>
<td>5 second</td>
</tr>
</tbody>
</table>

3. If the time delays are less than the controller scan rate, the minimum controller scan rate shall be the time delay.

F. Variable Frequency Drives
1. VFDs shall be switched between HAND, OFF, and AUTO modes via manual local control adjustment at each VFD.
2. Control loops other than volume/pressure control loops using VFD speed outputs, shall continue to function in the HAND mode.
3. Motors shall operate at constant speed in the HAND mode. Remote start/stop control shall be via local control at each VFD.

4. All safety devices shall be wired as to be still active in the HAND mode.

5. Coordinate communication requirements with VFD manufacturer. All monitoring and control point data from VFD interface card shall be mapped to the BAS. VFD start/stop control and speed control points shall be hard wired from the BAS controller to the drive.

6. The control contractor shall coordinate with the Testing and Balancing Contractor to establish all final minimum and maximum VFD speeds. All minimum and maximum speeds listed in this specification are initial setpoints only.

G. Safety Devices
1. All safety devices (low limits, high limits, etc.) shall have local manual reset.
2. All safety devices shall be wired as to be still active when a VFD is in the HAND mode.

H. Pressure Transmitter/Sensors
1. Pressure transmitter/sensors shall be hardwired directly back to the BAS controller that provides the control signal to the VFD(s). Sharing the static pressure or pressure differential signal via the network is not allowed for control.
2. All locations of pressure transmitters/sensors shall be supplied to the owner for inclusion on the building graphics.

I. Pump or Fan Operation Feedback
1. When a device is required to run, the control system shall command the device to start by energizing the discrete output to the motor starting device. The device shall run until the control system commands the device to stop by de-energizing the discrete output to the motor starting device or an equipment failure occurs.
2. Equipment failure is detected by opening of a low current switch, pressure differential switch, current input in Low-Low alarm condition (VFD), or VFD fault input when the device is commanded on, or is operating, or anytime the device status does not match the commanded state. If a failure occurs, the device shall be stopped and an alarm shall be generated at the BAS, designating that device has failed (see each sequence for alarm type details). This interlock shall be disabled for 30 seconds (FA) after the device is initially commanded to start. Failed pump or fan shall be locked out until manually reset through the BAS.
3. Current switches affixed to one of the motor feed cables or pressure differential switch piped across inlet and outlet of fan or pump shall be used for equipment status indication.

J. System Air Volume Control (for variable volume AHUs with static pressure transmitters)
1. Supply fans are variable speed and are controlled through variable frequency drives (VFD). Fan speed shall be controlled through BAS, to maintain system static pressure setpoint. Provide static pressure transmitter(s) in supply ducts (as shown on drawings) that will be referenced to modulate fan VFD thru BAS.
   b. See Section 3.1.H – Pressure Transmitter/Sensors
   c. Controls Contractor is to provide exact location of static pressure transmitters for inclusion on the building graphics.
2. Supply system static pressure control:
   a. If the static pressure at any transmitter drops below its respective setpoint, AHU supply fan VFD increase to maintain the static pressure transmitter at respective setpoint.
b. If multiple static pressure transmitters rise above their respective setpoints, AHU supply fan VFD decrease until the pressure at one static pressure transmitter drops to its respective setpoint.

c. All static pressure transmitter(s) shall be installed two-thirds down longest main duct section in each system and shall meet sensor manufacturer’s recommendations for locating devices of this type. Controls Contractor shall verify location of automatically operating dampers (including control dampers, fire/smoke, and smoke dampers) in the duct upstream of the static pressure transmitters. Any dampers located upstream of static pressure transmitters that can close automatically without operator intervention (manually operated dampers are the only exclusion) shall have damper position monitored by the BAS. When one of these automatically operating dampers is proven closed, the operating fans shall automatically be commanded to 30% (FA) of their maximum speed. After a 3 minute (FA) delay, the fans shall be released to control, however, static pressure transmitter(s) that are downstream of closed automatically operating dampers shall be flagged as inoperable and shall be disregarded by the AHU supply duct static pressure control sequence. When automatically operating dampers are proven open, static pressure transmitter(s) downstream of the previously closed automatically operating dampers shall be used in the low select process to modulate supply fan speed to maintain system static pressure. The Controls Contractor is responsible for determining the quantity and location of all automatically operating dampers.

3. If any static pressure transmitter is 80% above or below its setpoint, the static pressure transmitter shall be alarmed at the BAS, disregarded for the supply air static pressure control and remaining static pressure transmitters shall be used for control.

3.4 Upon loss of Tridium static pressure average, each AHU shall control to static pressure sensor wired to individual AHU controller.

4. Control Contractor shall work in association with Test and Balance Contractor to determine actual required static pressure setpoint ranges of each transmitter. Setpoints indicated above are to be used for initial system startup. Actual static pressure setpoints shall be the minimum static pressure required to achieve system design flow at minimum and maximum design conditions.

3.2 POWER FAILURE MODE SEQUENCE

A. General:

1. Power failure shall be determined by position of automatic transfer switch in conjunction with test mode indication from power management system. Control Contractor is responsible for obtaining status signal and all necessary wiring for status signal from automatic transfer switches to BAS.

2. Pump and fan VFDs shall be programmed for automatic restart after a complete stop upon power resumption when normal power is lost and automatic transfer switches are in the essential power system position.

   a. Test mode indication from power management system shall be monitored by the BAS. During the monthly routine tests of the power system when test mode status is indicated, pumps and fans served by essential power shall not be shut down and restarted when automatic transfer switches are in essential power position.

3. All control valves serving reheat coils shall maintain their last control position upon loss of power or loss of control signal.

B. Managed Restart:

1. BAS shall monitor normal power indication and on loss of normal power for duration of 2 seconds (FA) or longer, all equipment shall be commanded stopped by the BAS. When Essential Power is established as indicated by automatic transfer switches, BAS shall restart
system components served by Essential Power based on the following Priority Sequence. Start sequence under each automatic transfer switch shall not begin until associated automatic transfer switch has been proven switched to the generators. Equipment designated to operate on essential power, but not included in the following priority list (referred to hereinafter as “subsequent” equipment) shall not start until priority equipment start-up sequence is complete. Start-up of subsequent equipment shall not be delayed for proof of actual operation of priority equipment. Once all priority equipment has been commanded to start, proceed immediately to start-up of subsequent equipment. Provide software adjustable time delay between starting of components serving a common system (set initial delay at 5 seconds (FA)).

2. Equipment operating under essential power shall not exceed the respective system capacity requirements. Capacity control sequencing (lead-lag control for capacity control) shall remain in effect during essential power operation. The following priority sequence indicates the equipment designated (given permission) to operate on essential power if needed by system capacity control sequence and the relative operation priority of that equipment.

C. Priority Sequence:
   1. Automatic Transfer Switches shall be monitored by the BAS via MODBUS connection. Monitor the following status:
      a. Switch in Normal Position
      b. Normal Source Not Available
      c. Switch in Essential Position
   2. Upon power failure, HVAC equipment shall begin restarting in sequence as indicated below upon indication the equipment’s respective Automatic Transfer Switch (ATS) has switched to Essential Power. No delay shall be programmed on a switch back to Normal Power from Essential power. Refer to electrical schedules, control sequences, and DDC points schedule for equipment connected to Essential Power and ATS the equipment resides on.
   3. When Equipment ATS is proven in the Essential Power position by contacts, the following HVAC devices shall be started in order listed by respective ATS as indicated in device sequences following with 5 second (FA) intervals between restart of devices:
      a. HW, RHW, CHW, MTCHW, Energy Recovery System (Konvekta)
         1). Converters
         2). Pumps
      b. All EAHUs
      c. All AHUs
      d. Humidification RO water system
      e. Terminal Units

3.3 ENERGY RECOVERY SYSTEM (KONVEKTA) - CONTROL SEQUENCE

A. Scope:
   1. Existing energy recovery system consists of:
      a. Hydronic skid which is provided with variable volume pumps, heating hot water heat exchangers, medium temperature chilled water pumps, medium temperature heat exchangers and all necessary control valves.
      b. Energy recovery coils in supply and exhaust air handling units.
      c. System is existing provided with a packaged controller which controls safety, operating and capacity control of the system.
2. Energy recovery pumps will circulate glycol water to energy recovery coils located in the supply and exhaust air handling units to recovery energy.

B. Unit Operation:
1. Unit operation shall be automatic and activated through building automation system.
2. Konvekta shall provide a BACnet MSTP connection port on their controller for communication to the controller contractors system.
   a. BACnet MSTP connection BAS.

C. Interlocking:
1. Energy Recovery System shall be interlocked with the following:
   a. Interlock with each AHU and EAHU associated with the energy recovery system startup shutdown.
   b. Each AHU (AHU-1 thru 8) via BAS BACnet MSTP communication will provide the following:
      1). Supply air flow
      2). Outside air temperature
      3). Supply air temperature setpoint
      4). Supply air temperature
      5). Glycol water supply temperature
   c. Each AHU (AHU-1 thru 8) shall have the following sensors/valves hardwired back to the Konvekta controller:
      1). Glycol water supply control valve (provided by Konvekta)
      2). Glycol water supply temperature sensor
      3). Coil discharge temperature sensor (provided by Konvekta)
   d. MeeFog Humidification
      1). Shall have a direct cable connection between the MeeFog controller and the Konvekta controller.
      2). Shall have a connection to each solenoid valve control panel.

