PURCHASING DEPARTMENT

Newport News Public Schools

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September 26, 2025
Addendum #2
FOR IMMEDIATE ATTENTION

ADDENDUM NO. 2 TO ALL BIDDERS:

Reference – Invitation for Bid:	IFB #003-0-2026/SB Menchville High School HVAC System Replacement
For Delivery To:	Newport News Public Schools
Bids Due:	October 7, 2025 at 2:00 PM EST

The above is hereby changed to read:

1. **Updates to Specifications, Drawings, and Responses to Pre-Bid Questions:** See the following pages.

All other provisions of the IFB shall remain unchanged.

Sincerely,
Shannon Bailey, VCCO, VCO
Director of Procurement
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757-591-4560 x10752

_____
Name of Firm

_____
Signature/Title

_____
Date

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September 26, 2025

ADDENDUM NO. 2

HVAC Replacement
Menchville High School
Bid # 003-0-2026/SB
Newport News, Virginia
TCE #23-065

Except as may be otherwise described, bidding requirements, materials, and workmanship for the work described herein shall conform to all requirements of the original Contract Documents dated September 8, 2025. The following Addendum to the specifications and drawings are made a part of the project and take precedence over the section of the specifications, in part, as originally written and over the drawings, in part, as originally drawn and/or written.

Each Bidder must acknowledge receipt of the Addendum in the space provided on the BID FORM of the Specifications. Failure to do so may subject the Bidder to disqualification.

SPECIFICATIONS

1. **REVISE Section 230900-2.1.D to the following:**

   D. **All equipment with on-board controllers shall be Honeywell BACnet Optimizer T1L or BACnet MSTP compatible. Additionally, provide Niagara N4.414 Version 4.8.0.110 on all JACEs or Honeywell CIPer controllers.**

2. **DELETE Section 010800-1.5.G does not apply to this project and shall be removed.**

3. **REVISE Section 230500-2.4.C.6.a to the following:**

   a. **Products shall be provided by the following manufacturers:**

      1) **Basis of design is ABOVE AIR TECHNOLOGIES indoor model "FCE-012S", outdoor model "XP1-012S". Vertiv wall mount model shall be the only alternate manufacturer accepted.**

GENERAL

1. **REVISE ALL references on drawings from 'Alternate Bid' to 'Additive Bid'.**

DRAWINGS

Sheet M-101 through M-110:

- **Construction Notes: REVISE keynote 40 to the following: PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE**

WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.

Sheet E-002:
- **CHANGE Panel "BR1" to Panel "BR3".**

Sheet ED102:
- **CHANGE Panel "BR1" to Panel "BR3".**

Sheet ED103:
- **CHANGE keynote 2 at Panel "BL2" to keynote 1.**

Sheet ED109:
- **See revised drawing attached.**

Sheet E-105:
- **See revised drawing attached.**

Sheet E-109:
- **See revised drawing attached.**

Sheet E-117:
- **See revised drawing attached.**

Sheet E-202:
- **Construction Notes: REVISE keynote 8 to the following: SAW CUT EXISTING CURBS AND PAVEMENT FOR INSTALLATION OF PANEL "EDP2" FEEDER. BURY CONDUITS 24" BELOW GRADE. PATCH CURBS WITH CONCRETE AND PAVEMENT WITH ASPHALT TO MATCH EXISTING TO THE SATISFACTION OF THE OWNER. NOTIFY "MISS UTILITY" TO LOCATE AND MARK ALL EXISTING UNDERGROUND UTILITIES ALONG THE ENTIRE PATH OF THE NEW PANEL FEEDER.**

Sheet E-301:
- **See revised drawing attached.**

Sheet E-401:
- **DELETE this drawing in its entirety from the construction documents. All work associated with the new emergency generator will be performed under a separate contract.**

QUESTIONS

1. **Specs call out for temporary conditioning of the Media Center and IDF Room adjacent to library. During the 09/22/25 site walk, Jeff Gill of NNPS advised that only the Media Center needs temporary conditioning. Please confirm if it is both areas or if it is just Media Center.**
   Answer: Media center will be the only room that will need temporary conditioning, NNPS will turn everything in the IDF room off for the duration of summer work.

2. **Can the temporary spot coolers in the Media Center be exhausted into the drop ceiling?**
   Answer: Yes, we also recommend using ceiling kits while doing this to prevent air leaks from the exhaust back in the room.

3. **Jeff Gill also advised that typically when needing temporary conditioning in the media center they use spot coolers that plug into standard outlets. Given that information, we would likely have the ACs placed in the corners of the room and exhausted into the drop ceiling with ceiling kits. The condensation bucket will need to be monitored/emptied. Please advise if this is acceptable.**
   Answer: Yes, This is acceptable means will need over flow safety on drains to not overflow and damage floor/carpet.

4. **Regarding the Mechanical Duct Insulation Section 230700 and the impact of the internal duct cleaning work's impact on the external insulation scope:**
   What are your expectations when we follow behind your duct interior cleaning scope subcontractor:

   a. **We will need to re-insulate the back pans of the supply air diffusers after they are removed, cleaned and reinstalled, correct?**
      Answer: Yes

   b. **Will we need to externally insulate the existing and newly installed access doors in the ductwork to allow for cleaning? Any idea on a quantity?**
      Answer: Yes, externally insulated existing and newly installed access doors. Unsure of quantity would have to contact duct cleaning contractor.

   c. **Do we need to provide pricing for some additional quantity of external duct insulation removed beyond the access doors for cleaning work? Quantity?**
      Answer: A contingency is up to contractor's discretion.

5. **The following plans are listed in the specifications but not included in the plan set:**

   E002
   E201
   E202
   E301
   E401
   Answer: Drawings were provided in Addendum #1

6. **Existing to Remain Cabinet Unit Heaters are currently controlled by a FTT10 LON bus Communicating DDC controller. How should they be addressed in light of the BACnet Communications Requirement? 230900A**
   Answer: Cabinet Unit Heater controllers are being replaced with BACnet Controllers

7. **Existing to Remain KW Power Meter are currently monitored by a FTT10 LON bus Communicating DDC controller. How should they be addressed in light of the BACnet Communications Requirement? 230900A**
   Answer: These will be phased out per owner.

8. **Existing to Remain Single Phase Monitor is currently monitored by a FTT10 LON bus Communicating DDC controller. How should they be addressed in light of the BACnet Communications Requirement? 230900A**
   Answer: These will be phased out per owner.

9. **Existing to Remain Power Service Surge Suppression Monitor is currently monitored by a FTT10 LON bus Communicating DDC controller. How should they be addressed in light of the BACnet Communications Requirement? 230900A**
   Answer: These will be phased out per owner.

10. **Existing to Remain Distribution Panel Surge Suppression Monitors are currently monitored by a FTT10 LON bus Communicating DDC controller. How should they be addressed in light of the BACnet Communications Requirement? 230900A**
    Answer: These will be phased out per owner.

11. **Existing to Remain Lighting Control relays are currently controlled by a FTT10 LON bus Communicating DDC controller. How should they be addressed in light of the BACnet Communications Requirement? Additionally there is no way to obtain a count on these as the record submittals refer the reader to E-Plans which are not included in this bid package. Please indicate the quantity of these devices. 230900A**
    Answer: Taken care of with BACnet.

12. **Please clarify if we are to remove and replace all Victaulic pipe, fittings, couplings with weld pipe as Additive #2 as noted on plans; or if we are to use spool pieces as indicated on drawing M-403. Please clarify if there are any requirements to do any of this work in the base bid. M-403**
    Answer: welded or buttwelded is acceptable. It depends on the funding whether Additive #2 will be accepted.

13. **RFI: Please add Venmar (Nortek) to the approved list of manufacturers for the Specification 230500, Section 2.3, Paragraph B, Rooftop Units with Energy Recovery (RTU-1,2,5,6 and RTU-8 thru 17).**
    Answer: In accordance with the Owner's requirements, acceptable alternatives have been identified in the specifications.

14. **RFI: Please add Addison to the approved list of manufacturers for the Specification 230500, Section 2.3, Paragraph C, Packaged Rooftop Unit (RTU-3).**
    Answer: In accordance with the Owner's requirements, acceptable alternatives have been identified in the specifications.

15. **RFI: Please add Addison to the approved list of manufacturers for the Specification 230500, Section 2.3, Paragraph D, Packaged Rooftop Unit (RTU-18 & 19).**
    Answer: In accordance with the Owner's requirements, acceptable alternatives have been identified in the specifications.

16. **RFI: Please add Addison to the approved list of manufacturers for the Specification 230500, Section 2.4, Paragraph A and Paragraph B, Split System Air Handling Units (AHU-4, 7 and 7A) and Split System Condensing Units (CU-4, 7 and 7A).**
    Answer: In accordance with the Owner's requirements, acceptable alternatives have been identified in the specifications.

17. **RFI: Please add R-32 refrigerant packaged rooftop units and split systems (in lieu of R-454b) as acceptable refrigerants used. Some manufacturers (Daikin) use R-32 as a standard construction in lieu of R-454b in packaged rooftop units and split systems.**
    Answer: In accordance with the Owner's requirements, acceptable alternatives have been identified in the specifications.

18. **RFI: Please allow variable speed scroll compressor to be used in lieu of two stage compressors. Some manufacturers single variable speed compressor in small tonnage, packaged rooftop units.**
    Answer: Variable speed compressors would be acceptable.

19. **RFI: Please add Stulz to the approved list of manufacturers for Specification 230500, Section 2.4, Paragraph C, Computer Room Air Conditioning Unit (SS-1/OU-4).**
    Answer: Pre-approved manufacturers have been listed in specification per owner's direction.

20. **We reviewed the Asbestos Inspection Reports and do not see a particularly large amount of asbestos pipe insulation identified. Can you advise if there will be an asbestos abatement contract performed prior to or simultaneously with this HVAC project or is the asbestos inspection information provided for our own information and use and there will be no large-scale abatement performed? If that is correct, then we presume, under the HVAC scope, only minor glove bag removals for the heating hot water pipe insulation identified to be removed and or replaced would impact our performance schedule, correct? We are trying to imagine how crowded the work spaces will be in the Summer of 2026.**
    Answer: Asbestos inspection information is provided for contractor's information and use. Abatement shall be performed by NNPS. Please refer to Asbestos Disclosure Statement on Drawing G-001.

21. **Reference - Sheet E-401 , New Work Note #2 :**
    "New 300KW Emergency Generator..... See Emergency Power Riser Diagram"
    Answer: All work associated with the new emergency generator is going to be performed under a separate contract.
    Request for Clarification :
    I do not see an Emergency Power Riser Diagram in this set of drawings. Also, see question #2 for further need of clarifications related to Emergency Power.

22. **Reference - Sheet E-202 , New Work Note #1 : indicates that the Emergency Generator Work is going to be performed under a separate contract.**
    Answer: Yes, that is correct.
    Request for Clarification :
    Please provide a clear delineation between the HVAC replacement project scope and the work being performed under separate contracts.

23. **Does TABS need to be complete for each phase before substantial completion is granted or can TABs be completed after substantial completion?**
    Answer: Tabs must be completed for each phase before substantial completion.

24. **Will Liquidated Damages be assessed if Commissioning is not completed within 30 days after Substantial completion?**
    Answer: NNPS expects TABs and commissioning will be completed in the 60 days that has been allowed at each phase between substantial and final completion dates.

25. **Is the project phasing negotiable if a better plan can be submitted for approval?**
    Answer: Yes, this option will be considered.

26. **Is the owner open to allowing some work to be performed outside of the phase dates as long as it does not affect the operation of the School?**
    Answer: Yes, this option will be considered.

27. **Which Roofing Contractor currently holds the Roof Warranty on the school?**
    Answer: Tremco, Inc – Refer to Drawing G-001 for further information.

28. **If I bid the job and the Mechanical contractor uses my bid will we be awarded the project even though we are not an *Authorized Control Integrator (ACI)*?**
    It was because of the ACI requirement in the 230900 specs on Richneck ES that Chesapeake Controls threatened you all with protesting the project and then Comfort Systems of Virginia was not able to use our number and we caused them to lose the monetary difference between our quote and Chesapeake's quote. I do not want this to happen again and I doubt they would use my number if this is a possibility. Are you able to have the engineer remove the ACI requirement and issue that in an addendum prior to bid day?

Answer: ACI Licensed Contractors are required by NNPS.

29. **Regarding the requirement for Orange Colored PVC jacket on the new heating hot water piping required by Mechanical Insulation Specification 230700:**

    Can you advise if all the current Heating Hot Water Piping Insulation has the Orange PVC Jacket where exposed in the mechanical room?
    Answer: Exposed piping in mechanical room and mezzanines shall have PVC jacket per section 230100.

30. **Can you also advise if the HW Pipe Insulation concealed in the ceilings for the Alternate #2 Victaulic Removal Scope and the Base Bid occasional vertical runouts to the new RTUs has the Orange PVC Jacket installed?**
    Answer: Unable to confirm if it has orange PVC Jacket installed or not. Contractor shall field verify existing conditions prior to removal and make all necessary provisions accordingly.

31. **In review of the bid for the project page three (3) additive #2 states replacement of all Victaulic fitting and welded connections, should it say with welded connections? Please clarify.**
    Answer: All Victaulic fittings, elbows and tees.

32. **In review of addendum 1 this morning under the Thompson Consulting Engineers pre-bid meeting agenda page 13, paragraph D note #1 indicates there is a pre-bid question form included the specifications. Please provide location in the specifications or provide the pre-bid question form. If the form is not in the current specifications will the cutoff date of September 23, 2025 be extended?**
    Answer: Questions may be emailed to the Procurement Officer. TCE has confirmed there is not a pre-bid form as part of the Project Specifications as noted in the Pre-Bid Meeting Agenda. Question due date was changed to September 25, 2025 at 3:00 PM per Addendum #1.

33. **Will there be any staff/students in the facility during the construction/work period?**

    a. **If so, is the contractor required to provide temporary conditioning in the spaces that will be occupied?**
       Answer: Work is to be done during the summer so building will not be occupied.

34. **VAV schedule on sheet M-007 has remarks "1" and "2" beside various VAVs, but there is no indication as to what these remarks mean. Please advise.**
    Answer: M-007 is for reference only for airflow and GPM totals.

35. **On sheet M-001, Project General Note #4 indicates that the contractor is to remove & replace 160 Victaulic connections in the main piping header of the 1st and 2nd floors with welded connections. The "Alternate Bid Item #2" on the same sheet indicates that work includes the replacement of all Victaulic with welded connections.**

    a. **Is the Bid Item #2 Item B mean to include any fittings in addition to the 160 listed as "general work" or is it meant to include any additional Victaulic fittings beyond the 160 referenced in General Note #4?**
       Answer: Yes, this includes any fittings in addition to the approximate 160 listed.
    b. **If this is meant to include any fittings beyond the initial 160, is there any indication of how many additional fittings are required for replacement? Can this be handled as a unit price bid option?**
       Answer: Any additional repairs above 160 will be added to the cost of the project.

36. **Reference: E-202 (New Work Note #1) & E-401 (New Work Note #2)**

    a. **Please clarify if the work associated with a new 300KW emergency generator is to be included in this project.**
    b. **If so, please provide the emergency power riser diagram referenced in New Work Note #2 on sheet E-401.**
    Answer: All work associated with the new emergency generator is going to be performed under a separate contract. Sheet E-401 will be removed from construction documents in this Addendum.

37. **Phasing plans note #8 on G-001 indicates that the contractor is to engage the services of the commissioning agent. Is the contractor responsible to bear the costs of the commissioning agent or will this cost be borne by the owner?**
    Answer: Cost will be by the owner.

38. **Specification 010200.1.2.B indicates that temporary cooling is required in all media centers throughout each summer phase. Is this required even if the equipment serving that space is operational?**
    Answer: If the equipment in the Media Center has been replaced and is fully operational temporary cooling is not required

39. **Note #D13 on MD111 indicates that contractor is to utilize the "OWNERS ROOFING CONTRACTOR." Please provide Company Name and/or contact information for the owner's roofing contractor.**
    Answer: Refer to Drawing G-001.

40. **Is the intent for the contractor to replace all VAV valve packages when the control valves are replaced?**
    Answer: As indicated on the drawings the VAV Boxes are not being replaced just the controllers.

41. **New Work Note #8 on E-202 & New Work Note #1 on E-401 indicates that the contractor is to patch all pavement with asphalt. Please provide specific requirements or details for asphalt patching.**
    Answer: The patching shall be made to match the existing curb and asphalt.

42. **Is the contractor required to provide new fencing for the generator replacement work or is the intent to remove only what's necessary and reinstall existing fencing?**
    Answer: The fencing will be covered under the generator contract.

43. **Demolition Note #2 on E-401 indicates that the generator concrete pad(s) are to be removed completely. Please provide specific requirements for new generator pad(s).**
    Answer: The generator pad will be covered under the generator contract.

44. **Specification 010800.1.5.G references furniture being provided by the owner under separate contract. The drawings reference that the contractor is required to label, relocate, store and/or protect all furniture. Please advise which is applicable.**
    Answer: Section 010800.1.5.G does not apply to this project and shall be removed.

45. **230100.1.14.D indicates the contractor is to clean strainers through the warranty period. At what frequency?**
    Answer: Strainers should be cleaned quarterly through warranty period.

46. **230100.1.14.D indicates the contractor is to replace filters through the warranty period. Will this be according to project phase or is the contractor required to replace filters for the entire building for 12 months after overall project final completion?**
    Answer: Contractor shall replace filters through warranty period per project phase.

47. **Bid additive item 1 has requested a lump sum price to remove all 2' X 4' ceiling tiles and replace with 2'X2' tile. Does this additive item include all areas of school or tiles removed for new construction?**
    Answer: Additive Item includes all areas of the school.

48. **Bid additive item 2 has requested a lump sum price for the replacement of all Victaulic fittings and welded connections. Drawing M-403 Pipe replacement detail has indicated replace 160 Victaulic couplings in the main piping header of the 1st and 2nd floors. New welded connections shall be installed upon discovery of pipe deterioration. Question - A Bid form has indicated all Victaulic fitting, does this include tee's and elbows? the M-403 detail has indicated only to replace coupling. M-403 detail has indicated only to replace coupling after an inspection has determined deterioration. Please confirm if contractor is to price all Victaulic fitting or 160 coupling or as determined after field inspection.**
    Answer: Yes, that includes all tees and elbows. Any additional repairs above 160 will be added to the cost of the project.

49. **Please advise if the Venmar (Nortek) wall construction will be acceptable. The Specification 230500, Section 2.3, Paragraph B, Rooftop Units with Energy Recovery (RTU-1,2,5,6 and RTU-8 thru 17), subsection 3.a.1 and 3.a.2 call for 2" thermocomposite walls or 4" aluminum walls. Thermocomposite walls is proprietary to the basis of design. Venmar would use 3" (R18) aluminum wall construction.**
    Answer: In accordance with the Owner's requirements, acceptable alternatives have been identified in the specifications.

50. **Specification Section 230500 and the mechanical drawing set: Par. 2.3 B. 3. a. 1) specifies 2" Thermo-Composite w/ foam panel (min. R-14) construction and thermal break. It also allows for aluminum construction but stipulates 4" foam panel. Why the increase in panel thickness if the aluminum 2" foam panel exceeds a min. R-14? Please define thermo-composite.**
    Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

51. **Par. 2.3 B. 3. a. 9) specifies access doors with nylon hinges. Equipment specified in other paragraphs specifies continuous piano hinges. Should this sub-paragraph specify continuous piano hinges?**
    Answer: Provide hinges each to their specified. Refer to specifications.

52. **Par. 2.3 B. 3. a. 11) specifies the unit casing to have a lifetime warranty against corrosion under normal use. What is the projected lifetime of the equipment, and what defines normal use? Does maintenance factor in?**
    Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

53. **Par. 2.3 B. 3. b. 1) specifies aluminum intake hoods. Does that qualify as thermo-composite construction?**
    Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

54. **Par. 2.3 B. 3. e. specifies the fans. Are the fan motors to be EC or can they be standard motors and associated VFDs? Other air handling equipment is specified to have direct drive plenum fans with premium efficiency ODP motors and VFDs.**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

55. **Par. 2.3 B. 3. f. specifies MERV 10 pre-filters. MERV 10 is not a common rating. Is MERV 8 or MERV 13 acceptable?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

56. **Par. 2.3 B. 3. h. 2) and i. 6) specify all compressors as inverter or variable speed (individual and tandem). If further states a variable speed lead-only compressor is not acceptable because the system isn't as efficient at part load as one with all variable speed compressors. Please provide data from the basis of design manufacturer that states how the operation of the variable speed compressors is sequenced, and that this is more efficient since variable speed compressors cannot reduce their speed as much in low ambient conditions. Also, this is a very complicated setup that requires sophisticated maintenance. Does the Owner want equipment this complicated and maintenance-intensive?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

57. **How do variable speed compressors provide the required reheat capacity to the reheat coil when the compressors associated with reheat circuits aren't operating at full speed?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

58. **Par. 2.3 B. 3. h. 6) specifies aluminum micro-channel condenser coils. Par. 2.3 B. 3. i. 6) specifies copper tube/aluminum fin condenser coils. Are copper tube/aluminum fin condenser coils acceptable for all condenser coils?**
Answer: One spec section is for Air-cooled Condensers, one if for Air Source Heat Pumps. Provide each type of condenser coil as specified.

59. **Par. 2.3 B. 3. h. 7) and i. 7) specify cooling operation from 40F to 125F. Why is mechanical cooling specified to operate down to 40F ambient? Are these units not able to have an airside economizer function? The Sequences of Operation in the mechanical drawing set have an economizer sequence.**
Answer: This spec section relates to the operational tolerances of the refrigeration system in the unit. Units shall not operate too near to the edge of compressor maps. Provide as specified.

60. **Par. 2.3 B. 3. k. 2) specifies that the reheat coil be installed 4" from the DX evaporator coil. Is that enough space to keep water from migrating off the DX coil and onto the reheat coil? Is that enough room to access the coils for cleaning and other maintenance?**
Answer: Yes

61. **Par. 2.3 B. 3. j. 4) and k. 6) specify that the DX and reheat coils be constructed with galvanized steel casings. Par. 2.3 B. 3. l. 5) specifies stainless steel casings for the hot water coils. Other equipment hot water coil paragraphs specify galvanized steel coil casings. Should all hot water coil casings be constructed from galvanized steel for consistency?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

62. **Par. 2.3 B. 3. m. 1) specifies the electrical and controls enclosures to have a NEMA 4X rating. Section 230100, 2.6 J. specifies all starters and controls to be NEMA Type 1 for interior equipment, NEMA Type 4X for kitchen equipment, and NEMA Type 3R for exterior equipment. Should device ratings for this equipment and other exterior equipment, not serving the kitchen, be NEMA Type 3R? Par. 2.3 B. 3. o. 5) a) specifies a NEMA 4 rating for the OA air flow measuring station transducer. Should this be NEMA 3R?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

63. **Par. 2.3 B. 3. m. 6) and the equipment schedule on M-002 specifies an SCCR of 65 kA. Other equipment for this project is specified to have an SCCR of 5 kA and 10 kA. Should all equipment be specified to have an identical SCCR for consistency and proper protection?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

64. **Does other specified air handling equipment, that isn't specified with thermo-composite foam panel construction, require a 4" thick casing?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole source any product. Equal products will be considered after bid and during shop drawing review.

65. **Par. 2.3 C. 14. b. specifies a 5-year, parts-only, economizer assembly warranty. This is specified in other subparagraphs. Are the unit's electrical system, controls, fans, etc. part of the economizer assembly or is the economizer assembly only the mixing box, dampers, damper rods, and actuators?**
Answer: Refer to basis-of-design unit manufacturer warranty guide on economizer assembly warranty.

66. **Par. 2.4 A. and the equipment schedule on sheet M-003 specifies AHU-4, 7, and 7A to have exhaust fans and an enthalpy wheel. How are the exhaust fans and enthalpy wheel oriented in an air handler as illustrated in the AHU-4, 7, and 7B Configuration diagram on sheet M-003?**
Answer: The wheel is located in the center of the diagram below the outside air arrow section.

67. **Par. 2.4 A. specifies the air handlers as double-wall construction with a min. R-6.25. Why is the R-value requirement different than other equipment?**
Answer: Unit must comply with the specifications. Pre-approval of alternative manufacturers will not be provided. It is not the intent of the specifications to sole

source any product. Equal products will be considered after bid and during shop drawing review.

68. **Why is some equipment specified to be designed, engineered, and manufactured in the USA, while the basis-of-design Annexair equipment is not?**
Answer: The basis of design for equipment was selected based on products aligning with owner preferences and applicable requirements. The specification allows for flexibility provided the performance and quality criteria are met.

69. **Should the hot water heating coils in the air handling equipment be designed to handle entering air temperatures in the event of the enthalpy wheel failing? This will lead to lower entering air temperatures than scheduled.**
Answer: No, that is not the intent of the drawings. Mixed air dampers shall control unit leaving conditions should the hot water coil fail.

70. **Due to the number and gravity of questions, the time it will take to answer and post responses, and the time it will take to study the responses and price the project, will consideration be given to extend the bid date by a minimum of 2 weeks?**
Answer: Bids will not be extended.

71. **Is the generator work supposed to be included in this contract or not?**
Answer: All work associated with the new emergency generator is going to be performed under a separate contract.

72. **Are the disconnect switches for the RTU's Nema3R or 4X?**
Answer: 3R

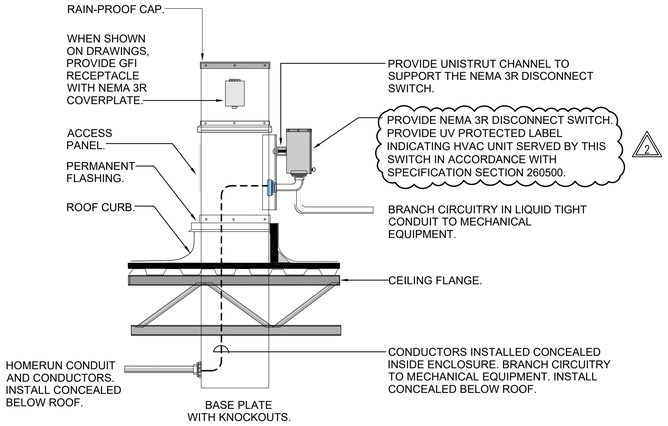
73. **What are the ratings for the motor rated switches?**
Answer: Motor rated switches shall be rated for the motors they serve.

74. **Need the breaker KAIC ratings for existing panels where new breakers are to be**
Answer: provided and installed.
Breaker KAIC ratings shall match the ratings of the other existing circuit breakers in the panels.

75. **Drawing E-301 shows a new panel PDP-4…. Where is this panel to be installed? (I have not been able to find it on the drawings)**
Answer: Pannel "PDP4" is in Room J241.

76. **Who is the preferred roofing contractor for NNPS?**
Answer: Tremco, Inc – Refer to Drawing G-001 for further information.

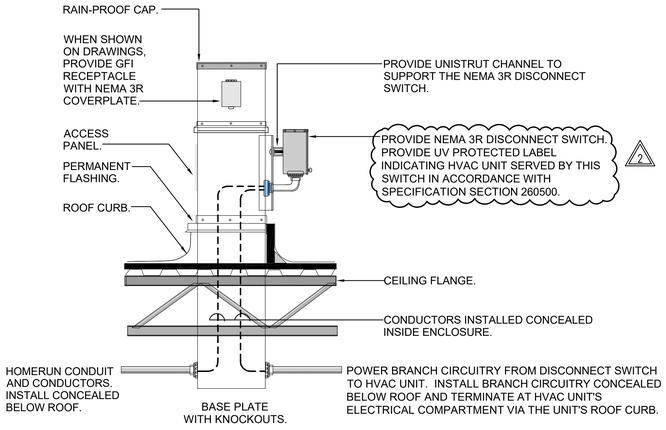
END OF ADDENDUM NO. 2



TYPICAL ROOF MOUNTED POWER PEDESTAL POST DETAIL 3

NOT TO SCALE

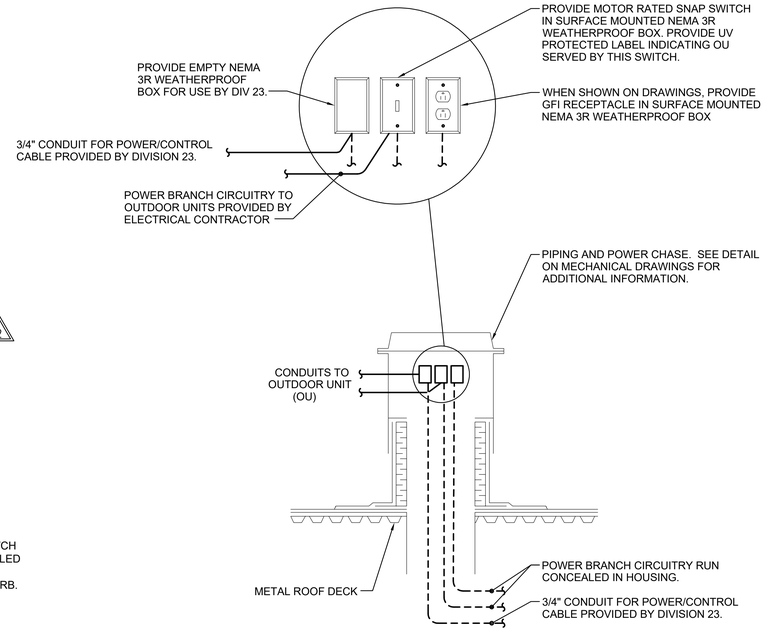
NOTE: PROVIDE ROOF POWER PEDESTAL, ELECTRA PORT STYLE 2 WITH SLOTTED BRACKETS AND RECEPTACLE OUTLET. INSTALL ON ROOF IN ACCORDANCE WITH MANUFACTURERS INSTRUCTION.



TYPICAL ROOF MOUNTED POWER PEDESTAL POST DETAIL 4

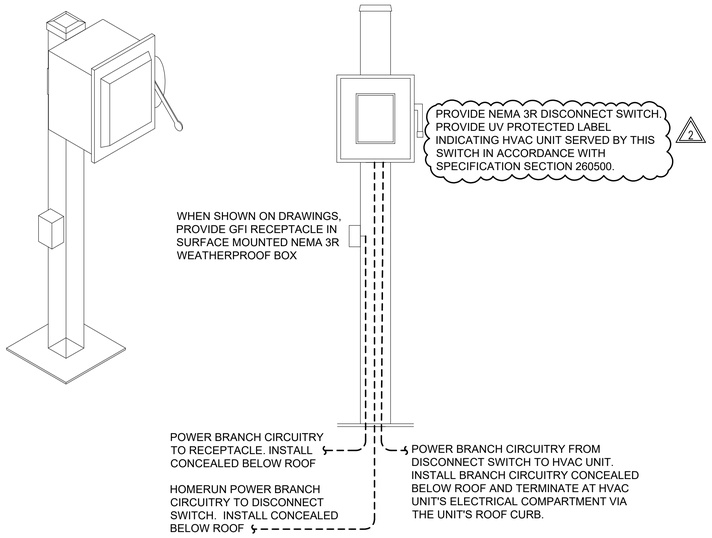
NOT TO SCALE

NOTE: PROVIDE ROOF POWER PEDESTAL, ELECTRA PORT STYLE 2 WITH SLOTTED BRACKETS AND RECEPTACLE OUTLET. INSTALL ON ROOF IN ACCORDANCE WITH MANUFACTURERS INSTRUCTION.



TYPICAL POWER ROOF CHASE HOUSING PENETRATION DETAIL

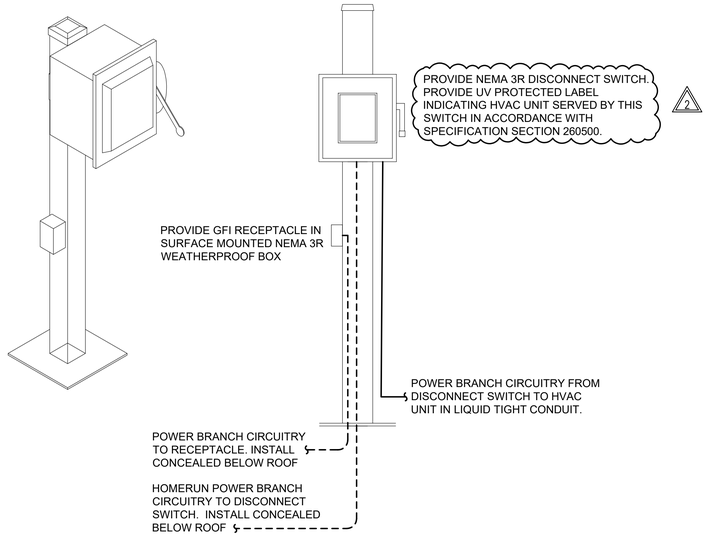
NOT TO SCALE



TYPICAL ROOF MOUNTED POWER PEDESTAL POST DETAIL 1

NOT TO SCALE

NOTE: PROVIDE POWER PEDESTAL, ORBIT INDUSTRIES 60" PEDESTAL BASE #PP-60-B WITH 60" PEDESTAL STAND #PP-60-S. INSTALL ON ROOF IN ACCORDANCE WITH MANUFACTURERS INSTRUCTION.



TYPICAL ROOF MOUNTED POWER PEDESTAL POST DETAIL 2

NOT TO SCALE

NOTE: PROVIDE POWER PEDESTAL, ORBIT INDUSTRIES 60" PEDESTAL BASE #PP-60-B WITH 60" PEDESTAL STAND #PP-60-S. INSTALL ON ROOF IN ACCORDANCE WITH MANUFACTURERS INSTRUCTION.

EXISTING ROOF WARRANTY

NOTE: ROOFING MEMBRANE IS STILL UNDER WARRANTY, "WARRANTY COMPANY: TREMCO, INC. & NUMBER: 275100924". ALL ROOF WORK REQUIRED BY THIS PROJECT SHALL BE PERFORMED IN SUCH A MANNER THAT THE WARRANTY IS MAINTAINED. CONTRACTOR SHALL COORDINATE ALL WARRANTY REQUIREMENTS WITH OWNER & MANUFACTURER PRIOR TO PERFORMING ANY WORK ON ROOF. PLEASE CONTACT SHELTON CLOUGH, P.E. (757) 617-7663 SCLOUGH@TREMCOINC.COM OR STEPHEN LAMM, CDT (757) 619-4495 SLAMM@TREMCOINC.COM FOR PRICING AND REQUIREMENTS.