3.4 HUMIDIFICATION RO WATER SYSTEM (MEEFOG) - CONTROL SEQUENCE

A. Scope
1. Existing humidification system consists of:
   a. Two humidifier booster pumps will deliver RO water to AHU-5 thru 8, atomizing humidifier control valves.
2. Humidification RO water system shall provide humidification to AHUs meet the humidification setpoint.

B. Operation
1. On call for either evaporative cooling or humidification, MeeFog skid shall be enabled and interlocked pumps shall start.
   a. On call for evaporative cooling, via Konvekta control, Konvekta will send signals to MeeFog valve control panel.
      1). Konvekta will enable MeeFog valve control panel based on airflow in EAHU from airflow measuring station.
      2). Konvekta will send a humidification setpoint 4-20V signal, to the MeeFog valve control panel to modulate the evaporative cooling valves.
b. On call for humidification from AHUs, BAS shall send signals to MeeFog valve control panel.
   1). BAS will enable MeeFog valve control panel based on airflow in AHU via supply airflow measuring station.
   2). BAS will send a humidification setpoint. 4-20V signal, to the MeeFog valve control panel to modulate the evaporative cooling valves.
      a). When the exhaust relative humidity less than 30% (FA), the MeeFog valves shall modulate to maintain the exhaust humidity setpoint. The reverse shall occur as the exhaust air humidity increases past the setpoint.

C. Interlocking:
   1. Humidification RO water system shall be interlocked with the following:
      a. Interlock with each AHU and EAHU that is provided with humidification or adiabatic cooling startup shutdown.
      b. Each AHU via BAS communication will provide the following:
         1). BAS shall calculate exhaust air dew point to send signal to modulate humidification valves
            a). Exhaust air Humidity
            b). Exhaust air temperature
         2). Airflow via supply airflow measuring station.
         3). High limit supply humidity sensor shall shut off humidification valves when high humidity setpoint is met.

3.5 VIVARIUM AHU-7 & 8 (5&6 EXSITING) - CONTROL SEQUENCE

A. System Description:
   1. Refer to drawings IC-750.
   2. System
      a. Air handling units operate in parallel Lead-lag-lag-Standby to serve each respective vivarium space. AHU-7 and 8 serve Level SB vivarium spaces.
      b. Each unit is 100% outside air unit with run-around heat recovery/preheating, cooling and humidification, single duct, variable volume system.
      c. Units are sized so that one of the three air handling units can serve the respective vivarium space at 100% design air flow to allow downtime for routine maintenance of one unit at a time.
   3. Each air handling unit consists of:
      a. Supply fan array with backdraft damper on each fan
      b. Two VFDs for each fan array. One VFD in each array is fully redundant.
      c. Energy Recovery coil
      d. Cooling coil
      e. Humidifier
      f. Pre-filter and final filter
      g. UV Light
      h. Outside air damper
      i. Supply/discharge air smoke/isolation damper
   4. Air handling unit supply fan array. Each fan is controlled via a packaged VFD with backup VFD.

B. Interlocking:
1. Whenever an AHU stops, all supply fans stop, AHU outside air and supply isolation dampers shall close and be proven closed by end switches.

2. Energy Recovery system shall be proven operational prior to enabling supply air system as indicated by BAS signal from Energy Recovery System controller.
   a. There shall be an optional override at the BAS to start the unit without the Energy Recovery system enabled.

3. Exhaust air handling unit (EAHU-X) fans shall be proven operational via exhaust fan status prior to enabling supply air system.
   a. There shall be an optional override at the BAS to start the unit without the associated EAHU enabled.

4. Refer to Energy Recovery System Control Sequence for additional interlocked points and hardwired sensors.

5. Software interlock associated humidifier so that humidifier will be inoperative and humidifier control valves will be fully closed when the following conditions occur:
   a. Respective air handling unit supply fans are not operating.

6. When an air handling unit is not operating except during low temperature switch shutdown, control devices shall be in the following positions:
   a. Supply smoke/isolation air damper Closed
   b. Outside air damper Closed
   c. Chilled water cooling coil control valve Closed
   d. Hot glycol water heating coil control valve Closed
   e. Energy Recovery coil control valves Under Control
   f. Humidifier solenoid control valves Under Control
   g. Supply fans Off

C. Unit Operation:
   1. Unit operation shall be automatic and activated through TridiumBAS.
      a. If one of three units in parallel is shut down for maintenance or due to safety interlock, the other unit shall continue to operate and the standby AHU shall be started.
      b. If one unit is on (primary-lead unit) and the other is off (standby unit) in parallel, when the standby unit is commanded to start, following start up sequence below, unit shall restart with the leadprimary unit still on. When the standby unit is proven operational and fan arrays for primary unit and standby unit are operating in parallel, leadprimary unit shall stop. When leadprimary AHU is stopped, primary/standby/lead-lag-standby AHU designation shall be switched.
      c. On failure of lead/lagprimary AHU, lock out primary AHU, start standby AHU, and generate an alarm through the BAS.
         1) When an automatically locked out AHU is released from lockout, it shall become the standby AHU, and the operating AHU shall become the primary.
   2. System does not require occupied-unoccupied operation. System shall operate continuously when enabled.

D. System and Fan Operation:
   1. System shall manually start/stop and run continuously by command from operator via BAS command point.
2. When an AHU is commanded to start via BAS command point, the following sequence shall occur:
   a. Associated EAHU system shall be proven on.
   b. Energy recovery system shall be proven on.
   c. AHU supply fans shall start and hold at minimum speed while AHU discharge smoke/isolation damper and outside air damper open. When discharge smoke/isolation damper and outside air dampers are proven open via open position end switches, AHU supply fans shall be released to control allowing fans to ramp up.
      1). On initial startup and any time system has been restarted after a shutdown, supply and associated exhaust systems shall be held at minimum speed and released to control simultaneously.
      2). Whenever the respective supply isolation damper or outside air damper do not prove open via open position end switches within 60 seconds (FA) of open command, the dampers shall close, the AHU fans shall fail, and an alarm shall be annunciated at the BAS. The failed AHU shall be locked out and remain locked out until manually reset through the BAS.
   d. When system is commanded to stop; supply fans shall stop, the outside air dampers shall close. AHU supply smoke/isolation damper shall close when supply fans reach minimum speed.
   e. When any fan is commanded to start via H-O-A switch on VFD, the following sequence shall occur:

E. Fan Failure Detection:

1. If an AHU supply fan failure occurs, as detected by VFD status or fault indication, the failed supply fan shall be stopped, remaining operating supply fans shall ramp up to maintain system airflow, and an alarm shall be annunciated at the BAS. This alarm interlock shall be disabled for 60 seconds (FA) after the fan is initially commanded to start.
   a. When failed AHU supply fan is reset through BAS, failed supply fan shall restart on minimum speed. When failed AHU supply fan is operating normally, AHU supply fan speeds shall be controlled in parallel.
2. If two or more supply fans fail, as detected by VFD status or fault indication, or system duct static pressure falls and remains below setpoint for 5 consecutive minutes (FA), the AHU shall be stopped, the outside air and outlet isolation dampers shall be closed, and an alarm shall be annunciated at the BAS. This alarm interlock shall be disabled for 60 seconds (FA) after the AHU is initially commanded to start.
   a. When failed AHU is reset through BAS, failed AHU supply fans shall restart as indicated previously in this section. When failed AHU supply fan is operating normally, AHU supply fan speeds shall be controlled in parallel.
3. If both AHU fan arrays fail, as detected by system duct static pressure falls and remains below setpoint for 10 consecutive minutes (FA), the interlocked EAHU exhaust fans shall go to minimum speed. Interlocked EAHU exhaust fans shall remain at minimum speed until system duct static pressure setpoint is met.
4. If an AHU failure occurs, as detected by all VFD fault indications, or failed outlet isolation damper, the failed AHU shall be stopped, standby AHUs shall start and ramp up to maintain system airflow, and an alarm shall be annunciated at the BAS. This alarm interlock shall be disabled for 60 seconds (FA) after the AHU is initially commanded to start.
a. When failed AHU is reset through BAS, failed AHU supply fan wall array fans shall restart on minimum speed. When failed AHU supply fans are proven operational by status indication, outside air damper of failed AHU shall open. When outside air damper is proven open with open position end switch, AHU supply fans shall ramp up to 20% speed while operating AHU’s serving the system ramp down to 55%. When AHU fan speeds are at the speeds indicated, the restarted AHU’s supply smoke/isolation damper shall open and restarted AHU fan speeds shall ramp up to match the operating AHU’s fan speeds. When all fans are operating at same speed, speed control of all AHU’s shall be released to control, to maintain system at static pressure setpoint.

5. If both AHU’s fail, as detected by system duct static pressure falls and remains below setpoint for 10 consecutive minutes (FA), the interlocked EAHU exhaust fans shall go to minimum speed. Interlocked EAHU exhaust fans shall remain at minimum speed until system duct static pressure setpoint is met.

6. Provide a manual reset switch at the AHU temperature control panel to reset all locked out fans locally as well as through the BAS.

7. Provide a manual reset switch at the AHU temperature control panel to reset all locked out fans locally as well as through the BAS.

F. System Air Volume Control:
1. Each AHU shall have its own hardwired discharge static pressure sensor. Both sensors will be located where the ducts first converge into a single duct.
   a. WireProvide the following to the individual AHU controller:
      1. (1) one existing sensor for AHU-7
      2. (1) one existing sensor for AHU-8

2. Static pressure control shall low select the lowest reading static of existing pressure transmitters. Low selected remote static pressure sensor shall reset setpoint of both AHU discharge static pressure transmitters.
   a. See 3.1.J System Air Volume Control (for variable volume AHUs with static pressure transmitters)
   b. Controls Contractor is to provide exact location of static pressure transmitters for inclusion on the building graphics.