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PROJECT NUMBER: 25-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
ELECTRICAL DETAILS

REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: DWC
DRAWN BY: MWH
CHECKED BY: KC

E-002

DATE: 09/08/2025

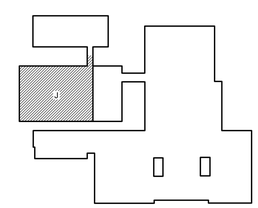
ELECTRICAL SECOND FLOOR PLAN - AREA 'J' - DEMOLITION ②

SCALE: 1/8" = 1'-0"

DEMOLITION NOTES (THIS DRAWING ONLY)

1. EXISTING ELECTRICAL EQUIPMENT TO REMAIN.
2. DISCONNECT AND REMOVE ALL CEILING MOUNTED LIGHT FIXTURES, LIGHT SENSOR DEVICES ASSOCIATED WITH LIGHT FIXTURES SHOWN ON THIS FLOOR PLAN AND SAVE FOR REUSE. LABEL EACH LIGHT FIXTURE WITH REGARDS TO ROOM NUMBERS SHOWN ON THIS DRAWING AND LOCATIONS TO ENSURE EACH LIGHT FIXTURE IS INSTALLED IN THE SAME LOCATION FROM WHICH THEY WERE REMOVED. SAVE BRANCH CIRCUITRY FOR REUSE. RELOCATE AND EXTEND BRANCH CIRCUITRY AS REQUIRED TO ACCOMMODATE THE REMOVAL AND INSTALLATION OF ROOF MOUNTED MECHANICAL EQUIPMENT. REMOVE ALL CEILING MOUNTED FIRE ALARM DEVICES, INTERCOM SPEAKERS, WIRELESS ACCESS DEVICES, AND CCTV CAMERAS SHOWN ON THIS DRAWING. SAVE ALL WIRING FOR REUSE. REMOVE ALL CEILING MOUNTED PROJECTORS SHOWN ON THIS DRAWING. SAVE ALL POWER AND SYSTEMS WIRING FOR REUSE.
3. REMOVE DUCT SMOKE DETECTOR AND SAMPLING TUBES BEFORE REMOVAL OF THE RTU. SAVE DETECTOR FOR REUSE.
4. DISCONNECT AND REMOVE EXISTING PANEL. SAVE EXISTING PANEL FEEDER AND ALL EXISTING BRANCH CIRCUITS FOR REUSE.

NOTE: EXISTING CONDITIONS ILLUSTRATED HAVE BEEN DETERMINED FROM ORIGINAL CONSTRUCTION DOCUMENTS AND LIMITED NON-INVASIVE FIELD INVESTIGATION. THE CONTRACTOR SHALL INVESTIGATE FIELD CONDITIONS PRIOR TO COMMENCEMENT OF WORK, COORDINATE AND MAKE ADJUSTMENTS AS NECESSARY.



KEY PLAN
NOT TO SCALE

1/8" = 1'-0" SCALE 5' 0 5' 10' 15' 20' FEET

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TELEPHONE: (757) 599-6415 PROJECT NUMBER: 25-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
ELECTRICAL SECOND FLOOR PLAN - AREA 'J' - DEMOLITION

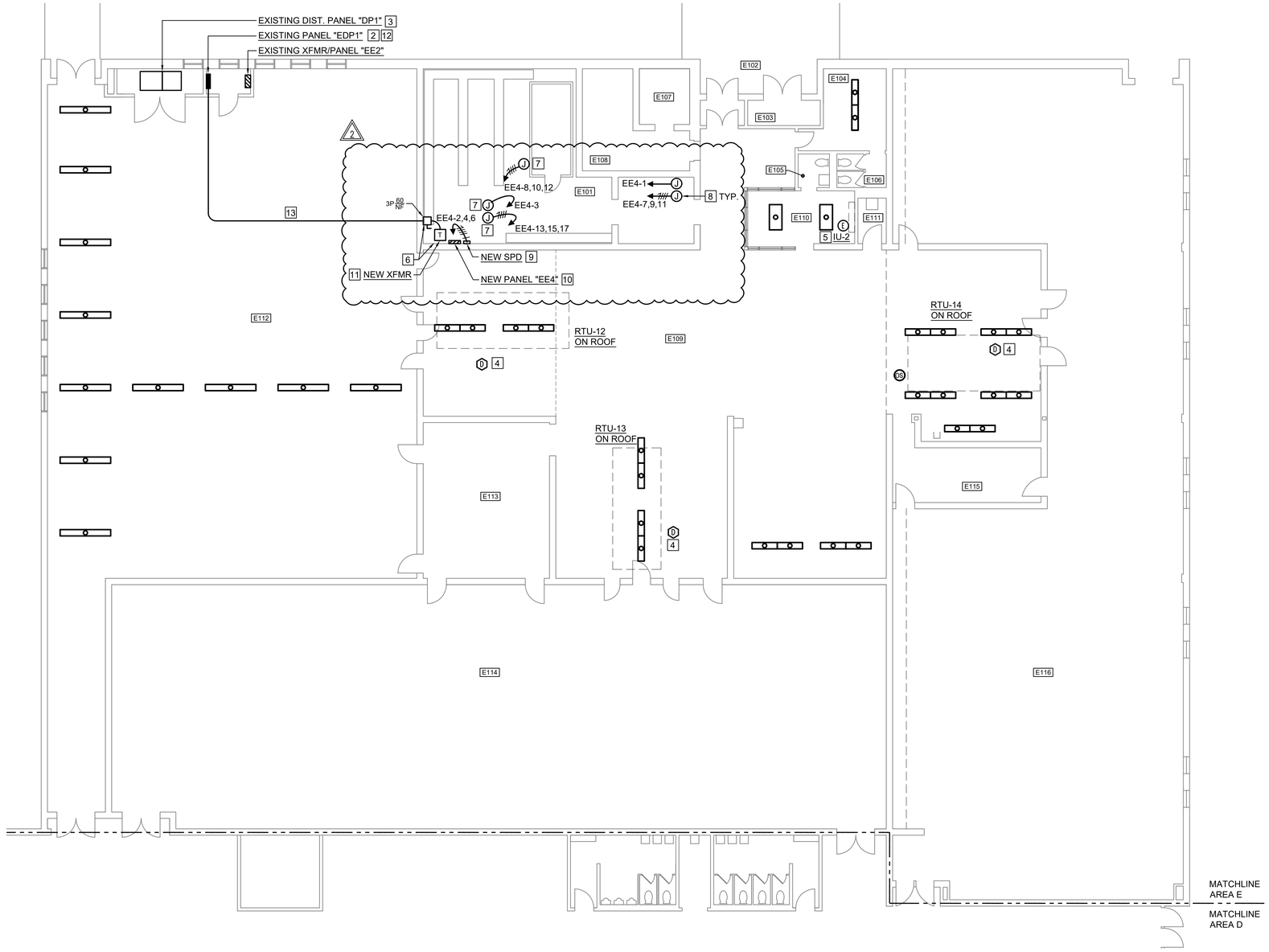
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: DWC
DRAWN BY: MWH
CHECKED BY: KC

ED109

DATE: 09/08/2025



ELECTRICAL FIRST FLOOR PLAN - AREA 'E' - NEW WORK 1

SCALE: 1/8" = 1'-0"

NEW WORK NOTES (THIS DRAWING ONLY)

1 REINSTALL ALL CEILING MOUNTED LIGHT FIXTURES, AND LIGHT SENSOR DEVICES ASSOCIATED WITH LIGHT FIXTURES SAVED DURING DEMOLITION IN CEILING IN ORIGINAL LOCATIONS, AND RECONNECT TO EXISTING BRANCH CIRCUITRY SAVED DURING DEMOLITION. EXTEND EXISTING BRANCH CIRCUITRY AS REQUIRED. COORDINATE NEW LIGHT FIXTURE SUPPORTS WITH EXISTING DUCTWORK AND PIPING AND ADJUST AS DIRECTED BY THE MECHANICAL CONTRACTOR.

2 REMOVE 80A-30P CIRCUIT BREAKER FOR RTU-12, 80A-3P CIRCUIT BREAKER FOR RTU-13. PROVIDE 150A-3P CIRCUIT BREAKER FOR NEW RTU-10, 125A-3P CIRCUIT BREAKER FOR NEW RTU-14, AND 100A-3P CIRCUIT BREAKER FOR NEW RTU-13 AND INSTALL ALL IN PANEL. PANEL "EDP1" IS SQUARE D TYPE "HCN" PANELBOARD,480 VOLT,600AMP,3 PHASE,4 WIRE, M.L.O.

3 REMOVE SPARE 60A-3P, 80A-3P, AND 150A-3P CIRCUIT BREAKERS AND TURN ALL OVER TO THE OWNER. PROVIDE SPACE COVERS AS REQUIRED. REMOVE 70A-3P CIRCUIT BREAKER FOR RTU-11. PROVIDE 80A-3P CIRCUIT BREAKER FOR RTU-11. PROVIDE 125A-3P CIRCUIT BREAKER FOR RTU-12 AND INSTALL IN PANEL. MATCH K.A.I.C. RATING OF EXISTING CIRCUIT BREAKERS. SWITCHBOARD DP1 IS A SIEMENS TYPE "P4" SWITCHBOARD.

4 THOROUGHLY CLEAN EXISTING DUCT SMOKE DETECTOR SAVED DURING DEMOLITION. PROVIDE NEW SAMPLING TUBES. REINSTALL EXISTING DUCT SMOKE DETECTOR AND NEW SAMPLING TUBES IN EXISTING DUCTWORK. CONNECT DUCT SMOKE DETECTOR TO EXISTING FIRE ALARM WIRING SAVED DURING DEMOLITION. TEST DETECTOR TO ENSURE PROPER OPERATION.

5 PROVIDE ELECTRICAL CONNECTION TO IU VIA DISCONNECT SWITCH FURNISHED BY EQUIPMENT PROVIDER.

6 REMOVE EXISTING STORAGE RACKS FOR INSTALLATION OF NEW PANELS, AND TRANSFORMER. RELOCATE RACK AS DIRECTED BY THE OWNER.

7 PROVIDE JUNCTION BOX ON THE END OF WALK IN FREEZER BRANCH CIRCUIT SAVED DURING DEMOLITION AND EXTEND BRANCH CIRCUITS TO NEW PANEL IN ACCORDANCE WITH PANELBOARD SCHEDULE ON DRAWING E-301.

8 PROVIDE JUNCTION BOX ON THE END OF WALK IN COOLER BRANCH CIRCUIT SAVED DURING DEMOLITION AND EXTEND BRANCH CIRCUITS ON NEW PANEL IN ACCORDANCE WITH PANELBOARD SCHEDULE ON DRAWING E-301.

9 PROVIDE NEW SPD IN ACCORDANCE WITH SPECIFICATION SECTION 264313.

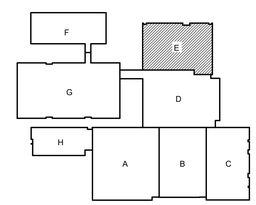
10 PROVIDE NEW PANELBOARD IN ACCORDANCE WITH SPECIFICATION SECTION 262416 AND THE PANELBOARD SCHEDULE ON DRAWING E-301.

11 PROVIDE NEW 30KVA DRY-TYPE TRANSFORMER IN ACCORDANCE WITH SPECIFICATION SECTION 262200. PROVIDE 4 #3 AND 1 #8 GROUND IN 1-1/4" FLEXIBLE METAL CONDUIT FROM TRANSFORMER AND CONNECT TO MAIN CIRCUIT BREAKER IN PANEL "RHH1".

12 PROVIDE NEW 45A-3P CIRCUIT BREAKER AND MOUNTING HARDWARE. INSTALL CIRCUIT BREAKER IN AVAILABLE SPACE IN PANEL. MATCH K.A.I.C. RATING OF EXISTING CIRCUIT BREAKERS. PANEL "EDP1" IS SQUARE D TYPE "HCN" 480 VOLT, 600AMP, 3 PHASE, 4 WIRE, M.L.O. PANELBOARD. CHANGE PANEL INDEX TO READ "NEW TRANSFORMER".

13 PROVIDE 3 #8 AND 1 #10 GROUND IN 3/4" CONDUIT FROM NEW 45A-3P CIRCUIT BREAKER PROVIDED BY NEW WORK NOTE 12, AND CONNECT TO PRIMARY TERMINALS ON NEW 30 KVA TRANSFORMER VIA NEW DISCONNECT SWITCH.

NOTE: EXISTING CONDITIONS ILLUSTRATED HAVE BEEN DETERMINED FROM ORIGINAL CONSTRUCTION DOCUMENTS AND LIMITED NON-INVASIVE FIELD INVESTIGATION. THE CONTRACTOR SHALL INVESTIGATE FIELD CONDITIONS PRIOR TO COMMENCEMENT OF WORK, COORDINATE AND MAKE ADJUSTMENTS AS NECESSARY.



KEY PLAN
NOT TO SCALE

1/8" = 1'-0"

SCALE 5' 0 5' 10' 15' 20' FEET

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PROJECT NUMBER: 25-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
ELECTRICAL FIRST FLOOR PLAN - AREA 'E' - NEW WORK

REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: DWC
DRAWN BY: MWH
CHECKED BY: KC

E-105

DATE: 09/08/2025

ELECTRICAL SECOND FLOOR PLAN - AREA 'J' - NEW WORK 1

SCALE: 1/8" = 1'-0"

NEW WORK NOTES (THIS DRAWING ONLY)

1. REINSTALL ALL CEILING MOUNTED LIGHT FIXTURES, AND LIGHT SENSOR DEVICES ASSOCIATED WITH LIGHT FIXTURES SAVED DURING DEMOLITION IN CEILING IN ORIGINAL LOCATIONS, AND RECONNECT TO EXISTING BRANCH CIRCUITRY SAVED DURING DEMOLITION. EXTEND EXISTING BRANCH CIRCUITRY AS REQUIRED. COORDINATE NEW LIGHT FIXTURE SUPPORTS WITH EXISTING DUCTWORK AND PIPING AND ADJUST AS DIRECTED BY THE MECHANICAL CONTRACTOR. REINSTALL ALL CEILING MOUNTED FIRE ALARM DEVICES, INTERCOM SPEAKERS, WIRELESS ACCESS DEVICES, AND CCTV CAMERAS SAVED DURING DEMOLITION IN CEILING IN ORIGINAL LOCATIONS, AND RECONNECT TO EXISTING WIRING SAVED DURING DEMOLITION. EXTEND EXISTING WIRING AS REQUIRED. REINSTALL CEILING MOUNTED PROJECTORS SAVED DURING DEMOLITION IN CEILING IN ORIGINAL LOCATIONS, AND RECONNECT TO EXISTING POWER AND SYSTEMS WIRING SAVED DURING DEMOLITION.

2. INTERCEPT EXISTING CIRCUITS HM-2,4, AND 6 ABOVE EXISTING PANEL "HM". PROVIDE JUNCTION BOX ON THE END OF BRANCH CIRCUITRY AND EXTEND AS INDICATED.

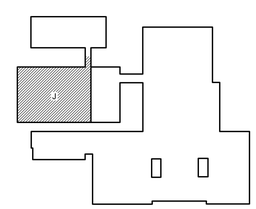
3. THOROUGHLY CLEAN EXISTING DUCT SMOKE DETECTOR SAVED DURING DEMOLITION. PROVIDE NEW SAMPLING TUBES. REINSTALL EXISTING DUCT SMOKE DETECTOR AND NEW SAMPLING TUBES IN EXISTING DUCTWORK. CONNECT DUCT SMOKE DETECTOR TO EXISTING FIRE ALARM WIRING SAVED DURING DEMOLITION. TEST DETECTOR TO ENSURE PROPER OPERATION.

4. PROVIDE NEW PANELBOARD IN ACCORDANCE WITH SPECIFICATION SECTION 262416 AND THE PANELBOARD SCHEDULE ON DRAWING E-301. REMOVE EXISTING BOOK SHELVES AS REQUIRED TO MAINTAIN NEC REQUIRED WORKING CLEARANCE AROUND THE PANEL AND AS DIRECTED BY THE OWNER.

5. REMOVE THREE (3) 20A-1P CIRCUIT BREAKERS IN SPACES 2, 4 AND 6 AND TURN OVER TO OWNER. PROVIDE 60A-3P, 10 K.A.I.C. CIRCUIT BREAKER AND INSTALL IN SPACES. PANEL "HM" IS A SQUARE D TYPE "NQOD" PANELBOARD. PROVIDE 4 #6 AND 1 #10 GROUND IN 1-1/4" CONDUIT. CONNECT TO NEW 60A-3P CIRCUIT BREAKER AND TO MAIN LUGS IN NEW PANEL "HM1".

2 6. PROVIDE NEW PANEL "PDP4" IN ACCORDANCE WITH PANELBOARD SCHEDULE ON E-301. REUSE AND EXTEND EXISTING FEEDER CONDUCTORS AND HOMERUN BRANCH CIRCUITS TO NEW CIRCUIT BREAKERS.

NOTE: EXISTING CONDITIONS ILLUSTRATED HAVE BEEN DETERMINED FROM ORIGINAL CONSTRUCTION DOCUMENTS AND LIMITED NON-INVASIVE FIELD INVESTIGATION. THE CONTRACTOR SHALL INVESTIGATE FIELD CONDITIONS PRIOR TO COMMENCEMENT OF WORK, COORDINATE AND MAKE ADJUSTMENTS AS NECESSARY.



KEY PLAN
NOT TO SCALE

1/8" = 1'-0" SCALE 5' 0 5' 10' 15' 20' FEET

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TELEPHONE: (757) 599-4415 PROJECT NUMBER: 25-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
ELECTRICAL SECOND FLOOR PLAN - AREA 'J' - NEW WORK

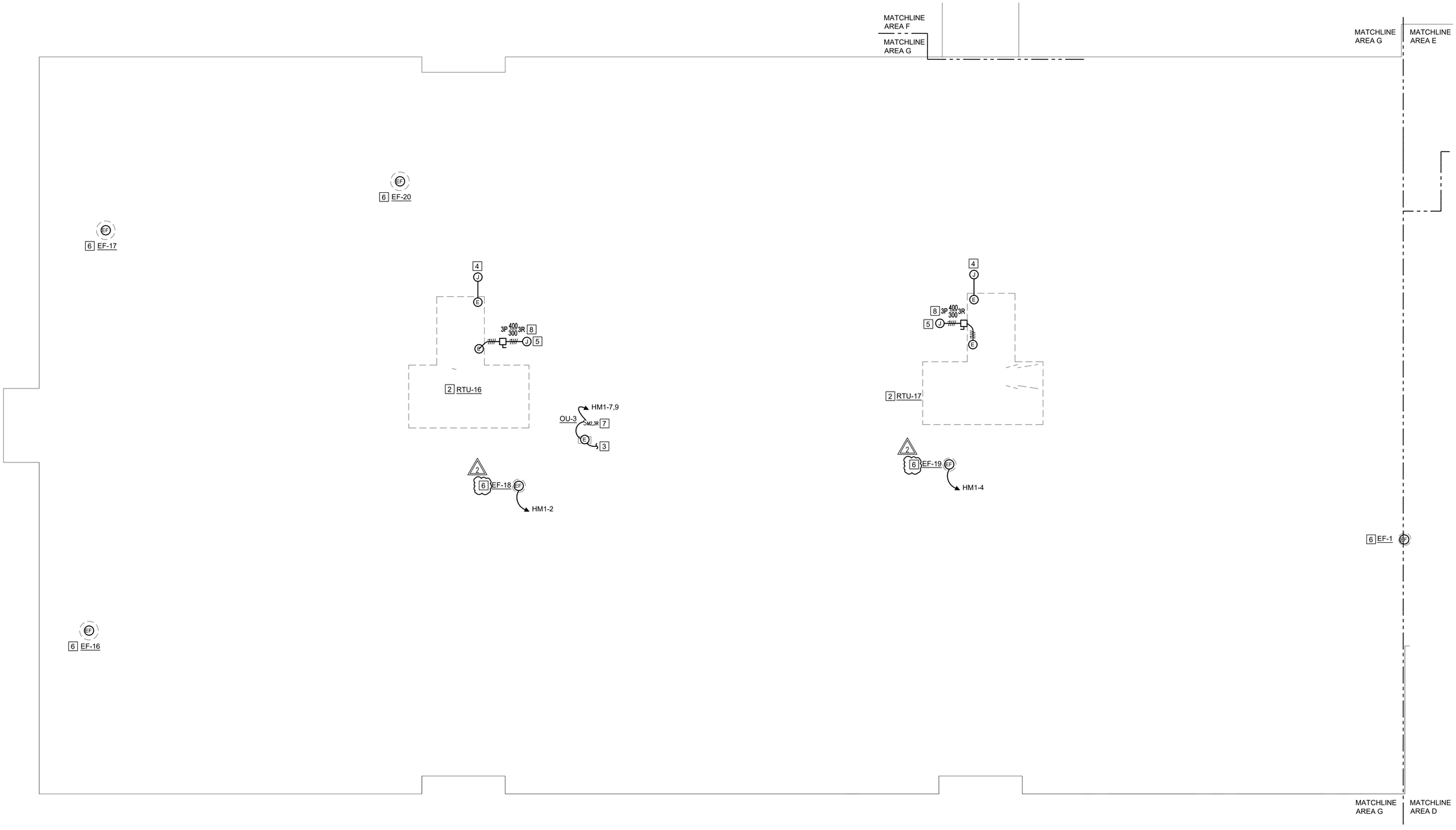
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: DWC
DRAWN BY: MWH
CHECKED BY: KC

E-109

DATE: 09/08/2025

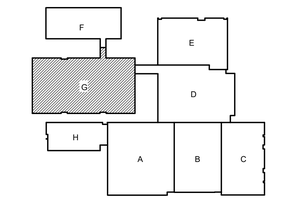


ELECTRICAL ROOF PLAN – AREA 'J' – NEW WORK 1

SCALE: 1/8" = 1'-0"

NEW WORK NOTES (THIS DRAWING ONLY)

1. SEE DRAWING E109 FOR LOCATION OF PANELS "FR4", "FR5", "DP4", AND "HM1".
2. PROVIDE POWER PEDESTAL POST (IN ACCORDANCE WITH "ROOF MOUNTED POWER PEDESTAL POST DETAIL #1" ON DRAWING E-002) TO SERVE MECHANICAL EQUIPMENT. PATCH ROOF AROUND THE POWER PEDESTAL TO THE SATISFACTION OF THE OWNER. FIELD VERIFY LOCATION WITH OWNER AND ENGINEER.
3. PROVIDE 3/4" CONDUIT BETWEEN OU AND CORRESPONDING IU ON FIRST FLOOR. SEE DRAWING E101 FOR LOCATION. FOLLOW PATH OF REFRIGERANT PIPING WITH CONDUIT. CONVERT CONDUIT BELOW ROOF PENETRATION TO LIQUID-TIGHT FLEXIBLE METAL CONDUIT. COORDINATE LOCATION OF ROOF PENETRATION WITH MECHANICAL CONTRACTOR. INSTALL AND CONNECT EQUIPMENT MANUFACTURER CONDUCTORS BETWEEN IU AND OU AS DIRECTED BY EQUIPMENT MANUFACTURER.
4. PROVIDE JUNCTION BOX ON THE END OF EXISTING RECEPTACLE BRANCH CIRCUIT BELOW ROOF SAVED DURING DEMOLITION. PROVIDE BRANCH CIRCUIT IN LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND CONNECT TO UNIT MOUNTED DUPLEX RECEPTACLE.
5. PROVIDE JUNCTION BOX (SIZE AS REQUIRED) ON THE END OF EXISTING BRANCH CIRCUIT ABOVE THE CEILING SAVED DURING DEMOLITION. PROVIDE 3-350 KCMIL AND 1 #4 GROUND IN 3" LIQUID-TIGHT FLEXIBLE METAL CONDUIT FROM JUNCTION BOX, CONNECT BRANCH CIRCUIT TO MECHANICAL EQUIPMENT NEW VIA DISCONNECT SWITCH.
6. CONNECT EXHAUST FAN TO EXISTING BRANCH CIRCUIT SAVED DURING DEMOLITION.
7. PROVIDE NEW MOTOR RATED SWITCH AND INSTALL ON HOOD CHASE HOUSING. SEE "TYPICAL PIPING AND POWER ROOF CHASE HOUSING PENETRATION DETAIL" ON DRAWING M-403.
8. PROVIDE NEW DISCONNECT SWITCH AND INSTALL ON POWER PEDESTAL POST PROVIDED BY NEW WORK NOTE 2. INSTALL ALL BRANCH CIRCUITRY CONCEALED WITHIN POWER PEDESTAL POST, BELOW THE ROOF, AND WITHIN MECHANICAL EQUIPMENT ROOF CURB.



KEY PLAN
NOT TO SCALE

1/8" = 1'-0"
5' 0 5' 10' 15' 20'
SCALE FEET

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MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
ELECTRICAL ROOF PLAN - AREA 'J' - NEW WORK

REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: DWC
DRAWN BY: MWH
CHECKED BY: KC

E-117

DATE: 09/08/2025

PANEL "GL–1" 100 AMP 480Y/277V, 3ø, 4W, M.L.O., SURFACE MTD.

LOAD SERVED	LOAD (AMPS) A	B	C	CKT.BKR. KAIC	TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	CKT.BKR. KAIC	TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
LIGHTS	EX			10	20	EX	1	2	EX	10	20	EX			LIGHTS
LIGHTS		EX			20	EX	3	4	EX		20		EX		LIGHTS
LIGHTS			EX		20	EX	5	6	EX		20			EX	LIGHTS
LIGHTS	EX				20	EX	7	8	–		20	–			SPARE
LIGHTS		EX			20	EX	9	10	–		20		–		SPARE
LIGHTS			EX		20	EX	11	12	–		20			–	SPARE
XFMR	EX				40	EX	13	14	–		–	–			SPACE
XFMR		EX					15	16	–		–		–		SPACE
XFMR			EX				17	18	–		–			–	SPACE
SPACE	–				–	–	19	20	–		–	–			SPACE
SPACE		–			–	–	21	22	–		–		–		SPACE
SPACE			–		–	–	23	24	–		–			–	SPACE
SPACE	–				–	–	25	26	–		–	–			SPACE
SPACE		–			–	–	27	28	–		–		–		SPACE
SPACE			–		–	–	29	30	–		–			–	SPACE
SPACE	–				–	–	31	32	–		–	–			SPACE
SPACE		–			–	–	33	34	–		–		–		SPACE
SPACE			–		–	–	35	36	–		–			–	SPACE
SPACE	–				–	–	37	38	–		–	–			SPACE
SPACE		–			–	–	39	40	–		–		–		SPACE
SPACE			–		–	–	41	42	–		–			–	SPACE

PANEL "PDP–1" 600 AMP 480Y/277V, 3ø, 4W, M.L.O., SURFACE MTD.

LOAD SERVED	LOAD (AMPS) A	B	C	CKT.BKR. KAIC	TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	CKT.BKR. KAIC	TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
SPARE	–			22	200	–	1	2	EX	22	100	EX			PANEL "AL2"
SPARE		–					3	4					EX		PANEL "AL2"
SPARE			–				5	6						EX	PANEL "AL2"
DIMMER PANEL	EX				90	EX	7	8	EX		100	EX			UNKNOWN
DIMMER PANEL		EX					9	10					EX		UNKNOWN
DIMMER PANEL			EX				11	12						EX	UNKNOWN
DIMMER PANEL #9	EX				90	EX	13	14	EX		60	EX			PANEL "AR1"
DIMMER PANEL #9		EX					15	16					EX		PANEL "AR1"
DIMMER PANEL #9			EX				17	18						EX	PANEL "AR1"
SPACE	–				–	–	19	20	–		60	–			SPARE
SPACE		–			–	–	21	22					–		SPARE
SPACE			–		–	–	23	24						–	SPARE
SPACE	–				–	–	25	26	–		–	–			SPACE
SPACE		–			–	–	27	28	–		–		–		SPACE
SPACE			–		–	–	29	30	–		–			–	SPACE
SPACE	–				–	–	31	32	–		–	–			SPACE
SPACE		–			–	–	33	34	–		–		–		SPACE
SPACE			–		–	–	35	36	–		–			–	SPACE
SPACE	–				–	–	37	38	–		–	–			SPACE
SPACE		–			–	–	39	40	–		–		–		SPACE
SPACE			–		–	–	41	42	–		–			–	SPACE

SWITCHBOARD PDP2

1600 AMP, 480Y/277 VOLT, 3 PHASE, 4 WIRE, MAIN LUGS ONLY, FREE STANDING, DEAD FRONT, BRACED FOR 22 KAIC.

CKT. No.	TO FEED	BREAKER RATING	BREAKER FRAME	FEEDER CONDUIT	FEEDER WIRE	FEEDER GROUND
1	SPARE	200A-3P	225 AMP	-	-	-
2	WATER HEATER B-1	400A-3P	400 AMP	EX	EX	EX
3	PANEL "BL3"	125A-3P	225 AMP	EX	EX	EX
4	SPARE	200A-3P	225 AMP	-	-	-
5	PANEL "CL2"	100A-3P	100 AMP	EX	EX	EX
6	BOYS & GIRLS LOCKERS	100A-30	100 AMP	EX	EX	EX
7	PANEL 4 TRANSFORMER	60A-3P	100 AMP	EX	EX	EX
8	PANEL "BR1"	50A-3P	100 AMP	EX	EX	EX
9	PANEL "BL1"	30A-3P	100 AMP	EX	EX	EX
10	PANEL "BR2"	60A-3P	100 AMP	EX	EX	EX
11	PANEL "BL2"	30A-3P	100 AMP	EX	EX	EX
12	SPARE	60A-3P	100 AMP	-	-	-
13	SPACE	-	225 AMP	-	-	-
14	SPACE	-	225 AMP	-	-	-

PANEL "PDP–3" 600 AMP 480Y/277V, 3ø, 4W, M.L.O., SURFACE MTD.

LOAD SERVED	LOAD (AMPS) A	B	C	CKT.BKR. KAIC	TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	CKT.BKR. KAIC	TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
PANEL "FL1"	EX			22	150	EX	1	2	EX	22	150	EX			PANEL "FL2"
PANEL "FL1"		EX					3	4					EX		PANEL "FL2"
PANEL "FL1"			EX				5	6						EX	PANEL "FL2"
PANEL "FR3" & "FR4"	EX				150	EX	7	8	EX		60	EX			PANEL "FR1"
PANEL "FR3" & "FR4"		EX					9	10					EX		PANEL "FR1"
PANEL "FR3" & "FR4"			EX				11	12						EX	PANEL "FR1"
PANEL "GL1"	EX				100	EX	13	14	EX		50	EX			PANEL "FR2"
PANEL "GL1"		EX					15	16					EX		PANEL "FR2"
PANEL "GL1"			EX				17	18						EX	PANEL "FR2"
PANEL "AB"	–				90	EX	19	20	–		60	–			SPARE
PANEL "AB"		–					21	22					–		SPARE
PANEL "AB"			–				23	24						–	SPARE
SPACE	–				–	–	25	26	–		–	–			SPACE
SPACE		–			–	–	27	28	–		–		–		SPACE
SPACE			–		–	–	29	30	–		–			–	SPACE
SPACE	–				–	–	31	32	–		–	–			SPACE
SPACE		–			–	–	33	34	–		–		–		SPACE
SPACE			–		–	–	35	36	–		–			–	SPACE
SPACE	–				–	–	37	38	–		–	–			SPACE
SPACE		–			–	–	39	40	–		–		–		SPACE
SPACE			–		–	–	41	42	–		–			–	SPACE

PANEL "PDP–4" 600 AMP 480Y/277V, 3ø, 4W, M.L.O., SURFACE MTD.

LOAD SERVED	LOAD (AMPS) A	B	C	CKT.BKR. KAIC	TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	CKT.BKR. KAIC	TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
PANEL "FL3"	EX			22	150	EX	1	2	EX	22	150	EX			PANEL "FL2"
PANEL "FL3"		EX					3	4					EX		PANEL "FL2"
PANEL "FL3"			EX				5	6						EX	PANEL "FL2"
PANEL "FR5/7/10"	EX				100	EX	7	8	EX		150	EX			PANEL "FL4"
PANEL "FR5/7/10"		EX					9	10					EX		PANEL "FL4"
PANEL "FR5/7/10"			EX				11	12						EX	PANEL "FL4"
PANEL "FR6/8"	EX				100	EX	13	14	EX		60	EX			WATER HEATER F3
PANEL "FR6/8"		EX					15	16					EX		WATER HEATER F3
PANEL "FR6/8"			EX				17	18						EX	WATER HEATER F3
PANEL "C"	EX				90	3	19	20	EX		80	EX			ELEVATOR
PANEL "C"		EX					21	22					EX		ELEVATOR
PANEL "C"			EX				23	24						EX	ELEVATOR
SPACE	–				–	–	25	26	–		–	–			SPACE
SPACE		–			–	–	27	28	–		–		–		SPACE
SPACE			–		–	–	29	30	–		–			–	SPACE
SPACE	–				–	–	31	32	–		–	–			SPACE
SPACE		–			–	–	33	34	–		–		–		SPACE
SPACE			–		–	–	35	36	–		–			–	SPACE
SPACE	–				–	–	37	38	–		–	–			SPACE
SPACE		–			–	–	39	40	–		–		–		SPACE
SPACE			–		–	–	41	42	–		–			–	SPACE

PANEL "EDP3" 400 AMP 480Y/277V, 3ø, 4W, M.L.O., SURFACE MTD.

LOAD SERVED	LOAD (AMPS) A	B	C	CKT.BKR. KAIC	TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	CKT.BKR. KAIC	TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
PANEL "EDP2"	240			65	300	500	1	2	4	65	70	34			PUMP P–1
PANEL "EDP2"		240					3	4					34		PUMP P–1
PANEL "EDP2"			240				5	6						34	PUMP P–1
BOILER B4	2				15	12	7	8	12		15	2			BOILER B3
BOILER B4		2					9	10					2		BOILER B3
BOILER B4			2				11	12						2	BOILER B3
BOILER B2	2				15	12	13	14	12		15	2			BOILER B1
BOILER B2		2					15	16					2		BOILER B1
BOILER B2			2				17	18						2	BOILER B1
PUMP P–3	3				15	12	19	20	12		15	3			PUMP P–4
PUMP P–3		3					21	22					3		PUMP P–4
PUMP P–3			3				23	24						3	PUMP P–4
PUMP P–5	3				15	12	25	26	12		15	3			PUMP P–6
PUMP P–5		3					27	28					3		PUMP P–6
PUMP P–5			3				29	30						3	PUMP P–6
XFMR/PANEL "EE1"	32				40	8	31	32	4		70	34			PUMP P–2 (STAND–BY)
XFMR/PANEL "EE1"		32					33	34					34		PUMP P–2 (STAND–BY)
XFMR/PANEL "EE1"			32				35	36						34	PUMP P–2 (STAND–BY)

PANEL "HM1" 60 AMP 208Y/120V, 3ø, 4W, M.L.O., SURFACE MTD.

LOAD SERVED	LOAD (AMPS) A	B	C	CKT.BKR. KAIC	TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	CKT.BKR. KAIC	TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
EXISTING LOAD	EX			10	20	12	1	2	10	10	30	16			EF–18
EXISTING LOAD		EX			20	12	3	4	10		30		16		EF–19
EXISTING LOAD			EX		20	12	5	6	–		–			–	SPACE
OU–3	7.8				15	10	7	8	–		–	–			SPACE
OU–3		7.8					9	10	–		–		–		SPACE
SPARE			–		20	–	11	12	–		–			–	SPACE

PANEL "EE4" 100 AMP 208Y/120V, 3ø, 4W, M.C.B., SURFACE MTD.