G. Unit Discharge Air Temperature Control:
1. General:
   a. Discharge air temperature shall be controlled through the BAS with temperature sensors located as specified herein.
   b. Discharge air temperature shall be controlled to 55°F (FA).

2. Energy Recovery/Preheating Coil– All Modes
   a. Energy recovery AHU control valves shall be enabled when air flow is detected via supply airflow measuring station.
   b. Energy recovery system controller shall modulate flow to each respective coil to maximize heat transfer and to maintain discharge air temperature setpoint immediately downstream of energy recovery coil.
      1). When cooling coil is off and unit supply temperature is above setpoint, cooling coil discharge temperature shall be reset -1°F (FA) until unit supply temperature is at setpoint.

3. Reheating Coil Discharge Air Temperature Control – Normal Operation:
   a. Reheating coil control valve shall modulate to maintain coil discharge air temperature at setpoint via averaging type sensor downstream of the humidifier.
1. As coil discharge air temperature decreases, reheating coil control valve shall modulate open to maintain coil discharge air temperature at setpoint. The reverse shall occur as coil discharge air temperature increases.

   b. Reheating coil discharge air temperature setpoint shall be reset to maintain AHU discharge air temperature at 55°F (FA), as measured by probe type sensor downstream of the discharge air smoke/isolation damper.

4. Reheating Coil Discharge Air Temperature Control – AHU Not Running Operation:
   a. Reheating coil control valve shall modulate to maintain 48°F (FA) reheating coil discharge air temperature anytime AHU is not running and safety low temperature limit control (freeze-stat) is not in alarm.

5. Cooling Coil Discharge Air Temperature Control:
   a. On a call for cooling, the heating valves shall be closed before the cooling coil control valve shall be allowed to modulate open.
   b. Cooling coil control valve shall modulate to maintain unit discharge air temperature of 55°F (FA) via probe type sensor located in the supply duct downstream of the AHU discharge smoke/isolation dampers.

   1). In cooling mode when outside air temperature is above 49°F (FA) as unit discharge air temperature increases, cooling coil control valve shall modulate open to maintain unit discharge air temperature at setpoint. The reverse shall occur as unit discharge air temperature decreases.
   c. Cooling coil control valve shall be locked in closed position whenever outside air temperature is below 49°F (FA) for 10 consecutive minutes (FA) or whenever associated supply fan is not operating, when safety low temperature limit control (freeze-stat) is not in alarm.
   d. The BAS shall monitor space humidity via return air humidity sensor. When the space dew point rises above 53°F (FA), the cooling coil control shall be overridden and the discharge air temperature set point shall be lowered to maintain space dew point at 52°F (FA) or below.

6. The cooling coil control valve and preheating coil control valve shall not be allowed to operate simultaneously.

H. Humidity Control:
   1. Humidifiers - Space Humidity Control
      a. If all supply fans are off, its respective humidifier valves shall close.
      b. Humidifier valves shall be enabled when air flow is detected via supply airflow measuring station.
      c. Humidifier control package, after being enabled by AHU control, shall be staged open/closed solenoid control valves to maintain exhaust humidity setpoint 30% RH within ±5% RH of setpoint (FA).
      2. Exhaust air humidity sensors are located in exhaust air ducts upstream of Exhaust Air Handling Unit.
      2-3. Exhaust Air Handling Units Control is part of the Phase 1 provided Controller. AHU shall receive humidity signal through Tridium for humidity control.

I. Duct Mounted Ion Detector (IDETECT)
   1. IDETECT sensor is owner furnished contractor installed. Install sensor in supply ductwork at discharge of AHU.

J. Smoke Control:
1. Duct Smoke Detectors
   a. Duct mounted smoke detectors are specified to be furnished, installed, and wired to the building fire alarm system under Fire Alarm.
   b. Each detector shall provide an available contact closure for use by BAS, or an external addressable relay module shall be provided for this function. The contact shall be hardwired by the BAS contractor to shut down the supply fan and return fan arrays, and generate a binary input alarm at the BAS. The BAS contractor shall provide a pilot relay if necessary.
   c. Through software, this shall disable the supply fan arrays, close the outdoor air damper, and close the chilled water valve.

K. Safeties:
   1. Provide safety low temperature limit control (freeze-stat), with 3 minute (FA) time delay from fan start signal at entering side of cooling coil. Low limit shall de-energize unit supply fans; close outside air damper, close supply isolation damper, open cooling coil control valve; and modulate reheating coil control valves to maintain reheat coil discharge air temperature (measured downstream of reheat coil) at 60°F (FA) when air temperature falls below 38°F (FA) over any one-foot section of the freezestat. Low limit shall be functional in VFD H-O-A mode of operation.
   2. Provide high static pressure limit control, with sensor located in unit discharge air duct downstream of supply smoke/isolation damper, to limit fan volume control at 4.5" WC (FA) when pressure reaches this value.
   3. Provide high static pressure safety switch between discharge of supply fan wall array fans and outlet smoke/isolation damper and wire in series with VFD safety circuits to stop respective supply fans. The pressure switch shall be adjusted to 5.0" WC (FA). The status of the pressure switch shall be wired to the BAS system for alarming. The pressure switch must be manually reset locally before the air handling unit can be restarted. High static pressure safety switch shall be functional in VFD hand mode of operation. If high static pressure safety switch is tripped, AHU shall be shutdown.
   4. Provide low static suction pressure safety switch downstream of cooling coil and upstream of supply fan wall array fans and wire in series with VFD safety circuit to stop respective supply fans. The pressure switch shall be adjusted to -5.0" WC (FA). The status of the pressure switch shall be wired to the BAS system for alarming. The pressure switch must be manually reset locally before the air handling unit can be restarted. Low static pressure safety switch shall be functional in VFD hand mode of operation. If low static suction safety switch is tripped, AHU shall be shutdown.

L. Power Failure Mode:
   1. AHU is served by emergency power and shall be allowed to operate during emergency power operation.
   2. When normal power fails as indicated by automatic transfer switch, all operating AHU in the system shall be commanded stopped.
   3. When emergency power is established as indicated by automatic transfer switch, normal control sequence shall be initiated. Refer to POWER FAILURE MODE SEQUENCE, Paragraph 3.2 for restart sequence.
   4. Upon resumption of normal power as indicated by automatic transfer switch, normal AHU system operation shall resume with no interruption of power to operating AHU. Refer to POWER FAILURE MODE, previously documented in this specification section for restart sequence of stopped AHUs.

M. Monitor and Alarm
1. Each alarm shall be recorded in the alarm event log. Each alarm shall require an operator acknowledgment at the BAS.

2. Each alarm shall automatically return to normal when status and command conditions match. The return to normal status shall be recorded in the alarm event log. No operator acknowledgment shall be required on the return to normal.

3. Monitor, through BAS, the following points associated with air handling system and generate the alarms indicated:
   a. Discharge air temperature – each AHU (AI)
      1. Generate Urgent Alarm if temperature exceeds setpoint by ±3°F (FA).
   b. Discharge air humidity – each AHU (AI) (See humidit13y control sequence)
      1. Generate Urgent if supply humidity rises above 70% RH (FA).
   c. Reheating coil discharge air temperature – each AHU (AI)
      1. Generate High Priority alarm if temperature deviates from setpoint by ±3°F (FA) for 10 consecutive minutes (FA).
   d. Low limit thermostat (freezestat) – each AHU (DI)
      1. Generate Urgent alarm and stop AHU.
   e. Discharge air humidity – each AHU (AI)
      1. Generate Urgent alarm if discharge % RH exceeds setpoint by ±5% RH.
   f. Supply fan VFD status - each fan (DI)
   g. Supply fan VFD Fault – (DI)
      1. Generate Urgent alarm.
   h. VFD H-O-A switch – VFD (DI)
      1. Generate High Priority alarm if switch is in any position other than auto.
   i. Outside air damper position – open and closed (DI)
      1. Generate Urgent alarm if damper is not proven open within 60 seconds (FA) of AHU start signal or closed within 60 seconds (FA) of AHU stop signal.
   j. AHU smoke/isolation damper position – open and closed – (DI)
      1. Generate Urgent alarm if damper is not proven open within 60 seconds (FA) of fan start signal or proven closed within 60 seconds (FA) of fan stop signal.
   k. Prefilter pressure drop – each filter (AI)
      1. Generate General Maintenance alarm when filter pressure drop exceeds setpoint of 0.5” WC (FA).
   l. Final filter pressure drop – each filter (AI)
      1. Generate General Maintenance alarm when filter pressure drop exceeds setpoint of 1.5” WC (FA).
   m. Supply duct static pressure transmitter – each transmitter (AI)
      1. Generate High Priority alarm if pressure deviates from setpoint by ±1” WC (FA) for 5 consecutive minutes (FA).
   n. Fan discharge low static pressure safety switch – (DI)
      1. Stop fan and generate Urgent alarm if pressure exceeds -5” WC (FA).
   o. Fan discharge high static pressure safety switch – (DI)
      1. Stop fan and generate Urgent alarm if pressure exceeds 5” WC (FA).
   p. Duct static pressure transmitter – (AI)
      1. Generate High Priority alarm if pressure exceeds setpoint by ±1.0” WC (FA).
   q. Supply fan discharge smoke detector – (DI)
3.6 LAB AIR HANDLING UNIT AHU-2 & 4 (1 & 3 EXISTING)

A. System Description:
   1. Refer to drawing IC-751.
   2. Each unit is 100% outside air unit with run-around heat recovery.
   3. Units are sized so that 4 air handling units can serve the respective lab space at 100% design air flow.
   4. Air handling unit consists of:
      a. Supply fan array with backdraft damper on each fan
      b. Two VFDs for supply fan array. One VFD is fully redundant.
      c. Chilled water cooling coil
      d. Energy Recovery water heating/cooling coil
      e. Pre-filter
      f. Final-filter
      g. Bipolar Ionization
      h. Outside air damper
      i. Supply smoke/isolation air damper
   5. Supply fan motor status is indicated by a current switch on each fan.