2

LOAD SERVED	LOAD (AMPS) A	B	C	CKT.BKR. KAIC	TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	CKT.BKR. KAIC	TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
WALK IN COOLER LIGHTS	5			10	20	12	1	2	10	10	30	1			SPD
WALK IN FREEZER LIGHTS		5			20	12	3	4					1		SPD
SPARE			–		20	–	5	6						1	SPD
WALK IN COOLER EVAPORATOR	24				30	10	7	8	10		30	24			WALK IN COOLER CONDENSER
WALK IN COOLER EVAPORATOR		24					9	10					24		WALK IN COOLER CONDENSER
WALK IN COOLER EVAPORATOR			24				11	12						24	WALK IN COOLER CONDENSER
WALK–IN FREEZER	24				30	10	13	14	–		–	–			SPACE
WALK–IN FREEZER		24					15	16	–		–		–		SPACE
WALK–IN FREEZER			24				17	18	–		–			–	SPACE
SPARE	–				20	–	19	20	–		–	–			SPACE
SPARE		–			20	–	21	22	–		–		–		SPACE
SPARE			–		20	–	23	24	–		–			–	SPACE

COMMONWEALTH OF VIRGINIA
KENZIE CAMBAR
Lic. No.049752
09-08-2025
PROFESSIONAL ENGINEER

THOMPSON
Consulting Engineers
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MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA

PANELBOARD SCHEDULES

REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: DWC
DRAWN BY: MWH
CHECKED BY: KC

E-301

DATE: 09/08/2025

SECTION 010800 - CODE OF CONDUCT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-l Specification Sections, apply to this Section.

1.2. SUMMARY

A. This Section specifies administrative and procedural requirements for the prescribed Code of Conduct while working on school premises.

1.3. CONDUCT

A. The following rules shall apply at all times that students, faculty and staff are on the premises:

1. Owner's Representatives are on site to assist the Contractor (and his subcontractors) in coordination of the Work at the school, and with any required interaction between school personnel. They shall be the only means of communication between the Contractor (and his subcontractors) and persons at the school, except in life threatening emergencies.
2. Minor first-time violation of this relationship will result in a warning or removal from the project. Repeated violations will result in removal from the project.
3. Construction workers shall under no circumstances consult with the school principal and / or teachers regarding any issue of a construction nature, except as noted above.
4. All Contractors (subcontractors) shall wear a colored identification badge while on school premises. Failure to do so is reason for removal from the Job Site.
5. The General Contractor will distribute and maintain badges in accordance with Owner guidelines.
6. Fraternization between construction workers and teachers or students is strictly prohibited. Any contact deviating from normal courteous behavior will be considered reason for removal from the project.
7. If any student or teacher persist in disrupting the activities of construction work, the Owner's representative shall be notified immediately. Any work proceeding at the direction of a teacher, administrator or staff may result in the work being undone, corrected in accordance with the Contract Documents, or no compensation to the contractor.
8. Use of vulgar, suggestive or abusive language is strictly prohibited in the presence of or within earshot of teachers, students, school administrators or staff.
9. Consumption of alcohol or alcohol containing beverages is strictly prohibited on school grounds.
10. Use and / or possession of any controlled substance or substances considered to be illegal are strictly prohibited on school grounds. Any violation will result in removal from the project, and violator shall be turned over to the proper authorities.
11. Use and / or possession of any firearms or weapons considered to be illegal are strictly

prohibited on school grounds. Any violation will result in removal from the project, and violator shall be turned over to the proper authorities.

12. Cigarette smoking is prohibited on school grounds.
13. The use of personal radios / stereos is not permitted.
14. Construction workers shall not use the restrooms throughout the school facility.
15. Contractors shall park in designated areas only.
16. All construction materials and equipment shall be safely secured and stored when not in use.
17. Any demolition work shall not cause any disruption of communication or fire alarm system in occupied areas.
18. All construction work shall be performed to minimize disruption to any school activity. This may require the contractor to schedule work during off peak hours, and shall be accounted for by the contractor during scheduling and included within the bid. Any conflicts shall be brought to the attention of the Architect and Owner's representative prior to proceeding with the work.
19. Construction workers are not permitted free access to the school: Access shall be limited to specific task of construction in designated areas only. The school shall not be used as a shortcut from one portion of construction Work to another, unless specifically designated as a construction route by the Contract Documents or the Owner's representative. This shall apply at all times during the Work without exception.
20. Adequate temporary lighting shall be provided in all demolished / construction areas, including provisions for parking areas which remain in use subsequent to removal of fixtures.
21. Fire exits may not be blocked. (except as indicated in the documents, and as directed by the local authority having jurisdiction)
22. School dumpsters are not for construction debris. The contractor shall provide suitable equipment for prompt and safe removal of all construction debris.
23. Adequate ventilation must be maintained during welding or torch cutting procedures. In addition, spark screens shall be used and adequate fire extinguishing equipment shall be present. All standard safety procedures shall be observed.
24. Appropriate barricading, fencing and signage shall be used to clearly indicate areas of on-going construction, material storage, or any other condition that may create an unsafe environment for non-construction workers.
25. The Contractor is responsible for the safety, security, and cleanliness of all school property which may remain in the assigned areas of construction.
26. For the Contractor's protection, he may solicit the confirmation of the quantity, quality, etc. of the items of concern with the Owner's representative prior to occupancy. Any shortages or damages noted upon returning to the area of the school shall be considered the Contractor's responsibility. This is of special concern in areas where items (such as athletic equipment) are stored. This shall also include, but not be limited to, damage to carpet, vinyl floor, painted walls, blackboards, bulletin boards, clocks, speakers and furniture.
27. Eating from the school cafeteria is not permitted.
28. Fumes from work that occurs adjacent to HVAC intake or exhaust areas shall be blocked so that they do not enter into the HVAC system.

1.4 RESPONSIBILITIES

A. Contractor's responsibilities shall include but not be limited to the following:

1. Owner's Representatives shall be informed and kept advised of all construction activities at the school. They will assist the Contractor in coordination of the Work effecting school systems, such as electrical, mechanical, plumbing, telephone, etc.
2. A minimum 48-hour notice is required prior to disruption of utilities or services to the school.
3. Owner's Representatives shall be informed and kept advised of the schedule for classroom turnover, and the need to have spaces vacated for construction.
4. Owner's Representatives shall be kept advised of any disruptions or concerns that develop at the school, or with any persons at the school not related to the construction.
5. The General Contractor shall have an authorized and qualified representative, project manager or superintendent *on the site at all times* during which Work is proceeding. *No exceptions*.

1.5 SPECIAL COORDINATION AND COOPERATION

A. Owner Occupancy of Existing School Facility: The Owner may occupy all or portions of the existing school facility outside of the construction contract limits for each phase of the construction during some of the construction period. The Contractor shall cooperate with the Owner during the construction period to minimize conflicts and facilitate Owner's usage of the building / premises.

B. The Contractor shall be responsible for scheduling Work so as not to interfere with the Owner's normal operations.

C. To best facilitate the continued operation of the school (while in session), determine with the Owner a general sequence of construction. The additions can generally be constructed with minimal disturbance of the existing school operation. There will be the need to provide construction tunnels for Life Safety issues. See Plans.

D. Generally, renovations shall be accomplished when areas are vacant or when school is not in session, with full access to the building unless noted otherwise.

E. Where isolating work areas requires closing off existing exit-ways, work shall be coordinated with the Owner and the Fire Marshall, providing and maintaining safe egress from the building.

F. Certain items / materials indicated for removal shall be salvaged and turned over to the Owner.

END OF SECTION 010800

SECTION 230500 - HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 “Mechanical General Provisions” apply to this Section.

B. Refer to Specification Sections 230900 “Automatic Temperature Controls” and the Control Diagrams on drawings for additional requirements and coordination between equipment and controls.

1.2 WARRANTY-GUARANTEE

A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of material and workmanship for a period of 12 months from date of Substantial Completion of the building. Refer to Section 230100 for additional warranty period responsibilities.

1.3 SUBMITTALS

A. Prior to fabrication of any ductwork, Mechanical Contractor shall prepare and submit for review and approval 1/4" scale ductwork shop drawings. Drawings shall indicate all equipment locations and double line ductwork layout. Drawings shall be coordinated with existing conditions and Architectural, Structural, Sprinkler and Electrical Drawings.

B. Submit manufacturer’s performance data and unit details on all products specified below or indicated on drawings.

1.4 PROTECTION OF EQUIPMENT AND MATERIAL

A. All equipment and material not specifically designed for exterior installation shall not be delivered to the job site until an indoor, dry location is available for storage. All equipment and material shall be covered and protected from dirt, debris, moisture, paint, coatings and damage of any kind. Store off the floor, in a location approved by the Owner, to prevent contact with water.

PART 2 - PRODUCTS

2.1 HEAT GENERATION

A. Boiler:

1. Contractor shall furnish and install full condensing boilers in accordance with the following specifications and capacities as shown on the plans. Basis of Design is LOCHINVAR "CREST". Alternates are CLEAVER-BROOKS "CLEARFIRE" and AERCO "BENCHMARK". NO SUBSTITUTIONS.
2. Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
3. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 30,000 to 40,000 Btu’s per tube. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or “O” rings in the heat exchanger design. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.
4. Condensate Collection Basin: Fully welded 316L stainless steel.
5. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
6. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 157 gallons.
7. Burner: Natural gas, forced draft single burner premix design with an upper and lower chamber supplied by individual combustion systems. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet requirements of South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2.
8. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

9. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns:

Model	Turndown	Minimum Input	Maximum Input
FB 25601	20:1	125,000	2,500,000

10. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

11. Casing:

    a. Jacket: Heavy gauge primed and painted steel jacket with snap-in closures.
    b. Control Compartment Enclosures: NEMA 250, Type 1A.
    c. Insulation: Minimum 1/2 inch thick, mineral fiber insulation surrounding the heat exchanger.
    d. Combustion-Air Connections: Inlet and vent duct collars.

12. Characteristics and Capacities:

    a. Heating Medium: Hot water.
    b. Design Water Pressure Rating: 160 psi working pressure.
    c. Safety Relief Valve Setting: 50 psig
    d. Minimum Water Flow Rate: 25 GPM

13. Trim:

    a. Safety Relief Valve:

        1) Size and Capacity: 1-1/2" and 3,075 MBH
        2) Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

    b. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
    c. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.
    d. Condensate Drain Dilution Tank and Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

14. Controls:

    a. Refer to Specification 230900 Automatic Temperature Controls or control diagram on drawing.

    b. Boiler controls shall feature a standard, factory installed 8" LCD screen display with the following standard features:

        1) Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
        2) Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
        3) Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
        4) Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.

5) Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
6) PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
7) Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
8) Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
9) Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
10) Night setback: Boiler shall be programmed to reduce the space heating temperature set point during a certain time of the day.
11) Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps shall turn off when the boiler water temperature rises above 43 degrees.
12) BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
13) Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.

c. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:

1) Lead lag:
2) Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
3) Front end loading:
4) Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.

d. Boiler operating controls shall include the following devices and features:

1) Set-Point Adjust: Set points shall be adjustable
2) Operating Pressure Control: Factory wired and mounted to cycle burner.

3) Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 35 deg F outside-air temperature, set supply-water temperature at 160 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 100 deg F.

e. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1) High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
2) Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
3) Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4) High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
5) Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
6) Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
7) Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

f. Building Automation System Interface: Factory installed BACnet gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

15. Electrical Power:

a. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
b. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

16. Source Quality Control:

a. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
b. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Boiler Vent System:

1. Vents shall be Saf-T Vent CI Plus as manufactured by HEATFAB, INC., SCHEBLER, JEREMIAS EXHAUST SYSTEM, Z-FLEX, SECURITY CHIMNEY, or approved equal.
2. All products furnished under this Section shall conform to the requirements of The National Fuel Gas Code, NFPA-54, where applicable and shall comply with and be listed to UL1738, Standard for Venting Systems for Gas-Burning Appliances, Category II, III and IV. Components coming in direct contact with products of combustion shall carry the appropriate UL listing mark or label.
3. The vent shall be of the double-wall, factory-built type for use on condensing appliances or pressurized venting systems serving Category II, III, or IV appliances or as specified by the equipment manufacturer. Maximum temperature shall not exceed 550°F (288°C).
4. Vent shall be listed for an internal static pressure of 6" w.g. and tested to 15" w.g.
5. Vent shall be constructed with an inner and outer wall, with a 1" annular insulating air space.
6. The inner wall (vent) shall be constructed of AL29-4C, superferritic stainless steel, .015" thickness for 6"-12" diameters and .024" thickness for 14"-24" diameters.
7. The outer wall (casing) shall be constructed of aluminized steel or 430 stainless steel, .018" thickness for 6"-12" diameters and .024" thickness for 14"-24" diameters.
8. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.
9. All vent parts exposed to the weather shall be stainless steel.
10. All supports, wall penetrations, terminations, appliance connectors and drain fittings, required to install the vent system shall be included.
11. Wall penetration pieces shall be UL listed and provided by the vent manufacturer.
12. All inner vent connections shall be secured by means of profiled connector bands with gear clamp tighteners. Joints shall be sealed with P077 Sealant.
13. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
14. Vent shall terminate in accordance with installation instructions and local codes.
15. Clean all breechings of dust and debris prior to final connection to appliances.
16. Contractor shall pressure test the Breeching Systems as recommended by the manufacturer to demonstrate System integrity. Make necessary adjustments as required to meet the manufacturer's recommendations for System airtightness.

2.2 REFRIGERATION (NOT USED)

2.3 AIR HANDLING EQUIPMENT

A. Exhaust Fans:

1. Fans shall be size, type, and have capacity as indicated on drawings. GREENHECK, LOREN COOK, or approved equal.
2. Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. Fan air performance ratings shall be based on tests conducted in an AMCA registered laboratory for AMCA 210 air performance testing. The Test Standard used shall be ANSI/AMCA Standard 210-85, ANSI/ASHRAE Standard 51-1985, "Laboratory Methods of Testing Fans for Rating." All sizes must be tested, calculations to other sizes not acceptable. Fan sound

performance shall be based on tests conducted in an AMCA registered laboratory for AMCA 300 Sound Performance Testing. The Test Standard used shall be AMCA 300 "Reverberant Room Method for Sound Testing of Fans." All sizes must be tested, calculations to other sizes are not acceptable. Air or Sound Test results are to be included in submittal.

3. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
4. Provide solid-state speed controls for all direct drive fans.
5. All fans shall be statically and dynamically balanced.
6. Install as required for quiet operation.
7. Motor shall be a DC electronic commutation type motor (ECM) specifically designed for fan applications unless otherwise noted.
8. Downblast power roof ventilators:

    a. Downblast power roof ventilators shall have aluminum housing, backward-inclined aluminum fan wheel, gravity-type back-draft dampers, bird screen, aluminum curb cap with pre-punched mounting holes, aluminum rub ring, motor isolated shock mounts, corrosion-resistant fasteners, lifting lugs and factory-wired NEMA 1 toggle disconnect switch. Provide direct or belt drive as indicated. Shaft shall be mounted in ball bearing pillow blocks. Bearings shall have grease fittings. Provide adjustable pulley and motor plate on belt drive units.

9. Kitchen Exhaust Fans:

    a. Fan shall be size, type and have capacity as indicated on drawings. GREENHECK, LOREN COOK, ACME or approved equal.
    b. Kitchen hood roof exhaust fans shall be upblast centrifugal belt driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Windbands shall have a rolled bead for added strength and shall be joined to curb caps with a leakproof, continuously welded seam.
    c. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
    d. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
    e. Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be factory installed a wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
    f. The fan shall be UL 762 listed for grease removal.

g. Fan shall be mounted on existing curbs. Where dimensions of fan bases do not match curb dimensions provide galvanized steel adapters. Provide curb extension if required to meet minimum discharge height of 40 inches.

B. Rooftop Units with Energy Recovery (RTU-1, 2, 5, 6 AND RTU-8 THROUGH RTU-17)

1. Work Included:

a. This specification is based on an Energy Recovery Model as manufactured by ANNEXAIR INC. Alternative manufacturers including ENGINEERED AIR AND INNOVENT will be considered provided the unit meets the specifications, dimensional and performance requirements as listed in the plans and specifications.
b. The units shall be installed in strict accordance with the specifications. Units shall be complete with all components and accessories as specified. All units shall be factory assembled, internally wired, and 100% run tested to check operation, fan/blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with ANSI-UL 1995/CSA C22.2 No.236.
c. Equipment start-up and project inspection shall be performed by qualified factory trained representatives.

2. Quality Assurance:

a. All units shall be factory run tested before shipping. A proof copy of the test shall be placed in the unit electrical power & control panel.
b. Units shall bear the ETL label, tested in accordance to UL 1995. Electrical components shall be UL listed.
c. Fans shall be tested in an AMCA certified laboratory; insulation shall comply with NFPA 90A.
d. Coils shall be tested in accordance to AHRI 410.
e. Energy recovery exchangers shall be in accordance to AHRI 1060, “Rating Air-to-Air Energy Recovery Equipment”.
f. Filters shall be tested in accordance to ASHRAE 52.
g. Units that shall be shipped in sections shall be reassembled by factory authorized personnel and inspected.

3. Construction:

a. Thermo-Composite Panels (with thermal break frame):

1) The unit housing shall be no-through metal with 2’’ Thermo-Composite and foam panel construction - interior and exterior or an all-aluminum 4” Foam thermal break construction - interior and exterior. Thermal break construction using a gasket to insulate two panels is not an acceptable equivalent to a no-through metal constructed casing. No-through metal construction will be inherent to all the component construction in the assembly.
2) All panels and access doors shall be double wall construction with R14 foam insulation for every 2” of construction. Any insulation incorporating CFCs or HCFCs in its construction is strictly prohibited from this application.

3) Unit casing will have no exterior condensation at interior AHU temperatures down to 42.5F while unit exterior conditions are maintained at 95 F dry bulb / 85 F wet bulb. The air handling unit manufacturer general construction shall be tested to demonstrate the thermal performance of the unit casing. The test shall include placing the entire test unit in a climate-controlled environment and exposing the unit to the conditions mentioned previously. If the manufacturer does not have access to such equipment, an independent testing agent must be hired to transport the test unit to a qualified test facility and perform the test at the expense of the manufacturer. Inability to provide this option to the engineer will make the manufacturer ineligible to bid on this project. The unit housing shall be constructed from a frame, base and panel assembly. Unit shall be completely factory assembled and shipped in one-piece as shown on drawings.
4) The panels shall be tested in accordance with SMACNA and ASHRAE 111 to have a deflection of no more than L/700 at 10'' and withstand air pressures up to 8" w.c. with less than 1% leakage. Fire resistance of the panel will be in compliance with UL 94 rated at 5VA; and a flame spread / smoke development in compliance with UL 723 ASTM E84 Class 1 rating.
5) Thermo-Composite or aluminum panels shall be provided for the entire unit construction, including but not limited to, walls, doors, floors, roof, interior partitions, and electrical compartment. Panels shall be non-load bearing type.
6) The frame shall consist of anodized extruded aluminum profiles which incorporates a thermally broken construction; welded together for reinforcement and insulated for superior thermal performance.
7) Base structure shall be fully welded G-90, painted exterior, and have integral lifting lugs which can be removed once the unit is installed.
8) All roof and side wall seams shall be positively sealed to prevent water and air leakage. The OA compartment shall have 1" PVC drain extended to exterior of unit
9) Access doors shall be provided to all major components to facilitate quick and easy access. Access doors will be made from the same material as the unit casing and shall incorporate thermal break construction. Fan access door(s) shall have Allegis type handles, with one handle interlinking multiple latches and threaded insert fastening handles for all remaining doors. If access doors do not open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement. Removable panels provided for equipment pull out for coil(s), and air to air heat exchanger section(s) shall have key tooled threaded insert fasteners. Hinges shall be Nylon hinge type designed to open 180 degrees.
10) Unit shall have the entire exterior finished with a PVDF coating designed for UV resistance. Panels shall be painted ANNEXAIR standard color Pantone Cool Gray 1C. Panels shall pass ASTM B117 3000-hour salt fog resistance test and ASTM D4585 3000-hour moisture condensation resistance test. In addition, paint must meet AAMA 620-02 standard for color, chalking, gloss retention, and abrasion resistance.
11) The air handler unit casing shall be provided with a lifetime warranty against corrosion resistance under normal use.

b. Weather Hoods:

1) The outdoor intake weather hood shall be completely constructed in aluminum for superior corrosion resistance. Painted galvanized hoods shall not be acceptable due to its susceptibility to corrosion.
2) The hood shall ship loose for field installation by the installing contractor.
3) The outdoor air hood shall be designed with a 4" extruded aluminum louver, bird screen and a plenum enclosure with drain holes. The louver blades shall be drainable type with a maximum 40-degree angle and curved with integral rain baffle. The louver design shall not allow more than 0.01 oz/ft2 water penetration when tested in accordance to AMCA 500. The pressure drop of the complete hood assembly shall not exceed 0.01" wc at a maximum 500 fpm face velocity.

c. Exhaust Air Louver:

1) The exhaust air outlet louvers shall be 2" extruded aluminum, with non-restricting blade design and bird screen.

d. Enthalpy Wheel:

1) The enthalpy wheel shall recover both sensible and latent heat.
2) The matrix shall be a minimum of 8'' thick to achieve optimal performance and be constructed from a corrugated aluminum alloy. The corrugation shall be uniform to obtain minimum pressure drops through the wheel.
3) All wheels will be one piece construction standard up to 85" diameter (size 12), and segmented construction above 96" diameter (size 16).
4) Wheels with varying flute sizes are not acceptable. Wheels with non-metallic matrices will not be considered for this application.
5) The media shall be specifically treated and coated with Silica gel desiccant to assist and enhance latent heat transfer.
6) The wheel bearing shall be permanently sealed, and press fitted into the wheel hub for wheel sizes up to 96" diameter, and greaseable bearings for larger than 96" diameter. The seal shall made from a dual band ultra-high molecular weight polyethylene and be self- lubricating, wear resistant, and airtight against prolonged use. Seals shall be full contact compression type, on both sides of the wheel to ensure minimal leakage. Specially designed stainless steel clips are used to position the seal across the face of the wheel. Any seal that is non-contact is not to be considered a seal and will not be acceptable. Labyrinth type seals do not operate properly under different air stream pressures therefore shall not be acceptable in any circumstances.
7) Drive system shall be operated by a fractional horsepower TEBC motor (maximum 1 HP), VFD micro drive, pulley and V-belt. Belts shall be made of multi-link high-tech urethane/polyester composite. An access panel shall be provided for maintenance on the drive system.
8) A double purge sector (2 x 5º) shall be factory installed to reduce cross contamination to under 0.04%.
9) Frost control prevention shall be provided by the unit manufacturer and accounted for if outdoor air temperatures are below 10°F at equal airflows and

return relative humidity below 30%. Frost control shall be accomplished by a variable speed drive and controlling the leaving air condition of the exhaust air. Other methods of frost control will not be considered for this application.

10) Wheel speed shall not rotate faster than 20 RPM (min 0.7rpm). Any rotational speed above 20 RPM will be unacceptable since this will reduce the efficiency of the purge section.
11) Media cleaning shall be accomplished with any of the following methods: compressed air, low pressure steam, hot water or light detergent without degrading the latent recovery.
12) The wheel cassette shall be made of corrosion resistance Thermo Composite panels with aluminum frame.
13) In corrosive environment, protection coating added shall be epoxy coated (entire channel)

e. Fans:

1) Fans shall be direct drive with non-obstructive air intake and externally mounted motor. No fan belts will be acceptable for this application. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade airfoil geometry protected by an epoxy powder coating.
2) To reduce vibration, the impeller shall be balanced with hub to an admissible vibration severity of less than 3.8 mm/s in conformity with ANSI/AMCA Standard 204-05 Fan Application Category for balance and vibration: HVAC BV-3, Balance Quality Grade for rigid Rotors/Impeller: G6.3.
3) The fan and motor assembly shall be directly wall mounted without isolation.
4) Fans will require to be operated by one speed controller per fan.
5) The permanent magnet motors shall have high efficiencies (up to 93%+controller) with low noise, low vibration output, compact design, longer life, increased torque at start, reduced heat losses and reduced friction between components.
6) The motor should be able to operate between -40F and +120F ambient temperature.
7) Dust and humidity protection should be IP54. Motor with Adsil corrosion protective, anti- microbial coating.
8) An insulated shaft-rotor kit will be provided to reduce shaft voltage electrical damage to motor bearings.
9) Speed controller will be used to set or regulate the fan speed and airflow for these units.
10) The speed controller shall be capable of controlling an IPM (Internal Permanent Magnet) motor to 400Hz. An auto-tuning system shall provide the ability to drive any IPM motors.
11) The efficiency of the speed controller at 100% speed and load shall not be less than 95%.
12) There shall be a regenerative avoidance function to minimize the effect of opposite rotation of another fan within the same duct and have Out-of-Range warning system to detect any potential mechanical problems.
13) The speed controller shall have momentary power-loss ride-thru capability.
14) The speed controller shall incorporate PID and Dual PID for process controls

such as flow rate, air volume, or pressure.

15) The input power section shall utilize a full wave 6-pulse bridge design incorporating diode rectifiers. The diode rectifiers shall convert AC line power of fixed voltage and frequency to fixed DC voltage. This power section shall be insensitive to phase sequence of the AC line voltage.
16) The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall utilize insulated gate bipolar transistors (IGBT's).
17) The speed controller includes 3 sets of user adjustable skip frequencies and choice of 0-5Vdc, 0-10Vdc or 4-20mA speed reference for input and output.
18) The speed controller shall incorporate a dedicated USB port for programming.
19) The speed controller will have PWM control, RS-485 / BACnet RTU & carrier frequency up-to 14.5 KHz.
20) Control logic terminals shall be of the clamp / vibration resistant type.
21) The speed controller shall incorporate a radio filter capable of meeting product standard EN61800-3 for Second (2nd) Environment.
22) The speed controller shall have built-in PLC capable of 6k steps.

f. Filters:

1) Pre-Filters:

a) Filters shall be factory installed where shown on the drawings.
b) The filters shall be MERV 10.
c) Each filter shall consist of 100% synthetic, mechanical media that does not support microbial growth.
d) MERV 10 model High Capacity Series filters, UL 900 classified are rated as per ASHRAE test 52.2.
e) The model High Capacity Series 400 could be operated at 500 FPM, surface area 18 FT2 of media based on 24 x 24 x 2 initial static pressure at 0.24", final will be 1".
f) Filters shall be placed in a completely sealed, galvanized holding frame with quick release latches for easy replacement.

g. Dampers – Unit Manufacturer Provided:

1) Dampers shall be installed where shown on the drawings.
2) Dampers shall be low leak type with rubber edges, opposed blades, and constructed from extruded aluminum.
3) Galvanized dampers will not be acceptable.
5) Dampers shall be installed in the compartments (as shown on the drawings) with linkage rod for actuators.
6) Actuators shall be 24V factory installed: two-position or modulating
7) All actuators shall have spring return mechanism and auxiliary switches. Dampers will be installed in the failed close positions unless otherwise noted.
8) Dampers, guard grills, and all accessories shall be provided by manufacturer.

h. Air Cooled Condensing Unit with Variable Speed Compressors

1) Provide an integral AIR COOLED CONDENSING UNIT (ACCU) section with variable speed compressors. The condensing section shall be factory piped, wired, and charged with R-454B refrigerant. The section shall be from the same manufacturer as the air handling unit. Factory mounting and piping the condensing unit, provided by a third party is not acceptable. Furthermore, the exterior cabinet of the ACCU section shall be of the same construction and paint color as the air handling unit.
2) Compressors shall be variable speed scroll type that can modulate from 33% to 100% capacity per compressor. Variable capacity compressors which do not modulate the speed of the scrolls are not considered equal to a variable speed scroll since they consume more energy at the same capacity output. Mechanically stepped scrolls which are unloaded via a digital signal to a solenoid valve, in a timed sequence, will not be acceptable for this application. The variable speed scrolls shall be operated via a factory supplied variable speed controller per compressor, and all tandem compressors will modulate in unison. Using a single variable speed controller on the lead circuit alone is not efficient during part load conditions, therefore will not be acceptable for this application. Each compressor and controller assembly shall be equipped with the following features: PERMANENT MAGNET MOTOR, electronic expansion valve, a crankcase heater function, anti-short cycling, built-in phase loss detector, EMC filter, oil return management system, and reverse rotation protection. All refrigeration parts, including the compressor and the speed controller, will be located in a closed and vented service compartment, separate from the condenser coil airflow.. Compressors shall be mounted on rubber isolators to limit vibration transmission.
3) All ACCU above 20 tons will have a minimum of two compressors.
4) Condenser fans shall have 7 blades with external mounted asynchronous motors that are class F insulated, IP54 and 100% variable speed. Each condenser fan bank shall be provided with a variable frequency drive which modulates via refrigerant head pressure control for superior part load performance. All the condenser fans in a fan bank shall modulate in unison for each respective circuit. Staging condenser fans are not an acceptable mode of control for head pressure control.
5) Protective guards shall be included on all condenser fans, and condenser coils. The coil protective guard (Permatron) shall be ideal to keep coil at maximum operating performance, protect the condenser coil from hail damage and allow for tool-free cleaning.
6) The condenser coils shall be micro-channel design (Al/Al) for maximum efficiency performance, consist of a single pass arrangement with integral receiver, and be pressure tested at 650 psig.
7) The standard ambient temperatures for cooling operation is 40F to 125F. Unit comes standard with head pressure control that can allow cooling operation down to 0F ambient air, given the ambient wind conditions permit (Max 5 mph or unit may trip on low pressure). For any lower ambient conditions down to -20F, a winter kit is required which includes two additional regulating valves, and full receiver sized for 100% refrigeration charge.
8) Condenser coils to be e-coated (4000 hr. salt spray resistance)

9) Minimum (5) five-year compressor warranties shall be provided. Refer to Section 230100 for additional requirements.

i. Air Source Heat Pump Unit with Variable Speed Compressors

1) Provide an integral AIR SOURCE HEAT PUMP (ASHP)section with variable speed compressors. The condensing section shall be factory piped, wired, and charged with R-454B refrigerant. The section shall be from the same manufacturer as the air handling unit. Factory mounting and piping the condensing unit, provided by a third party is not acceptable. Furthermore, the exterior cabinet of the ASHP section shall be of the same construction and paint color as the air handling unit.
2) Compressors shall be variable speed scroll type that can modulate from 17% to 100% capacity per compressor. Variable capacity compressors which do not modulate the speed of the scrolls are not considered equal to a variable speed scroll since they consume more energy at the same capacity output. Mechanically stepped scrolls which are unloaded via a digital signal to a solenoid valve, in a timed sequence, will not be acceptable for this application. The variable speed scrolls shall be operated via a factory supplied variable speed controller per compressor, and all tandem compressors will modulate in unison. Using a single variable speed controller on the lead circuit alone is not efficient during part load conditions, therefore will not be acceptable for this application. Each compressor and controller assembly shall be equipped with the following features: PERMANENT MAGNET MOTOR, electronic expansion valve, a crankcase heater function, anti-short cycling, built-in phase loss detector, EMC filter, oil return management system, and reverse rotation protection. All refrigeration parts up to 100 tons, including the compressor and the speed controller, will be located in a closed and vented service compartment, separate from the condenser coil airflow. Compressors will be located external to the cabinet. Compressors shall be mounted on rubber isolators to limit vibration transmission.
3) All ASHP above 20 tons will have a minimum of two compressors.
4) Condenser fans shall have 7 blades with external mounted asynchronous motors that are class F insulated, IP54 and 100% variable speed. Each condenser fan bank shall be provided with a variable frequency drive which modulates via refrigerant head pressure control for superior part load performance. All the condenser fans in a fan bank shall modulate in unison for each respective circuit. Staging condenser fans are not an acceptable mode of control for head pressure control.
5) Protective guards shall be included on all condenser fans, and condenser coils. The coil protective guard (Permatron) shall be ideal to keep coil at maximum operating performance, protect the condenser coil from hail damage and allow for tool-free cleaning.
6) The condenser coils shall be fin tube design (Al/Cu) for maximum efficiency performance.
7) The following components shall be included in each refrigeration circuit: Liquid line filter dryer, hi and low-pressure switch, hi and low pressure transducers, suction and liquid lines shutoff valves and suction line

accumulators. In addition, refrigeration piping must use Shrader type connections for all components, including but not limited to valves and transducers. Under no circumstances shall the units leave the factory without a complete run test and a copy of the QC report shall be provided upon request.

8) Minimum (5) five-year compressor warranties shall be provided. Refer to Section 230100 for additional requirements.

9) The standard ambient temperatures for cooling operation is 40°F to 125°F. Unit comes standard with head pressure control that can allow cooling operation down to 0°F ambient air, given the ambient wind conditions permit (Max 5 mph or unit may trip on low pressure). For any lower ambient conditions down to -20F, a winter kit is required which includes two additional regulating valves, and full receiver sized for 100% refrigeration charge.

10) Condenser coils to be e-coated (4000 hr. salt spray resistance) when installed within 15 miles from a coastal environment or in known corrosive environments.

11) Air source heat pump option comes standard with a reversing valve. Below 40°F ambient air operation, defrost cycle will be available. Heat Pump heating lock-out will be set at 15°F (default).

j. DX Coils:

1) Coils shall be factory installed in the unit.
2) Coils shall be designed with respective circuits to match the design requirements. All coils shall have a distributor per circuit connection. Coils shall be circuited for counter-flow heat transfer to provide maximum mean effective temperature difference for maximum heat transfer rates.
3) Primary surface shall be round seamless (3/8” O.D.) copper tube staggered in the direction of airflow. Secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
4) Casing shall be constructed of continuous galvanized steel.
5) Coils are to be pressurized and then completely submerged in warm water containing special wetting and final cleaning agents for leak testing and tested with a minimum of 650 psi air pressure. Maximum finned height shall be 60” and shall not exceed 500 FPM face velocity.
6) Drain pans shall be provided on cooling coils. Cooling coils shall sit on stainless steel tubular support rails, which shall stand a minimum of (2) two inches above the highest point of the floor drain pan. Stacked coils shall be provided for larger airflows and intermediate drain pans shall be provided for each coil bank. Drain pans shall be stainless steel with 1.25” stainless steel drain connections on one side only. Pan shall be sloped in three planes.
7) All coils shall be rated in accordance with AHRI standard 410.

8) All Coils shall be coated with ElectroFin or equivalent dipped flexible cationic epoxy polymer e-coat. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness from 0.6-1.2 mils (15-25 μm). E-coating shall meet 4B-5B rating for cross-hatch adhesion per ASTM B3359-93. COIL COATING SHALL BE FACTORY APPLIED.

k. Hot Gas Reheat Coil (Except RTU- 2, 5, 6, 8, 9, 12, 13 &14):

1) Coils shall be factory installed in the unit.
2) The hot gas reheat coil shall be installed at 4" from the moisture producing DX cooling coil. A plexiglass between the two items shall be required to visually inspect the DX cooling coil surface area.
3) A modulating valve shall be provided to control air leaving temperature for dehumidification.
4) Coils shall be designed with respective circuits to match the design requirements.
5) Primary surface shall be round seamless (3/8" O.D.) copper tube staggered in the direction of airflow. Secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
6) Casing shall be constructed of continuous galvanized steel.
7) The complete coil shall be tested with 315 pounds air pressure under warm water and be suitable for operation at 250 psig working pressures.
8) All coils shall be rated in accordance with AHRI standard 410.
9) All Coils shall be coated with ElectroFin or equivalent dipped flexible cationic epoxy polymer e-coat. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness from 0.6-1.2 mils (15-25 μm). E-coating shall meet 4B-5B rating for cross-hatch adhesion per ASTM B3359-93. COIL COATING SHALL BE FACTORY APPLIED.

l. Hot Water Coils:

1) Coils shall be factory installed in the unit.
2) Primary surface shall be round seamless (5/8" O.D.) copper tube with 0.018" plain wall thickness staggered in the direction of airflow. Secondary surface shall consist of a minimum 0.006" rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.
3) Coils shall be circuited for counter-flow heat transfer to provide maximum

mean effective temperature difference for maximum heat transfer rates.

4) Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
5) Casing shall be constructed of continuous stainless steel.
6) Coils shall be submerged in water and tested with a minimum of 315 psi air pressure. Maximum finned coil height shall be 60" and shall not exceed 500 FPM face velocity.
7) All coils shall be rated and certified in accordance with AHRI standard 410.
8) All Coils shall be coated with ElectroFin or equivalent dipped flexible cationic epoxy polymer e-coat. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness from 0.6-1.2 mils (15-25 μm). E-coating shall meet 4B-5B rating for cross-hatch adhesion per ASTM B3359-93. COIL COATING SHALL BE FACTORY APPLIED.

m. Power and Safety Controls:

1) The power and control center shall be integral to the unit housing and rated equivalent to NEMA 4X.
2) Under no circumstances shall any wiring or parts be field installed. If units show up at the job site without wiring by the manufacturer, the contractor will have to send back units to the manufacturer at the contractors' expense to get them factory wired and re-tested.
3) Each panel access door shall be provided with an approved locking device.
4) All electrical components contained in the panel shall be UL/CSA certified and labeled. The unit shall be complete with VFDs, fuses, relays, phase protection for compressorized units, terminals for main ON/OFF and step-down transformer. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch with external handle shall be factory installed for ON/OFF servicing.
5) An electrical pipe chase for power and control feeding shall be provided next to the control panel for roof mounted units.
6) Any power or control wiring that is field installed shall not be accepted under any circumstances. The Short Circuit Current Rating (SCCR) is 65 kA symmetrical, as noted on schedule.
7) GFI and switches shall be factory installed and wired to a common junction box. A separate power connection 120V/1 will be required.
8) Unit shall be provided with a high condensate level switch that shuts down the unit when a high water level is detected in the drain pan.
9) Provide unit with "BACnet general controller" to transmit additional control points from sensors provided by BAS contractor.

n. Air Temperature Controls

1) The unit shall be provided with factory mounted control system.
2) The refrigerant management controls shall be provided by the Unit Manufacturer to maintain the unit warranty.
3) All temperature and humidity sensors field installed by DDC contractor.

Dampers and actuators are provided, and factory installed by the Unit Manufacturer.

4) Refer to the Sequence of Operation and control schematic for detailed description.
5) Prior to Bid, the Unit Manufacturer shall coordinate the controls with controls contractor, reviewing all functions and provide a certification that all items are covered between the unit and controls.

o. Accessories – Unit Manufacture shall provide the following:

1) Dirty filter switch
2) Door interlocking switch (for fan section)
3) Magnehelic gauges (Dwyer 2000 model)
4) Condensate overflow switch (for drain pans).
5) OA Air Flow Monitoring Package

a) The airflow measuring station shall consist of a special probe, a transducer and a display. The probe will be designed to be accurate in turbulent airflow and will be a standard design to fit all ducts. Only the number of probes will change based on the surface area. Probes can be washed down if required. The high accuracy transducer shall be mounted inside a NEMA 4 enclosure where temperature is controlled and shall also include an auto-zero function to prevent drifting. The display will indicate airflow, temperature and alarms. It will also serve as the interface to configure the system via an internal Set-up Wizard. This Set-up Wizard will include start-up, commissioning and diagnostics functions without the use of a laptop computer or other tools. All calculations, and management operations will be done within the display unit. The accuracy shall be +/- 5% of reading between 200 and 965 ft/min and +/- 10% of reading between 75 and 200 ft/min.
b) Fan Airflow Monitoring Station Package (Supply and Exhaust Fans)
c) The unit shall be delivered with factory installed airflow measuring system. The airflow measuring system, consisting of a piezometer ring and transducer, shall be installed on the fan. The package consists of an inlet port on the fan inlet cone connected with flexible tubing to the transducer.

C. Packaged Rooftop Unit (RTU-3)

1. General Description

a. This section includes the design, controls and installation requirements for packaged rooftop unit RTU-3.

2. Quality Assurance

a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

b. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
c. Unit Energy Efficiency Ratio (EER) shall be equal to or greater than that prescribed by ASHRAE 90.1, Energy Efficient Design of New buildings except Low-Rise Residential Buildings.
d. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

3. Submittals

a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage and Handling

a. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
c. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the installation, operation and maintenance manual.

5. Warranty

a. Refer to Specification Section 230100 for warranty requirements.

6. Manufacturer

a. Products shall be provided by the following manufacturers:

1) Basis of design is AAON “RN” model. Units may also be provided by YORK “Sun”, DAIKIN “Rebel/Rebel Applied/Maverick I/Maverick II” or TRANE “Precedent/Voyager 2/Voyager 3”.

7. General Description

a. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, condenser fans, reheat coil, hot water coils and unit controls.

b. Unit shall be factory assembled and tested including leak testing of the DX coils, leak testing of the hot water coils, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
c. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
d. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
e. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
f. Installation, Operation and Maintenance manual shall be supplied within the unit.
g. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
h. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

8. Construction

a. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
b. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929-11 for a minimum flash ignition temperature of 610°F.
c. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
d. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360.Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
e. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
f. Access to filters, dampers, cooling coils, reheat coil, heaters and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
g. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
h. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
i. Unit shall include lifting lugs on the top of the unit.
j. Unit base pan shall be provided with 1/2 inch thick foam insulation.

k. Unit base shall be fabricated of 1 inch thick double wall, impact resistant, rigid polyurethane foam panels.
l. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.

9. Electrical

a. Unit shall be provided with standard power block for connecting power to the unit.
b. Unit shall have a 5kAIC SCCR.
c. Unit shall be provided with a factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.
d. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimize defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to ensure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall de-energize, and auxiliary heat shall energize.
e. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

10. Supply Fans

a. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
b. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
c. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
d. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

11. Evaporator and Hot Gas Reheat Coils

a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
b. Coils shall be hydrogen or helium leak tested.
c. Coils shall be furnished with factory installed expansion valves.
d. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum of 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per

ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual.

e. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

f. Lag refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

12. Heating Coils

a. Coils shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.

b. Coils shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.

c. Coils shall be one row, half serpentine circuitry, and 8 fins per inch.

d. Coils shall be located in the reheat position downstream of the cooling coil.

e. Control valves shall be field supplied and field installed.

f. Hot water heating capacity shall be available for operation when heat pump heating is in operation and when heat pump heating is not in operation.

13. Filters

a. Unit shall include 4-inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2-inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4-inch standard filters.

b. Unit shall include a clogged filter switch.

14. Outside Air/Economizer

a. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.

b. Economizer shall be furnished with a California Energy Commission Certified Title 24 Fault Detection and Diagnostic package. Economizer assembly shall carry

a 5-year parts warranty from the date of original equipment shipment from the factory.

c. Unit shall include outside airflow measuring station and airflow signal processor that communicates directly with the factory provided control systems or can also be used with customer provided controls with a 0-10 VDC output signal. BACnet shall be available. Monitoring size is dependent on the cfm.

15. Controls

a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.

b. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.

c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

d. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.

e. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. The equipment manufacturer shall supply the Owner with three (3) non-expiring copies (licenses) of the required service tool software for this project valid for the life of the equipment, regardless of if the owner already has the software/license for other projects. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.

f. Unit shall be provided with a high condensate level switch that shuts down the unit when a high water level is detected in the drain pan.

g. Provide unit with “BACnet general controller” to transmit additional control points from sensors provided by BAS contractor.

D. Packaged Rooftop Unit (RTU-18 & 19)

1. General Description

a. This section includes the design, controls and installation requirements for packaged rooftop heat pump units RTU-18 and 19..

2. Quality Assurance

a. Packaged rooftop air conditioning units with air-cooled condensers shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

b. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
c. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
d. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
e. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

3. Submittals

a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage and Handling

a. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
c. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

5. Warranty

a. Refer to Specification Section 230100 for warranty requirements.

6. Startup and Repair

a. Manufacturer shall provide startup and full-service warranty in accordance with Specification Section 230100.

7. Manufacturer

a. Products shall be provided by the following manufacturers:

1) Basis of design is AAON “RQ” model. Units may also be provided by YORK “Sun”, DAIKIN “Rebel/Maverick I”, or TRANE “Precedent”.

8. General Description

   a. Packaged rooftop unit shall include compressor, evaporator coil, filters, supply fan, dampers, air-cooled condenser coils, condenser fan, modulating reheat coil, and unit controls.
   b. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
   c. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
   d. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
   e. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
   f. Installation, Operation and Maintenance manual shall be supplied within the unit.
   g. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
   h. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

9. Construction

   a. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
   b. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
   c. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
   d. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 210/240. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
   e. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
   f. Access to filters, dampers, cooling coil, reheat coil, heater, compressor and electrical and controls components shall be through hinged access doors with quarter turn, lockable handles. Full-length stainless-steel piano hinges shall be included on the doors. Provide door hold open devices.

g. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
h. Units shall include double sloped 304 stainless steel drain pans.
i. Unit shall be provided with through the base vertical discharge and return air openings. All openings through the unit shall have upturned flanges of at least 1/2 inch around the opening.
j. Unit shall include lifting lugs on the top of the unit.
k. Unit base pan shall be provided with 1/2-inch-thick foam insulation.

10. Electrical

a. Unit shall be provided with standard power block for connecting power to the unit.
b. Unit shall have a 10kAIC SCCR.
c. Unit shall be provided with a factory installed and non-wired 115V, 12 amp GFI receptacle in the unit control panel.
d. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.
e. Unit manufacturer shall provide an integral step-down transformer to power the Air Purification System. Refer to Section 2.9 in this Specification for additional information

11. Supply Fans

a. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
b. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
c. Motor shall be a high efficiency electrically commutated motor.

12. Exhaust Fans

a. Exhaust dampers shall be sized for 100% relief.
b. Fans and motors shall be dynamically balanced.

13. Evaporator and Hot Gas Reheat Coils

a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
b. Evaporator coils shall be standard capacity.
c. Coils shall be helium hydrogen or helium leak tested.
d. Coils shall be furnished with factory installed electronic expansion valves.
e. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane

topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual. Coil coatings shall be applied at the factory prior to shipment of unit

14. Refrigeration System

    a. Unit shall be factory charged with R-454B refrigerant.
    b. Compressors shall be scroll type with thermal overload protection.
    c. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
    d. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
    e. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
    f. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low-pressure sides and a factory installed replaceable core liquid line filter driers.
    g. Unit shall include a two-stage compressor which shall modulate between two capacity settings, 67% and 100%.
    h. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
    i. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling and an adjustable compressor lockout.
    j. Reheat Coil shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6 year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual.

15. Air-Cooled Condenser

    a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
    b. Coils shall be designed for use with R-454B refrigerant.
    c. Condenser coils shall be multi-pass and fabricated from aluminum microchannel tubes.

d. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
e. Coils shall be hydrogen or helium leak tested.
f. Condenser fans shall be high efficiency electrically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout.
g. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6 year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual.

16. Filters

a. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.
b. Unit shall include a clogged filter switch.

17. Outside Air/Economizer

a. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Unit shall include outside air opening bird screen, outside air hood with rain lip and barometric relief dampers.
b. Economizer shall be furnished with a California Energy Commission Certified Title 24 Fault Detection and Diagnostic package. Economizer assembly shall carry a 5 year parts warranty from the date of original equipment shipment from the factory.

18. Controls

a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
b. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

d. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
e. Constant Volume Controller:

1) Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
2) With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
3) Unit shall modulate heating with constant airflow to meet space temperature heating loads. Heating capacity shall modulate based on space temperature.

f. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. The equipment manufacturer shall supply the Owner with three (3) non-expiring copies (licenses) of the required service tool software for this project valid for the life of the equipment, regardless of if the owner already has the software/license for other projects. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.
g. Unit shall be provided with a high condensate level switch that shuts down the unit when a high water level is detected in the drain pan.
h. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
i. Provide unit with “BACnet general controller” to transmit additional control points from sensors provided by BAS contractor.

19. Roof Curbs

a. Curbs shall be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
b. Knockdown curb (with duct support rails) shall be factory furnished for field assembly.
c. Solid bottom curb shall be factory assembled and fully lined with curb rated 1 inch fiberglass insulation and include a wood nailer strip. (Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.)

20. Adapter Curbs (RTU-18 & 19)

a. Selections based on MGM Products, Inc. or approved equal. Adapter Curb with internal SA and RA transitions are specified on the drawings.

b. Construction

1) Adapter Curbs must be fully welded with no field assembly required.
2) Height must be adjusted to ensure proper airflow.
3) 3.5” Out turned flange with a 3” Down turned flange for proper fit over existing curb. 1.5”x .5” in and down-turned top flange to help secure insulation.
4) Corners shall be fully mitered and welded.
5) Adapters must include a metal identification tag.
6) Top of adapter curbs must include insulated factory specified deck pans.
7) All welds coated with Zinc-rich primer: SSPC- Paint 20 Type II.

c. Materials

1) Minimum 16-gauge G90 galvanized steel, watertight gaskets, and complying with NRCA standards.

d. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA90B.

1) Materials: ASTM C1071, Type I or II.
2) Thickness: 1 inch or greater.

e. Insulation Application: Factory applied with adhesive and mechanical fasteners to the internal surface of the curb.

1) Liner adhesive: Comply with ASTM C 916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on surface air velocity.

2.4 UNITARY EQUIPMENT

A. Split System Air Handling Units (AHU-4, 7 and 7A)

1. General

a. This section includes the design, controls, and installation requirements for indoor air handling units.

2. Quality Assurance

a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

b. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
c. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL label.

3. Submittals

a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided. Run test report shall be supplied with the unit in the control compartment's literature packet, and also available electronically after the unit ships.
b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with detail for power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage, and Handling

a. Unit shall be on a wooden pallet with skeleton crating prior to shipment to prevent damage during transport and thereafter while in storage awaiting installation.
b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
c. Unit shall be handled carefully to avoid damage to components, enclosures and finish.
d. Unit shall be stored in a clean, dry place protected from weather and construction traffic in accordance with Installation, Operation and Maintenance manual instructions.

5. Warranty

a. Refer to Specification Section 23 01 00 for warranty requirements.

6. Manufacturer

a. Products shall be provided by the following manufacturers:

1) Basis of design is AAON "V3" model. Units may also be provided by DAIKIN "RCS", or TRANE "Odyssey".

b. Alternate equipment by the manufacturers listed above may be considered for approval that includes at a minimum:

1) VFD driven direct drive backward curved plenum supply fans

2) Double wall cabinet construction
3) Insulation with a minimum R-value of 6.25
4) Hinged access doors with lockable handles
5) LED service lights in the control panel
6) Designed, engineered, and manufactured in the USA
7) All other provisions of this specification must be satisfactorily addressed

7. General Description

a. Indoor air handling units shall include filters, supply fans, hot water coil, exhaust fans, energy recovery wheel and unit controls.
b. Unit shall have a draw-through supply fan configuration and discharge air vertically.
c. Unit shall be shipped in sections and factory assembled and tested including leak testing of the coils and run testing of the supply fans and factory wired system. Run test report shall be supplied with the unit in the control compartment's literature packet, and also available electronically after the unit ships.
d. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
e. Unit components shall be labeled, including electrical and controls components.
f. Installation, Operation and Maintenance manual shall be supplied within the unit.
g. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
h. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

8. Construction

a. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam injected panels.
b. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
c. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel and prevents exterior condensation on the panel.
d. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
e. Access doors shall be flush mounted to cabinetry.
f. Units shall include double-sloped 304 stainless steel drain pan. Drain pan connection shall be on the right-hand side of unit with a 1" MPT fitting.
g. Unit shall be provided with a high condensate level switch that shuts down the unit when a high-water level is detected in the drain pan.
h. Unit shall include factory wired control panel compartment LED service lights.

9. Electrical

    a. Unit shall be provided with an external control panel with separated low and high voltage control wiring. Both side walls of the control panel shall include louvered vents. Control panel shall be field mounted and shall include a piano hinged service access door with tooled entry.
    b. Unit shall be provided with standard power block for connecting power to the unit.
    c. Unit shall include a factory installed 24V control circuit transformer.
    d. Unit shall have a 5kAIC SCCR.
    e. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

10. Supply Fans

    a. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
    b. Blower and motor assembly shall be dynamically balanced.
    c. Motor shall be IE5 efficiency permanent magnet totally enclosed motor. Variable frequency drive shall be factory wired and mounted in the unit.
    d. Blower and motor assembly shall utilize neoprene gasket.
    e. Access to supply fan shall be through removable bolted access panels on the top and bottom of the unit.
    f. Access to supply fan shall be through removable bolted access panels on the top and bottom of the unit or through service access door with piano hingers and lockable quarter turn handles located on the opposite access side of the unit.

11. Exhaust Fans

    a. Unit shall include direct drive, unhoused, backward curved, plenum exhaust fans.
    b. Blower and motor assembly shall be dynamically balanced.
    c. Motor shall be a high efficiency electronically commutated motor (ECM).
    d. Blower and motor assembly shall utilize neoprene gasket.
    e. Access to exhaust fan shall be through an access door with removable pin hinges and lockable quarter turn handles.
    f. ECM driven exhaust fan speed shall be controlled with the factory installed controller.