B. Interlocking:
   1. Whenever an AHU stops, all AHU supply fans stop, AHU outside air damper and supply isolation damper shall close and be proven closed by end switches.
   2. Energy Recovery system shall prove operational prior to enabling supply air system as indicated by BAS signal from Energy Recovery System controller.
      a. There shall be an optional override at the BAS to start the unit without the Energy Recovery system enabled.
   3. Exhaust air handling unit (EAHU-1, 2 and 3) fans shall be proven operational via current sensor on exhaust fans prior to enabling supply air system.
      a. There shall be an optional override at the BAS to start the unit without the associated EAHU enabled.
   4. Refer to Energy Recovery System Control Sequence for additional interlocked points and hardwired sensors.
   5. When an air handling unit is not operating except during low temperature switch shutdown, control devices shall be in the following positions:
      a. Supply smoke/isolation air damper Closed
      b. Outside air damper Closed
      c. Chilled water cooling coil control valve Closed
      d. Hot glycol water heating coil control valve Closed
      e. Energy Recovery coil control valves Under Control
      f. Supply fans Off

C. Unit Operation:
   1. Unit operation shall be automatic and activated through BAS Tridium.
2. All units shall start and ramp fans together. All units shall receive static pressure setpoint from Tridium for fan control.


D. System and Fan Operation:
   1. System shall operate continuously.
   2. System shall manually start/stop and run continuously by command from operator via BAS command point.
   3. When an AHU is commanded to start via BAS command point, the following sequence shall occur:
      a. AHU supply fans shall start and hold at minimum speed while AHU discharge smoke/isolation damper and outside air damper open. When supply smoke/isolation damper and outside air dampers are proven open via open position end switches, AHU supply fans shall be released to control allowing fans to ramp up.
      b. When system is commanded to stop; supply fans shall stop, the outside air dampers shall close. AHU supply smoke/isolation damper shall close when supply fans reach minimum speed.
      c. When any fan is commanded to start via H-O-A switch on VFD, the following sequence shall occur:

E. Fan Failure Detection:
   1. If an AHU supply fan failure occurs, as sensed by current switch, an alarm shall be annunciated at the BAS. This alarm interlock shall be disabled for 120 seconds (FA) after the fans are initially commanded to start. Upon failure, affected supply fan shall shut down while remaining supply fans continue to operate to maintain static pressure setpoint.
   2. If supply fan VFD failure occurs, as detected VFD fault indication from VFD output, the fans shall be stopped and an alarm shall be annunciated at a Tridium workstation. This alarm interlock shall be disabled for 60 seconds (FA) after the fans are initially commanded to start. Upon failure, the AHU shall be shut down.
   3. If AHU fails, the interlocked EAHU exhaust fans shall go to minimum speed. Interlocked EAHU exhaust fans shall remain at minimum speed until system duct static pressure setpoint is met.
   4. Provide manual reset switch at the AHU temperature control panel to reset unit locally as well as through the BAS.
      a. Each alarm shall automatically return to normal when status and command conditions match. The return to normal status shall be recorded in the alarm event log. No operator acknowledgment shall be required on the return to normal.

F. System Air Volume Control
   1. Each AHU shall have its own hardwired discharge static pressure sensors. Both sensors will be located where the ducts first converge into a single duct.
      a. Wire to existing:
         1). (5) sensors for AHU-3/4
2. Existing static pressure transmitters in supply ducts shall reset setpoint of both AHU discharge static pressure transmitters. Discharge static pressure transmitter shall be used to modulate fan VFD thru BAS.
   a. See 3.1.O System Air Volume Control (for variable volume AHUs with static pressure transmitters)
   b. AHU controller shall receive an averaged static pressure control setpoint from Tridium.
   c. Controls Contractor is to provide exact location of static pressure transmitters for inclusion on the building graphics.

G. Unit Discharge Air Temperature Control:
   1. General:
      a. Discharge air temperature shall be controlled through the BAS with temperature sensors located as specified herein.
      b. Discharge air temperature shall be controlled to 55°F (FA).
   2. Energy Recovery/Preheating Coil– All Modes
      a. Energy recovery AHU control valves shall be enabled when air flow is detected via supply airflow measuring station.
      b. Konvekta control package shall modulate flow to each respective coil based on proprietary software to maximum heat transfer and to maintain discharge air temperature setpoint immediately downstream of energy recovery coil.
         1). When cooling coil is off and unit supply temperature is above setpoint, cooling cool discharge temperature shall be reset -1°F (FA) until unit supply temperature is at setpoint.
      c. Energy recovery coil control valve shall modulate to maintain 48°F (FA) heating coil discharge air temperature anytime AHU is not running and safety low temperature limit control (freeze-stat) is not in alarm.
   3. Cooling Coil Discharge Air Temperature Control:
      a. On a call for cooling, the heating valves shall be closed before the cooling coil control valve shall be allowed to modulate open.
      b. Cooling coil control valve shall modulate to maintain unit discharge air temperature of 55°F (FA) via probe type sensor located in the supply duct downstream of the AHU discharge smoke/isolation dampers.
         1). In cooling mode when outside air temperature is above 49°F (FA) as unit discharge air temperature increases, cooling coil control valve shall modulate open to maintain unit discharge air temperature at setpoint. The reverse shall occur as unit discharge air temperature decreases.
      c. Cooling coil control valve shall be locked in closed position whenever outside air temperature is below 49°F (FA) for 10 consecutive minutes (FA) or whenever associated supply fan is not operating, when safety low temperature limit control (freeze-stat) is not in alarm.
      d. The BAS shall monitor space humidity via return air humidity sensor. When the space dew point rises above 53°F (FA), the cooling coil control shall be overridden and the discharge air temperature set point shall be lowered to maintain space dew point at 52°F (FA) or below.
   4. The cooling coil control valve and preheating coil control valve shall not be allowed to operate simultaneously.

H. Smoke Control:
   1. Duct Smoke Detectors
a. Duct mounted smoke detectors are specified to be furnished, installed, and wired to the building fire alarm system under Fire Alarm.

b. Each detector shall provide an available contact closure for use by BAS, or an external addressable relay module shall be provided for this function. The contact shall be hardwired by the BAS contractor to shut down the supply fan and return fan arrays, and generate a binary input alarm at the BAS. The BAS contactor shall provide a pilot relay if necessary.

c. Through software, this shall disable the supply fan arrays, close the outdoor air damper, and close the chilled water valve.

I. Duct Mounted Ion Detector (IDETECT)
   1. IDETECT sensor is owner furnished contractor installed. Install sensor in supply ductwork at discharge of AHU.

J. Safeties:
   1. Provide safety low temperature limit control (freeze-stat), with 3 minute (FA) time delay from fan start signal at entering side of cooling coil. Low limit shall de-energize unit supply fans; close outside air damper, close supply isolation damper, open cooling coil control valve; and modulate reheating coil control valves to maintain reheat coil discharge air temperature (measured downstream of reheat coil) at 60°F (FA) when air temperature falls below 38°F (FA) over any one-foot section of the freezestat. Low limit shall be functional in VFD H-O-A mode of operation.
   2. Provide high static pressure limit control, with sensor located in unit discharge air duct downstream of supply smoke/isolation damper, to limit fan volume control at 4.5" WC (FA) when pressure reaches this value.
   3. Provide high static pressure safety switch between discharge of supply fan wall array fans and outlet smoke/isolation damper and wire in series with VFD safety circuits to stop respective supply fans. The pressure switch shall be adjusted to 5.0" WC (FA). The status of the pressure switch shall be wired to the BAS system for alarming. The pressure switch must be manually reset locally before the air handling unit can be restarted. High static pressure safety switch shall be functional in VFD hand mode of operation. If high static pressure safety switch is tripped, AHU shall be shutdown.
   4. Provide low static suction pressure safety switch downstream of cooling coil and upstream of supply fan wall array fans and wire in series with VFD safety circuit to stop respective supply fans. The pressure switch shall be adjusted to -5.0" WC (FA). The status of the pressure switch shall be wired to the BAS system for alarming. The pressure switch must be manually reset locally before the air handling unit can be restarted. Low static pressure safety switch shall be functional in VFD hand mode of operation. If low static suction safety switch is tripped, AHU shall be shutdown.

K. Power Failure Mode:
   1. AHU is served by emergency power and shall be allowed to operate during emergency power operation.
   2. When normal power fails as indicated by automatic transfer switch, all operating AHU in the system shall be commanded stopped.
   3. When emergency power is established as indicated by automatic transfer switch, normal control sequence shall be initiated. Refer to POWER FAILURE MODE SEQUENCE, Paragraph 3.2 for restart sequence.
   4. Upon resumption of normal power as indicated by automatic transfer switch, normal lab AHU system operation shall resume with no interruption of power to operating AHU. Refer to
POWER FAILURE MODE, previously documented in this specification section for restart sequence of stopped AHUs.

L. Monitor and Alarm
1. Each alarm shall be recorded in the alarm event log. Each alarm shall require an operator acknowledgment at the BAS.
2. Each alarm shall automatically return to normal when status and command conditions match. The return to normal status shall be recorded in the alarm event log. No operator acknowledgment shall be required on the return to normal.
3. Monitor, through BAS, the following points associated with air handling system and generate the alarms indicated:
   a. Unit discharge air temperature – each AHU (AI)
      1). Generate High Priority Alarm if temperature deviates from setpoint by ±2°F (FA) for 10 consecutive minutes (FA).
   b. Discharge air humidity – each AHU (AI) (See humidity control sequence)
      1). Generate High Priority Alarm if supply humidity rises above 65% RH (FA).
   c. Low limit thermostat (freezestat) – each AHU (DI)
      1). Generate Urgent alarm and stop AHU.
   d. Supply fan VFD Fault – each fan (DI)
      1). Generate Urgent alarm.
   e. Supply fan VFD motor status – each fan (DI)
      1). Generate High Priority alarm if fan is not in commanded state after a 120 (FA) second delay.
   f. VFD H-O-A switch – each VFD (DI)
      1). Generate High Priority alarm if switch is in any position other than auto.
   g. Discharge static pressure high limit – each AHU (AI)
      1). Generate High Priority alarm if pressure deviates from setpoint by +0.5” WC (FA) for 5 consecutive minutes (FA).
   h. Supply duct static pressure transmitter – each transmitter (AI)
      1). Generate High Priority alarm if pressure deviates from setpoint by ±1” WC (FA) for 5 consecutive minutes (FA).
   i. Discharge static pressure safety switch – each AHU (DI)
      1). Generate Urgent alarm and stop AHU if pressure exceeds 4.0” WC (FA).
   j. AHU supply static suction safety switch – each AHU (DI)
      1). Generate Urgent alarm and stop AHU if pressure falls below -3.0” WC (FA).
   k. Supply discharge smoke detector – each AHU (DI)
      1). Generate Urgent alarm and stop AHU.
   l. Pre-filter pressure drop – (AI)
      1). Generate General Maintenance alarm when filter pressure drop exceeds setpoint of 0.5” WC (FA).
   m. Final filter pressure drop – each AHU (AI)
   n. Generate General Maintenance alarm when pressure drop exceeds 1.2” WC
   o. IDETECT - Duct Mounted Ion Detector
      1). Generate High Priority alarm.
3.7 EXISTING EXHAUST ENERGY RECOVERY WITH EVAPORATIVE COOLING (UNITS 1-4)

A. Scope
   1. System Function
      a. Each exhaust energy recovery unit has one fan will always be on standby.
      b. Fan use will be rotated on a lead/standby status.
      c. Outlet cones are selected to provide minimum stack velocities at minimum flow with the use of OA bypass. Outlet cones for will require replacement as the system capacity is increased when additional spaces are fitted out.
   2. Components/control devices provided by others.
      a. Exhaust fans with no bypass starters.
      b. Isolation dampers per exhaust fan.
      c. Exhaust fan VFDs.
      d. DIV 28 smoke detectors
      e. Glycol water valve will be furnished by Konvektia.
      f. Dampers shall be provided with the unit.
      g. All other devices are assumed to be by this controls contractor.
   3. Operating Modes:
      a. Normal Occupied Mode: Fans shall run continuously.
      b. Normal Unoccupied Mode: Not applicable.
      c. Emergency Standby Power Mode: Fans are connected to emergency standby power. Fans shall automatically restart on resumption of power per cold start sequence.
      d. Fire/Smoke Mode: Fans shall continue to operate when a general fire alarm is annunciated and shall stop when smoke is detected in the supply air at any associated air handling unit.

B. Interlocking:
   1. EAHU-1 is interlocked with the following units:
      a. AHU-1
      b. AHU-2
      c. EF-1A thru 1D
      d. North side of the building exhaust and fume hoods for all floors
      e. HBP-2
   2. EAHU-2 is interlocked with the following units:
      a. AHU-3
      b. AHU-4
      c. EF-2A thru 2D
      d. South exhaust ducts and fume hoods for all floors
      e. HBP-2
   3. EAHU-3 is interlocked with the following units:
      a. AHU-1
      b. AHU-2
      c. EF-3A thru 3D
      d. HBP-3
   4. EAHU-4 is interlocked with the following units:
      a. AHU-5 (Existing)
      b. AHU-6 (Existing)
      c. AHU-7
      d. AHU-8
5. Whenever an EAHU stops, exhaust inlet air and exhaust outlet isolation dampers shall close and be proven closed by end switches.

6. Associated AHU will stop when associated EAHU stops.

3.8 TERMINAL UNITS - CONTROL SEQUENCES

A. General:

1. Where CO2 sensors are shown in a space with air terminal units, the BAS shall monitor the CO2 level, and a General Maintenance alarm shall be annunciated at the BAS when the space CO2 level exceeds 1000 ppm.
   a. Where multiple CO2 sensors are shown in a space, the BAS shall average the reading among the sensors and use the average reading for control.
   b. On failure of one or more CO2 sensors as, indicated by loss of control signal the control loop(s) associated with the failed transmitter(s) shall be removed from the average reading algorithm, an alarm generated at the BAS and the remaining operating CO2 sensor(s) shall be used for CO2 control.

2. When a space is provided with multiple temperature sensors, unless otherwise indicated, the BAS shall select the temperature sensor which is farthest from set point for terminal unit control.
   a. On failure of one or more temperature sensors as, indicated by loss of control signal, the control loop(s) associated with the failed transmitter(s) shall be removed from the average reading algorithm, an alarm generated at the BAS and the remaining operating temperature sensor(s) shall be used for temperature control.

3. When a space is served by multiple supply air terminals, unless otherwise indicated, controls shall modulate the reheat valves to maintain common supply air temperature from each supply air terminal which is reset to maintain space temperature.
   a. When a space is served by multiple supply air terminals, controls shall modulate the damper actuators in parallel unless otherwise noted in the sequences below.

4. Where humidity sensors are shown, the BAS shall calculate room dew point using space humidity and temperature sensors.

5. The electrical contractor shall provide an occupancy sensor with a dedicated dry contact or relay for each occupancy sensor. Occupancy sensors shall be hard wired from the dry contact/relay to the controller by the Controls Contractor. Where multiple occupancy sensors are shown within a space, wire the sensors in series or parallel to provide one occupied/unoccupied signal to the controller. Occupancy sensors shall be used for control of ‘Vacant Mode’ as described below in each sequence.

6. Dew point monitoring and safety control (where applicable) shall be active in occupied and unoccupied modes.
   a. When the space dew point rises above 56°F (FA), the chilled water control valve serving the space shall be commanded closed.
   b. When the space dew point drops below 56°F (FA), the chilled water control valve serving the space shall be released back to control per Air Flow Control and Temperature Control.

7. The office areas served by chilled beam shall use a common area (hallway) humidity sensor for dew point safety.
   a. When the dew point rises above 56°F (FA), the associated chilled water control valves serving the spaces shall be commanded closed.
   b. When the space dew point drops below 56°F (FA), the chilled water control valve serving the space shall be released back to control per Air Flow Control and Temperature Control.
8. Room Pressure Monitor:
   a. The room pressure shall be monitored at the BAS.

B. Occupied Modes

1. Office Area Occupancy Modes:
   a. Each zone shall operate on an occupied/unoccupied schedule. Initial occupied schedule shall be from 7 am to 7 pm and shall be fully adjustable at the BAS. Occupancy schedule shall be globally adjustable for all zones.
      1). Occupied Mode
          a). Terminal units and space temperature shall be controlled as described below.
          b). Spaces with adjustable thermostats shall have the maximum and minimum setpoint range programmed at the BAS. Initial range shall be 68°F - 74°F (FA). Local LCD display shall not be capable of adjustment beyond the range set at the BAS.
          c). Initial Occupied setpoint for spaces with non-adjustable thermostats shall be:
          d). Interior Zones: 73°F (FA) with a field adjustable deadband between heating and cooling adjustable at the BAS.
          e). Exterior Zones: 75°F Cooling (FA) and 70°F heating (FA).
      2). Unoccupied Mode
          a). Terminal units shall close or modulate to minimum, refer to mechanical schedules.
          b). Space temperature shall be allowed to drift ±4°F (FA) from space setpoint.
          c). When the space temperature drifts outside the allowable range, the air terminal and cooling terminal devices shall be released to control to bring the space back into the allowed range.
          d). Relative humidity shall be allowed to drift ±5%RH (FA) from space setpoint.
          e). When the space relative humidity drifts outside the allowable range, the air terminal and cooling terminal devices shall be released to control to bring the space back into the allowed range.
          f). Occupant-adjustable temperature sensors shall have an occupancy override button. The occupancy override button, when pressed shall override the zone into occupied mode for 2 hours (FA). For each zone graphic, provide a button/icon to allow the BAS operator to lock out the occupancy override button.
      3). Vacancy Mode
          a). During Occupied Mode, when the space occupancy sensor indicates that the room is unoccupied, the room shall enter Vacant Mode.
          b). During vacant mode, the space temperature shall be allowed to drift ±3°F (FA) from space setpoint. The air terminal serving the space shall remain under Occupied Mode control.
          c). When the occupancy sensor indicates that the room is occupied, the space shall return to Occupied Mode.

2. Lab Occupancy Modes:
   a. Lab zones shall not have occupied/unoccupied modes. Zones shall operate continuously.
   b. Occupancy schedule shall be globally adjustable for all zones.
      1). Occupied Mode
          a). Terminal units and space temperature shall be controlled as described below.
b). Spaces with adjustable thermostats shall have the maximum and minimum setpoint range programmed at the BAS. Initial range shall be 65°F - 75°F (FA). Local LCD display shall not be capable of adjustment beyond the range set at the BAS.

c). Initial Occupied setpoint for spaces with non-adjustable thermostats shall be 73°F (FA) with an adjustable degree deadband between heating and cooling adjustable at the BAS.

3. Lab Occupancy Modes for zones with Aircuity
   a. Lab zones shall not have occupied/unoccupied modes. Zones shall operate continuously.
   b. Occupancy schedule shall be globally adjustable for all zones. Purge Mode (each Zone)
      1). Indicated at the BAS or Purge Push Button within the zone.
         a). For each zone graphic, provide a button/icon to allow the BAS operator to start/stop the Purge Mode.
      2). When Purge Mode is activated, Terminal units shall maintain Maximum Occupied airflow as indicated on terminal unit schedules.
   c. Occupied Mode
      1). For each zone graphic, provide a button/icon to allow the BAS operator to
      2). Occupied Mode
         a). Terminal units and space temperature shall be controlled as described below.
         b). Spaces with adjustable thermostats shall have the maximum and minimum setpoint range programmed at the BAS. Initial range shall be 70°F - 74°F (FA). Local LCD display shall not be capable of adjustment beyond the range set at the BAS.
         c). Initial Occupied setpoint for spaces with non-adjustable thermostats shall be 73°F (FA) with a 4 degree deadband between heating and cooling.

4. Occupancy Modes for Vivarium
   a. Vivarium spaces shall not have occupied/unoccupied modes. Zones shall operate continuously.

C. Zones will typically consist of the following units:
   1. Terminal Chilled Beams, reheat coils, and/or radiant panels:
      a. Refer to drawings IC07-30 through IC07-33 for determination of control sequence applications.
      b. Provide one control valve per zone for each type of unit, i.e. for multiple chilled beams in a zone, provide one control valve.
   2. Air terminal Valves:
      a. Laboratory Temperature and Airflow Control System contractor shall provide controls and actuators. Refer to Section 23 3614 Laboratory Temperature and Airflow Control.
      b. Air Terminal Valves are pressure independent type.
      c. Refer to Air Terminal Device Schedules and drawings IC07-30 through IC07-33 for determination of control sequence applications.
      d. Unit dampers, damper actuators, pressure sensors, are furnished and installed by unit manufacturer.
   3. Fume Hoods:
      a. Fume hood air flow set point determination (vertical sash hoods).
1. The current sash height shall be determined by a sash position sensor installed into the hood. The sash shall be considered fully closed when it reaches any mechanical stops that limit closure.

2. Fixed parameters for each hood shall be configured for sash width, and for hood surface area in square feet.

3. Open face area shall equal the sash height multiplied by the sash width, in feet.

4. Current hood air flow setpoint shall be computed based on sash position.

b. Fume hood monitor
   1. The face-mounted fume hood monitor shall display current face velocity.
   2. The face-mounted fume hood monitor shall indicate alarm via dedicated indicator light.

4. Aircuity air quality sensors.

D. Air Flow for Terminal Units

1. Office
   a. Constant Volume Control
      1). Damper actuator on supply air terminal shall maintain airflow quantity scheduled. DDC Constant Air Volume (CAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.
      2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to total supply airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.
         a). Refer to terminal unit schedules for tracking pairs, including exhaust terminals tracking multiple supply terminals.
      3). Refer to terminal schedules for CFM setpoints.
   b. Variable Volume Control
      1). Damper actuator on supply air terminal shall modulate between maximum and minimum airflow setpoints to maintain space setpoint or CO2 level, as described below. DDC Variable Air Volume (VAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.
      2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room’s total supply airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.
      3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

2. Laboratory
   a. Constant Volume Control (Negatively Pressurized Space)
      1). Damper actuator on exhaust air terminal shall maintain airflow quantity scheduled. DDC Constant Air Volume (CAV) controller shall utilize airflow sensor in exhaust air terminal to continuously measure exhaust flow rate.
      2). DDC controller shall utilize airflow sensors in supply air terminal to continuously measure room supply airflow. CAV controller shall continuously calculate required supply airflow rate necessary to maintain predetermined offset, between total exhaust
and supply airflows, by subtracting or adding offset from/to room’s total exhaust airflow rate to determine supply airflow rate. Damper actuator serving supply air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

b. Constant Volume Control (Positively Pressurized Space)
1). Damper actuator on supply air terminal shall maintain airflow quantity scheduled. DDC Constant Air Volume (CAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.

2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room’s total supply airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

c. Variable Volume Control (Negatively Pressurized Space)
1). Damper actuator on exhaust air terminal shall modulate between maximum and minimum airflow setpoints to maintain space setpoint or CO2 level, as described below. DDC Variable Air Volume (VAV) controller shall utilize airflow sensor in exhaust air terminal to continuously measure exhaust flow rate.

2). DDC controller shall utilize airflow sensors in supply air terminal to continuously measure room supply airflow. VAV controller shall continuously calculate required supply airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room’s total exhaust airflow rate to determine supply airflow rate. Damper actuator serving supply air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

d. Variable Volume Control (Positively Pressurized Space)
1). Damper actuator on supply air terminal shall modulate between maximum and minimum airflow setpoints to maintain space setpoint or CO2 level, as described below. DDC Variable Air Volume (VAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.

2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room’s total exhaust airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

e. Variable Volume Control with Fume Hood
1). Airflow control for these zones consists of three fume hood exhaust terminals, general exhaust terminal serving the open lab area, and three supply terminals – one constant volume terminal serving the fume hood room, one constant volume terminal serving chilled beams in the open lab area, and one variable volume terminal serving the open lab area.

2). Damper actuator on each fume hood exhaust air terminal shall modulate between maximum and minimum airflow setpoints to maintain sash velocity on fume hood. Refer to 23 3614. DDC Variable Air Volume (VAV) controller shall utilize airflow sensors in exhaust air terminals to continuously measure exhaust flow rates.
3). Damper actuators on the two constant volume supply air terminals shall maintain airflow quantities scheduled. DDC controller shall utilize airflow sensor in each supply air terminal to continuously measure supply flow rate.

4). DDC controller shall utilize airflow sensors in the general exhaust air terminal to continuously measure exhaust airflow. VAV controller shall continuously calculate the required exhaust airflow rate necessary to maintain total exhaust airflow equal to [general exhaust terminal scheduled maximum airflow plus combined fume hood exhaust terminal scheduled minimum airflows].
   a). As the combined total airflow measured at the fume hood exhaust air terminals increases, the general exhaust air terminal shall modulate from maximum airflow to minimum airflow to maintain total exhaust airflow rate above.

5). DDC controller shall utilize airflow sensor in variable volume supply air terminal to continuously measure supply airflow. VAV controller shall continuously calculate required supply airflow rate necessary to maintain predetermined offset, between total exhaust and total supply airflows, by subtracting or adding offset from/to room’s total exhaust airflow rate to determine supply airflow rate. Damper actuator serving supply air terminal shall be modulated to maintain predetermined offset.
   a). Total supply airflow shall be equal to airflow measured at the terminal serving chilled beams plus airflow measured at the terminal serving the fume hood room plus airflow measured at the terminal serving the open lab space.
   b). Total exhaust airflow shall be equal to total airflow measured at the terminals serving fume hoods plus airflow measured at the terminal the open lab space.

6). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

E. Temperature Control
   1. Heating and cooling devices in each space shall operate described below. Refer to individual sequences for order in which devices are activated to control room setpoints.
   2. Heating Devices
      a. On a decrease in space temperature the following can occur in any sequence or in parallel:
         1). The space temperature sensor shall reset the terminal unit discharge air setpoint. Reheat coil valve shall modulate to maintain terminal unit discharge air setpoint.
         2). The radiant ceiling panel valve shall modulate to maintain the space setpoint.
         3). The chilled beam hot water valve shall modulate to maintain the space setpoint.
         4). The supply terminal unit shall modulate airflow to maintain the space setpoint, refer to the mechanical schedules for the maximum heating airflows.
   3. Cooling Devices
      a. On an increase in space temperature the following can occur in any sequence:
         1). The chilled beam chilled water valve shall modulate to maintain the space setpoint.
         2). The supply terminal unit shall modulate the airflow to maintain the space setpoint, refer to the mechanical schedules for the maximum airflows.
      4. Program a 4°F (FA) deadband between heating and cooling devices. Heating and Cooling valves shall not operate at the same time.

F. Monitor and Alarm
   1. Refer to Points list for BAS monitoring points for possible points for each sequence and generate the alarms. Additionally, the BAS shall monitor all humidity, CO2, occupancy sensors, room pressure sensors, and points associated with Aircuity.
      a. Space temperature (Al)
1. Generate High Priority alarm if space temperature exceeds setpoint by ±5°F (FA) for 15 consecutive minutes.
   b. Space temperature fault (DI)
   1. Generate High Priority alarm if space temperature sensor indicates a loss of signal.
   c. Space relative humidity (AI)
   1. Generate High Priority alarm if space temperature exceeds setpoint by ±5%RH (FA) for 15 consecutive minutes.
   d. Space CO2 Level (AI) – where shown
      a). Generate High Priority alarm when space CO2 level exceeds 1000 ppm (FA).
   e. Space CO2 fault (DI)
      1. Generate High Priority if CO2 sensor indicates a loss of signal.
   f. Supply/Return or Exhaust Offset (AD) – each room
      a). Generate High Priority alarm if offset exceeds setpoint by ±25% (FA) for 15 consecutive minutes (FA).

G. Sequence #A: Office with Exterior Exposure
   1. General
      a. Refer to Detail 1 on IC-753.
   2. Zone Consists of:
      a. Terminal Supply Valve
      b. Reheat coil
      c. Radiant Ceiling Panel (each office)
      d. Chilled Beam (each office)
      e. Space temperature sensor in each office
   3. Occupancy Mode:
      a. Office Area Occupancy Mode
   4. Air Flow Control
      a. Office Variable Volume Control
   5. Temperature Control:
      a. The terminal supply valve discharge air temperature sensor setpoint shall reset to maintain the lowest space temperature setpoint. The reheat coil shall modulate to maintain the supply valve discharge air temperature setpoint.
      b. On a decrease in space temperature the following devices will modulate to maintain the office room temperature setpoint:
         1). Radiant panel valve
      c. On an increase in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
         1). Chilled beam chilled water valve
         2). Then the terminal unit valve modulates airflow

H. Sequence #B: Hallways Associated with Offices
   1. General
      a. Refer to Detail 2 on Drawing IC-753.
   2. Zone Consists of:
      a. Terminal exhaust valve
3. Occupancy Mode:
   a. Office Area Occupancy Mode

4. Air Flow Control
   a. Office Variable Volume Control

I. Sequence #C: Lobby Areas
   a. Refer to Detail 3 on Drawing IC-730.

2. Zone Consists of:
   a. Terminal supply unit with a reheat coil.
   b. Combo AFMS and damper
   c.

3. Occupancy Mode
   a. Office Area Occupancy Mode

4. Air Flow Control
   a. Office Variable Volume Mode
      1). Damper actuator on supply air terminal shall modulate between maximum and
         minimum airflow setpoints to maintain space setpoint or CO2 level, as described
         below. DDC Variable Air Volume (VAV) controller shall utilize airflow sensor in supply
         air terminal to continuously measure supply flow rate.
      2). DDC controller shall utilize airflow station in exhaust duct to continuously measure
         room exhaust airflow. CAV controller shall continuously calculate required
         exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and
         supply airflows, by subtracting or adding offset from/to room's total supply airflow rate
         to determine exhaust airflow rate. Damper actuator serving exhaust duct shall be
         modulated to maintain predetermined offset.
      3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

5. Temperature Control:
   a. On a decrease in space temperature the following devices will modulate in sequence to
      maintain the room temperature setpoint:
      1). Terminal supply valve shall modulate from max to min airflow per occupancy mode.
      2). Reheat coil valve
      3). Terminal supply valve shall modulate from min to max (max heating airflow per
         mechanical schedules) airflow per occupancy mode.
   b. On an increase in space temperature the devices will modulate in reverse of the above to
      maintain the room temperature setpoint:

J. Sequence #D: Main Hallways
   1. General
      a. Refer to Detail 4 on Drawing IC-753.
   2. Zone Consists of:
      a. Terminal supply valve
      b. Reheat coil
      c. Radiant Ceiling Panel
   3. Occupancy Mode
      a. Office Area Occupancy Modes
   4. Air Flow Control
a. Office Variable Volume Mode

5. Temperature Control:
   a. On a decrease in space temperature the following devices will modulate in sequence to
      maintain the office room temperature setpoint:
         1). Radiant panel valve
         2). Reheat coil
   b. On an increase in space temperature the devices will modulate in reverse of the above to
      maintain the room temperature setpoint:

K. Sequence #E: Open Two Story Area
   1. General
      a. Refer to Detail 1 on IC-754.
   2. Zone Consists of:
      a. Constant volume air terminal valve with a reheat coil.
      b. Heating and Cooling Chilled Beam(s)
      c. Fin tube radiation
   3. Occupancy Mode:
      a. Office Area Occupancy Mode
   4. Air Flow Control
      a. Office Variable Volume Control
   5. Temperature Control:
      a. The terminal supply valve discharge air temperature sensor setpoint shall reset to the
         maintain space temperature setpoint. The reheat coil shall modulate to maintain the
         supply valve discharge air temperature setpoint.
      b. On a continued decrease in space temperature the following devices will modulate in
         parallel to maintain the room temperature setpoint:
         1). Chilled beam hot water valve
         2). Fin tube radiation hot water valve
      c. On an increase in space temperature the following devices will modulate in sequence to
         maintain the room temperature setpoint:
         1). Chilled beam chilled water valve
         2). Then the terminal unit valve modulates airflow

L. Sequence #F: Open Office Areas
   1. General
      a. Refer to Detail 2 on Drawing IC-754.
   2. Zone Consists of:
      a. Terminal supply valve with a reheat coil.
      b. Terminal exhaust valve
      c. Chilled Beam(s)
   3. Occupancy Mode:
      a. Office Area Occupancy Mode
   4. Air Flow Control
      a. Office Variable Volume Control
   5. Temperature Control:
a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
   1). Terminal supply valve shall modulate from max to min airflow per occupancy mode.
   2). Reheat coil valve
   3). Terminal supply valve shall modulate from min to max (max heating airflow per mechanical schedules) airflow per occupancy mode.

b. On an increase in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
   1). Chilled beam chilled water valve
   2). Terminal supply valve shall modulate from min to max airflow per occupancy mode.

M. Sequence #G: Restrooms
   1. General
      a. Refer to Detail 4 on Drawing IC-754.
   2. Zone Consists of:
      a. Terminal Exhaust Valve
      b. Radiant Ceiling Panel (where shown on plans)
   3. Occupancy Mode
      a. Office Area Occupancy Mode
   4. Air flow Control
      a. Office Constant Volume Control
   5. Temperature Control:
      a. On a decrease in space temperature the following devices will modulate to maintain the room temperature setpoint:
         1). Radiant heating panel valve (where shown on plans)
      b. On an increase in space temperature the devices will modulate in reverse of the above to maintain the room temperature setpoint:

N. Sequence #H: Main Laboratory Area & Fume Hood Room
   1. General
      a. Refer to Detail 1 on IC-755.
   2. Zone Consists of:
      a. Terminal supply valve(s) with a reheat coil.
      b. Terminal exhaust valve(s)
      c. Aircurity
      d. Chilled Beam(s)
      e. Fume Hood(s)
   3. Occupancy
      a. Lab Occupancy Mode with Aircurity
   4. Air Flow
      a. Variable Volume Control with Fume Hood
   5. Temperature Control
      a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
         1). Terminal supply valve shall modulate from max to min airflow per occupancy mode.
2). The terminal supply valve discharge air temperature sensor setpoint shall reset to the maintain space temperature setpoint. The reheat coil shall modulate to maintain the supply valve discharge air temperature setpoint.

3). Terminal supply valve shall modulate from min to max (max heating airflow per mechanical schedules) airflow per occupancy mode.

b. On an increase in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:

1). Chilled beam chilled water valve
2). Terminal supply valve shall modulate from min to max airflow per occupancy mode.

O. Sequence #: Vivarium Animal Procedure/Holding Room
1. General
   a. Refer to Detail 1 on IC-756.

2. Zone Consists of:
   a. Terminal Supply Valve
   b. Terminal Exhaust Valve
   c. Terminal Exhaust Valve serving cages (where shown on plans)
   d. Reheat coil
   e. Aircuity

3. Occupancy Mode:
   a. Occupancy Mode for Vivarium

4. Air Flow:
   a. Laboratory Constant Volume Control

5. Temperature Control:
   a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
      1). Reheat coil valve
   b. On an increase in space temperature the devices will modulate in reverse of the above to maintain the room temperature setpoint:

P. Sequence #J: Linear Equipment Room
1. General
   a. Refer to Detail 2 on Drawing IC-756.

2. Zone Consists of:
   a. Terminal supply valve with reheat
   b. Terminal exhaust valve
   c. Chilled Beam

3. Occupancy Mode:
   a. Lab Occupancy Mode

4. Air Flow Control:
   a. Laboratory Constant Volume Control

5. Temperature Control:
   a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
      1). Reheat coil valve
b. On an increase in space temperature the following devices will modulate to maintain the 
   room temperature setpoint:
   1). Chilled beam chilled water valve

Q. Sequence #K: Wet Lab Procedure Room
   1. General
      a. Refer to Detail 3 on Drawing IC-756.
   2. Zone Consists of:
      a. Terminal supply valve with a reheat coil.
      b. Terminal exhaust valve
      c. Chilled Beam(s)
   3. Occupancy Mode:
      a. Lab Occupancy Mode
   4. Air Flow Control
      a. Laboratory Variable Volume Control
   5. Temperature Control:
      a. On a decrease in space temperature the following devices will modulate in sequence to
         maintain the room temperature setpoint:
         1). Terminal supply valve shall operate airflow per occupancy mode.
         2). The terminal supply valve discharge air temperature sensor setpoint shall reset to the
            maintain space temperature setpoint. The reheat coil shall modulate to maintain the
            supply valve discharge air temperature setpoint.
      b. On an increase in space temperature the following devices will modulate in sequence to
         maintain the room temperature setpoint:
         1). Chilled beam chilled water valve
         2). Then the terminal unit valve modulates airflow

R. Sequence #L: Sterilizer/Clean/Soil Room
   1. General
      a. Refer to Detail 4 on IC-756.
   2. Zone Consists of:
      a. Terminal Supply Valve
      b. Terminal Exhaust Valve serving sterilizer
      c. Reheat coil
   3. Occupancy Mode:
      a. Lab Occupancy Mode
   4. Air Flow:
      a. Laboratory Constant Volume Control
   5. Temperature Control:
      a. On a decrease in space temperature the following devices will modulate in sequence to
         maintain the room temperature setpoint:
         1). Reheat coil valve
      b. On an increase in space temperature the devices will modulate in reverse of the above to
         maintain the room temperature setpoint.

S. Sequence #N: Hallways
1. General  
   a. Refer to Detail 1 on Drawing IC-757.
2. Zone Consists of:  
   a. Terminal supply valve  
   b. Reheat coil
3. Occupancy Mode  
   a. Lab Occupancy Mode
4. Air flow Control  
   a. Lab Constant Volume Control
5. Temperature Control:  
   a. On a decrease in space temperature the following devices will modulate to maintain the room temperature 70°F (FA) heating setpoint:  
      1). Reheat coil  
   b. On an increase in space temperature the devices will modulate in reverse of the above to maintain the room temperature setpoint.

T. Sequence #Q: Vivarium Mechanical Room
1. General  
   a. Refer to Detail 2 on IC-757.
2. Zone Consists of:  
   a. Terminal Supply Valve  
   b. Terminal Exhaust Valve  
   c. Reheat Valve
3. Occupancy Mode:  
   a. Laboratory Occupancy Mode
4. Air Flow Control  
   a. Laboratory Variable Volume Control
5. Temperature Control:  
   a. On a decrease in space temperature the following devices will modulate to maintain the room temperature setpoint:  
      1). Then the reheat coil valve modulates to maintain room temperature setpoint of 70°F (FA).

3.9 FIN TUBE AND RADIANT PANEL - CONTROL SEQUENCE

A. General
   1. Refer to Detail 1 & 5 on drawing IC-758.

B. System Operation
   1. A space temperature sensor shall modulate control valve to each unit to maintain space set point temperature.

C. Monitor through the BAS the following points and generate the alarms indicated (refer to Points List for additional monitoring points):
   1. Space temperature (AI)  
      a. Generate General Maintenance alarm if space temperature exceeds setpoint by ±5°F (FA) for 15 consecutive minutes (FA).
3.10 UNIT HEATERS/CABINET UNIT HEATERS - CONTROL SEQUENCE

A. General
   1. Refer to Detail 2 on drawing IC-758.

B. Space temperature sensor shall open/close control valve in return line from each unit to maintain space set point temperature. Line voltage aquastat shall start unit fan on rise in return line temperature above preset temperature of 175°F (FA) and stop fan on drop below set temperature.

C. Cabinet unit heater serving ComEd space shall have line voltage temperature sensor.

3.11 BLOWER COIL UNIT/COOLING ONLY FAN COIL UNIT (COOLING ONLY)

A. General
   1. Refer to Detail 3 on drawing IC-758.

B. System Operation
   1. Fan shall start on a call for cooling and shall stop when space temperature setpoint is satisfied.
   2. Setpoint for IT closets/spaces shall be 72°F (FA).
   3. Setpoint for all other spaces shall be 80°F (FA).
   4. DDC controller shall modulate control valve on chilled water coil to maintain space temperature setpoint.
   5. On a call for cooling, when space temperature rises above setpoint by 2°F (FA), fan coil unit fan shall start and cooling coil control valve shall modulate open to maintain space temperature at setpoint. When space temperature falls below setpoint by 2°F (FA), cooling coil control valve shall modulate closed. When cooling coil control valve is closed for 5 consecutive minutes (FA) fan coil unit fan shall stop. Cooling coil control valve shall close if a fan failure is detected, as sensed by current switch.
   6. Wire the high level limit switch (float), located on the unit drain pan to shut the fan down and close the cooling coil upon activation.

C. Monitor and Alarm:
   1. Monitor through the BAS the following points and generate the alarms indicated (refer to Points List for additional monitoring points):
      a. Space temperature (AI)
         1). Generate General Maintenance alarm if space temperature exceeds setpoint by ±5°F (FA) for 15 consecutive minutes (FA).
      b. Fan coil unit fan current switch (DI)
         1). Generate a General Maintenance alarm if fan status does not match commanded state.
      c. High level water switch (DI)
         1). When water high level switch is activated, a High Priority alarm shall be generated, the fan shall be stopped, and fan coil unit cooling coil control valve shall be commanded closed.

3.12 HEATING AND COOLING FAN COIL UNIT

A. General
   1. Refer to Detail 4 on drawing IC-758.

B. System Operation
1. Fan shall start on a call for cooling or heating and shall stop when space temperature setpoint is satisfied.

2. Space cooling setpoint shall be 75°F (FA).

3. Space heating setpoint shall be 68°F (FA).

4. DDC controller shall modulate control valves on chilled or hot water coils to maintain space temperature setpoint.

5. On a call for cooling, when space temperature rises above cooling setpoint, fan coil unit fan shall start and cooling coil control valve shall modulate open to maintain space temperature at setpoint. When space temperature falls below setpoint, cooling coil control valve shall modulate closed. When cooling coil control valve is closed for 5 consecutive minutes (FA) fan coil unit fan shall stop.

6. On a call for heating, when space temperature drops below heating setpoint, fan coil unit fan shall start and heating coil control valve shall modulate open to maintain space temperature at setpoint. When space temperature rises above setpoint, heating coil control valve shall modulate closed. When heating coil control valve is closed for 5 consecutive minutes (FA) fan coil unit fan shall stop.

7. Valves shall be sequenced so that heating and cooling cannot occur simultaneously.

8. Cooling coil and heating coil control valves shall close when a fan failure is detected.

9. Wire the high level limit switch (float), located on the unit drain pan to shut the fan down and close the cooling coil upon activation.

C. Monitor and Alarm:

1. Monitor through the BAS the following points and generate the alarms indicated (refer to Points List for additional monitoring points):
   a. Space temperature (AI)
      1). Generate General Maintenance alarm if space temperature exceeds setpoint by ±5°F (FA) for 15 consecutive minutes (FA).
   b. Fan coil unit fan current switch (DI)
      1). Generate General Maintenance alarm if fan status does not match commanded state.
   c. High level water switch (DI)
      1). When water high level switch is activated, a High Priority alarm shall be generated, the fan shall be stopped, and fan coil unit cooling coil control valve shall be commanded closed.

3.13 SMOKE/FIRE ALARM MODE - CONTROL SEQUENCE

A. Smoke Detectors in Ductwork:

1. Smoke detectors will be furnished, installed, and wired to Fire Alarm Control Panel by Electrical Contractor.

2. Wire contact on Fire Alarm System provided by EC to air handling unit supply fan starter to shut down unit fan when Fire Alarm System is in alarm condition.

3. Wire auxiliary contact on smoke detector to air handling unit supply fan starter. Each air handling unit’s smoke detector(s) upon detection of smoke shall stop its respective air handling unit.

4. Smoke detectors will be provided as shown in plans.

B. Smoke Dampers:
1. Smoke dampers in ducts shall be furnished by TCC and installed by MC. Smoke dampers required in ducts passing through smoke partitions are shown on Mechanical Plans (smoke partitions are shown on Architectural Plans).

2. Smoke dampers shall be provided at air handling units for isolation for all AHUs:
   a. Supply air discharge
   b. Smoke dampers isolating air handling system shall be closed automatically when air system is not in operation.

3. Wire contracts provided by Fire Alarm System to close smoke dampers and shut down air handling units when fire alarm system is in alarm condition. Smoke dampers shall automatically reset on Fire Alarm System reset. Air handling units shall have manual restart on Fire Alarm System reset.

4. Wire auxiliary contacts on smoke detectors to close smoke dampers and shut down air handling units when smoke detectors are in alarm condition. Smoke dampers shall automatically reset on smoke detectors reset. Air handling units shall have manual restart on smoke detector reset.

   1. All locations of smoke detectors and dampers shall be supplied to the owner for inclusion on the building graphics.

3.14 RETURN FANS – CONTROL SEQUENCE
   A. Return fans shall be electrically interlocked with associated air handling unit as described in AHU control sequence.

3.15 ELECTRICAL AND COMMUNICATION MANHOLES
   A. Electrical Manhole 907 (sump pump) conduit run is required to be wired & installed as indicated on IC-800.
   B. All other conduit runs have been laid in a previous project phase. Control contractor to wire and monitor the points below.
   C. Monitor, through BAS, the following points associated with plumbing system and generate the alarms indicated:
      1. Communication Manhole Sump pump – provide moisture sensor (typical of 5)
         a. General High Priority Alarm
      2. Electrical Manhole Sump pump – provide moisture sensor (typical of 10)
         a. General High Priority Alarm

3.16 SUMP PUMP
   A. General
      1. DM-1 & DM-2
   B. Control contractor to provide four floats and wire floats back to sump pump controller.
   C. Monitor, through BAS, the following points associated with plumbing system and generate the alarms indicated:
      1. Sump pump Controller – dry contact (DI)
         a. General High Priority Alarm
END OF SECTION