12. Refrigeration System

    a. Coil shall two circuits and interlaced circuitry.
    b. Air handling unit and matching condensing unit shall be capable of operation as an R-454B split system air conditioner.
    c. Modulating hot gas reheat shall be provided on the lead refrigeration circuit. Air handling unit shall be provided with hot gas reheat coil, a check valve on the liquid line, and a check valve on the hot gas reheat line. The matching condensing unit must include modulating 3-way reheat valve, liquid line receiver, electronic controller, supply air temperature sensor and a dehumidification

control signal terminal. This allows the system to have a dehumidification mode of operation and includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. Reheat line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.

d. Unit shall be configured as heat pump. Refrigeration circuit shall be equipped with a thermal expansion with an external check valve on the indoor coil.
e. Reversing valve, outdoor coil thermal expansion valve, bi-flow filter drier, and liquid line receiver shall be factory installed in the matching condensing unit.
f. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual. Coil coatings shall be applied at the factory prior to shipment of unit.

13. Energy Recovery

a. Unit shall contain an energy recovery cabinet with back outside air opening, back exhaust air opening, top return air opening, and top supply air opening.
b. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge and end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Dampers shall be controlled by a fully modulating actuator.
c. Outdoor air temperature sensor shall be factory provided and wired to control the economizer dampers. The energy recovery wheel shall not operate during economizer mode of operation.
d. Unit shall include 2 inch thick, pleated panel outside air filters with MERV rating of 8, upstream of the wheel.
e. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
f. Wheel frame shall slide out for service and removal from the cabinet.
g. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
h. Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.

i. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

j. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.

k. Energy recovery wheel cassette shall carry a 5-year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Airxchange. The 5-year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Airxchange written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the Airxchange Energy Recovery Cassette Limited Warranty Certificate.

l. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

m. Energy recovery wheel, outside air dampers, economizer air dampers, and energy recovery wheel control panel access shall be through service access doors with removable pin hinges and lockable quarter turn handles.

14. Filters

a. Unit filter access shall be through service access door with piano hinges and draw latches.

b. Unit shall include 4 inch thick, pleated panel filters with MERV rating of 13, upstream of the cooling coil.

15. Controls

a. Unit shall be provided with a proof of airflow switch. When airflow is not detected, other electrical components cannot power on.

b. Unit shall be provided with an internal control panel with separated low and high voltage control wiring.
c. Access to external control panel shall be through an access door with removable pin hinges and lockable quarter turn handles.
d. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
e. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
f. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
g. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
h. Constant Volume Controller

1) Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
2) Unit shall modulate heating with constant airflow to meet space temperature heating loads. Modulating heating capacity shall modulate based on supply air temperature.

i. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.

16. Installation, Operation, and Maintenance

a. Installation, Operation and Maintenance manual shall be supplied with the unit.
b. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
c. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

B. Split System Condensing Unit (CU-4, 7 and 7A)

1. General

a. This section includes the design, controls and installation requirements for air-cooled condensers / condensing units.

2. Quality Assurance

a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
b. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
c. Energy Efficiency Ratio (EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
d. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL label.

3. Submittals

a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, clearances, and connection details. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage, and Handling

a. Unit shall be shipped on a wooden pallet with skeleton crating prior to shipment with doors bolted shut to prevent damage during transport and thereafter while in storage awaiting installation.
b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
c. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

5. Warranty

a. Manufacturer shall provide startup and full-service warranty in accordance with Specification Section 230100.

6. Manufacturer

a. Products shall be provided by the following manufacturers:

1) Basis of design is AAON “CF” model. Units may also be provided by DAIKIN or TRANE.

b. Alternate equipment by the manufacturers listed above may be considered for approval that includes at a minimum:

1) R-454B refrigerant
2) Hinged access doors with lockable handles
3) 2,500 hour salt spray exterior corrosion protection

4) Designed, engineered, and manufactured in the USA
5) All other provisions of the specifications must be satisfactorily addressed.

7. General Description

a. Air-Source heat pump condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, accumulator, receiver, reversing valve, filter driers with check valves, and thermal expansion valves.
b. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the control compartment.
c. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
d. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
e. Installation, Operation and Maintenance manual shall be supplied within the unit.
f. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
g. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

8. Construction

a. Unit shall be completely factory assembled, piped, and wired and shipped in one section.
b. All cabinet walls, access doors, and roof shall be fabricated of G90 galvanized steel panels.
c. Unit shall be specifically designed for outdoor application.
d. Access to compressors and control components shall be through hinged access doors with quarter turn, lockable handles.
e. Access to condenser coils and fans is through removable access panels.
f. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
g. Unit shall include lifting lugs.
h. Unit shall include forklift slots.
i. Unit shall be provided with hail guards to protect condenser coils.

9. Electrical

a. Unit shall be provided with standard power block for connecting power to the unit.
b. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
c. Unit shall have a 5kAIC SCCR.

d. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimize defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to insure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall energize, and auxiliary heat shall energize.
e. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
f. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage, or on phase reversal.

10. Refrigeration System

a. Each compressor shall be furnished with a crankcase heater.
b. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
c. Compressors shall be isolated from the base pan with the compressor manufacturer’s recommended rubber vibration isolators and mounted on an elevated compressor deck, to reduce any transmission of noise from the compressors into the building area.
d. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line and insulated hot gas bypass line, insulated hot gas reheat line and insulated suction line.
e. Unit shall include a factory holding charge of R-454B refrigerant and oil. Adjusting the charge of the system will be required during installation.
f. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall be equipped with a bi-flow liquid line filter drier, reversing valve, suction line accumulator, liquid line receiver, and a bypass loop with check valve around a thermal expansion valve. Reversing valve shall de-energize during the heat pump heating mode of operation. The matching indoor air handler must include a bypass loop with check valve around the thermal expansion valve.
g. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling. The controls shall also include an adjustable, 20 second delay timer for each additional capacity stage to prevent multiple capacity stages from starting simultaneously and adjustable compressor lock out.
h. Units shall be provided with a suction pressure transducer on each refrigeration circuit.

i. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 hours each (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing, with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 6-year warranty, from the date of original equipment shipment from the factory. Instructions coil cleaning, maintenance, and recording keeping must be followed. Refer to the unit Installation, Operation and Maintenance Manual. Coil coatings shall be applied at the factory prior to shipment of unit.

11. Fans

a. Condensing unit shall be provided with an electrically commutated motor (ECM) condenser fan, condenser head pressure controller, and discharge pressure transducers for modulating head pressure control to allow cooling operation down to 35°F.Fan motor shall be weather protected, single phase, direct drive, and totally enclosed air over (TEAO) with electronic protection.

12. Installation, Operating, and Maintenance

a. Installation, Operation and Maintenance manual shall be supplied with the unit.
b. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
c. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

C. Computer Room Air Conditioning Unit (SS-1/OU-4)

1. General

a. This section includes the design, controls, and installation requirements for a split configuration with compact depth indoor vertical floor console mounted dx evaporator precision air conditioner with outdoor dx air cooled propeller fan remote condenser. The system is designed to control space temperature and humidity.

2. Quality Assurance

a. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
b. Unit shall be factory run tested prior to shipment.

3. Submittals

a. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection

requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided. Run test report shall be supplied with the unit in the control compartment's literature packet, and also available electronically after the unit ships.

b. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with detail for power and control systems and differentiate between factory installed and field installed wiring.

4. Delivery, Storage, and Handling

   a. Unit shall be on a wooden pallet with skeleton crating prior to shipment to prevent damage during transport and thereafter while in storage awaiting installation.
   b. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
   c. Unit shall be handled carefully to avoid damage to components, enclosures and finish.
   d. Unit shall be stored in a clean, dry place protected from weather and construction traffic in accordance with Installation, Operation and Maintenance manual instructions.

5. Warranty

   a. Refer to Specification Section 23 01 00 for warranty requirements.

6. Manufacturer

   a. Products shall be provided by the following manufacturers:

      1) Basis of design is ABOVE AIR TECHNOLOGIES indoor model "FCE-012S", outdoor model "XP1-012S". Vertiv wall mount model shall be the only alternate manufacturer accepted.

7. General Description

   a. Indoor air handling units shall include filters, supply fans, hot water coil, exhaust fans, energy recovery wheel and unit controls.

8. Construction

   a. All cabinet walls and access panels shall be powder-coat painted heavy gauge galvanized steel for décor matching and corrosion resistance. Cabinet access panels shall rest in recessed pockets designed for minimum air leakage. The cabinet and access panels shall be lined with 2 lb/ft² high density sound and thermal insulation and sealed with self-extinguishing gasketing conforming to NFPA 90A and 90B.

b. Unit shall be serviceable through front access panels with quick-release quarter-turn fasteners.

9. Electrical

a. System shall conform to National Electric Code (NEC) requirements according to UL 1995.
b. Unit shall be provided with standard power block for connecting power to the unit.
c. Unit shall include a factory installed 24V control circuit transformer.

10. Evaporator Blower

a. Unit shall include direct drive centrifugal type, double width double inlet.
b. Blower and motor assembly shall be dynamically balanced.

11. Filters

a. Unit filter access shall be through a side service access panel without shutting down the system.
b. Unit shall include 2 inch thick, pleated panel filters with MERV rating of 8, upstream of the cooling coil.

12. Controls

a. Unit shall be provided with an MC-2000 advanced microprocessor based temperature and humidity controller with alarms.

D. Ductless Split System Air Handling Unit (IU-1, 2 & 3)

1. General

a. Basis-of-design manufacturer is LG. Acceptable alternate manufacturers include DAIKIN and MITSUBISHI.
b. Unit shall be factory-assembled, wired, piped, and run tested.
c. Unit shall be designed to be installed in indoor application.

2. Casing

a. Unit shall be designed to mount on a vertical surface and come complete with an installation mounting guide and a separate hanging bracket. The interior unit case shall be manufactured with coated metal. Cold surfaces shall be covered with a coated polystyrene insulating material.
b. The exterior unit case shall be manufactured using ABS polymeric resin and have a pearl white finish.

3. Fan Assembly and Control

a. The unit shall have a single, direct-drive, crossflow tangential Sirocco fan made of high strength ABS BSN-7530 polymeric resin.
b. The fan motor shall consist of a brushless digitally controlled (BLDC) design with permanently lubricated and sealed ball bearings.
c. The fan motor shall include thermal, overcurrent, and low RPM protection.
d. The fan motor assembly shall be mounted on vibration attenuating rubber grommets.
e. The fan impeller shall be statically and dynamically balanced.
f. The fan speed shall be controlled using a microprocessor-based direct digital control algorithm that provides a high fan speed in cooling thermal ON and low fan speed in cooling thermal OFF, high fan speed in heating thermal ON and fan off in heating thermal OFF.
g. The fan speeds shall be field adjustable between low, medium, and high speeds. The fan speed algorithm shall provide a field-selectable fixed-speed or auto-speed setting that changes the fan speed to simulate natural airflow.

4. Air Filter

a. Return air shall be filtered with a removable, washable filter with anti-fungal treatment. Filter access shall be from the front of the unit without the use of tools.

5. Airflow Guide Vanes

(5-15 MBh)

a. The indoor unit shall be provided with a motorized oscillating guide vane that automatically changes the direction of up-and-down airflow.
b. The indoor unit shall include factory installed, manually adjustable guide vanes that control the side-to-side direction of supplied airflow.

(18-36 MBh)

a. The indoor unit shall be provided with a motorized sweeping guide vane that automatically changes the direction of airflow from side-to-side and up-and down.

6. Microprocessor Control

a. The unit shall be provided with an integrated microprocessor controller capable of performing functions necessary to operate the system without the use of a wall-mounted controller. A temperature thermistor shall be factory-mounted in the return air stream. All unit operation parameters, excluding the operating schedule, shall be stored in non-volatile memory resident on the unit microprocessor. Operating schedules shall be stored in the wall-mounted, local, or central controller. Mechanical contractor shall coordinate with BAS contractor and Owner to determine the desired location for operating schedules.
b. The field-supplied communication cable between the indoor unit and outdoor unit shall be a minimum of 18 AWG, 2 conductor, stranded, and shielded cable (RS-485), terminated via screw terminals on the control boards. The microprocessor control shall provide the following functions: auto addressing, self-diagnostics,

auto restart following power restoration, test run, and shall operate the indoor unit using one of four operation modes:

1) Heating
2) Cooling
3) Dry
4) Fan only

c. Heated or cooled air delivery shall be dependent on outdoor unit operating mode.

d. In heating mode, the microprocessor control shall activate indoor unit operation when the indoor room temperature falls below set-point temperature. At which point, a signal shall be sent to the outdoor unit to begin the heating cycle. The indoor unit fan operation shall be delayed until coil pipe temperature reaches 76°F. Significant airflow shall be generated when pipe temperature reaches 80°F. A field-selectable option shall maintain fan operation for 30 minutes following cooling cycle operations. The unit shall be equipped with an infrared receiver designed to communicate with a wireless remote controller. In lieu of wireless remote or factory return air thermistor, screw terminals on the microprocessor circuit board shall accommodate various models of wall-mounted local controllers. The unit microprocessor shall be capable of accepting space temperature readings concurrently or individual from either a wall-mounted wired controller or a factory-mounted return air thermistor.

e. A single indoor unit shall have the capability of being controlled by up to two local wired controller. The microprocessor shall control space temperature using the value provided by the temperature sensor sensing a space temperature that is farthest away from the temperature set-point. The microprocessor control shall provide a cooling or heating mode test cycle that operates the unit for 18 minutes without regard to the space temperature. If the system is provided with an optional wall-mounted local or central controller, displayed diagnostic codes shall be specific, alpha-numeric, and provide the service technician with a reason for the code displayed.

f. The unit shall include the following controls features:

1) Auto operation
2) External on/off control
3) Dual thermistor control
4) Dual set-point control
5) Filter life display
6) Group control
7) Forced operation
8) Hot start
9) Self diagnostics
10) Timer (on/off)
11) Weekly schedule
12) Auto direction/swing (up/down)
13) Fan speed control
14) Jet cool (fast cooling)
15) Auto Fan
16) Leak detection

7. Condensate

   a. The unit shall be designed for gravity draining of condensate. The manufacturer shall provide a factory insulated flexible drain hose.
   b. The condensate drain pan shall be constructed of expandable polystyrene resin (EPS).

8. Coil

   a. The indoor unit coil shall be constructed with grooved design copper tubes with slit coil fins, two (2) rows, eighteen (18) fins per inch.

E. Ductless Split System Condensing Unit (OU-1, 2 & 3)

1. General

   a. The heat pump system shall consist of an outdoor unit, at least one indoor unit, integrated system controls, and interconnecting field-provided refrigerant pipe containing various fittings including Y-branch kits and Header kits (as necessary). Components shall be manufactured in a facility that meets or exceeds International Organization for Standardization (ISO) 9001 and 14001. The units shall be listed by Intertek (ETL) and bear the ETL listed mark.
   b. Basis-of-design manufacturer is LG. Acceptable alternate manufacturers include DAIKIN and MITSUBISHI.

2. Casing

   a. The outdoor unit case shall be constructed from 22-gauge coated metal. Exterior panels shall be cleaned and finished with a weather-resistant baked enamel finish.
   b. An easily removable front corner panel shall be provided to allow access to major components and control devices.
   c. Outdoor unit fan(s) shall be covered with guards made of heavy gauge, heavy duty polymeric resin. The outdoor unit shall be protected with a heavy gauge steel wire guard finished with baked enamel.
   d. Paint color shall be “warm gray.”

3. Refrigeration System

   a. The refrigeration system shall consist of a single refrigeration circuit and shall use refrigerant R-32.
   b. The outdoor unit shall be provided with factory installed components, including a refrigerant strainer, oil separator, accumulator, hot gas bypass valve, liquid injection valve, four-way reversing valve, electronic controlled expansion valve (EEV), high and low side charging ports, service valves, and interconnecting piping. An integral subcooler assembly shall also be included, consisting of a double spiral tube type heat exchanger and EEV providing refrigerant subcooling modulation up to 23°F.

4. Refrigeration Oil Control

    a. The refrigeration oil level in the compressor shall be maintained using a two-stage oil control system. The compressor discharge port shall be equipped with an oil filtering device designed to restrict oil loss from the compressor.
    b. The high-pressure discharge vapor shall leave the compressor and immediately enter a centrifugal oil separator that has no moving parts designed to extract oil from the refrigerant gas stream. A gravity drain shall return captured oil back to the compressor sump.
    c. The outdoor unit microprocessor shall be programmed to flush the refrigerant piping system for a minimum period of three (3) minutes after eight (8) hours of compressor operation.

5. Single Inverter/Compressor

    a. The outdoor unit shall be equipped with one hermetic, digitally-controlled inverter starting compressor. The compressor shall be specifically designed for the refrigerant provided and manufactured by the unit manufacturer.
    b. The frequency inverter shall be designed by the unit manufacturer and shall be capable of providing a modulation range from 20 Hz to 75 Hz (cooling and heating) modulating in increments of 1.0 Hz.
    c. The compressor motor shall be suction gas-cooled and have an acceptable voltage range of ±10% of nameplate voltage.
    d. External suction and discharge temperature and pressure sensors shall be provided to protect the compressor from damage caused by over/under temperature or over/under pressure conditions.
    e. The compressor shall be provided with a positive displacement oil pump providing sufficient oil film on all bearing surfaces across the entire inverter modulation range.
    f. The compressor shall be factory-charged with Polyvinyl ether (PVE) refrigeration oil having no hygroscopic properties. Compressor bearings shall be Teflon coated.
    g. The compressor shall be wrapped with a heat resistant, sound attenuating blanket and mounted on rubber isolation grommets.

6. Outdoor Unit Coil

    a. Outdoor unit coils shall be a minimum of two rows 14 fins per inch, and manufactured using copper tubes with mechanically bonded aluminum louvered fins.
    b. Fin surfaces shall be coated with Gold-Fin corrosion resistant hydrophilic silica gel coating.
    c. Coils shall be pressure tested at a minimum of 551 psig.

7. Fans and Motors

    a. Units shall be furnished with one axial flow fan providing horizontal airflow from the rear and discharging from the front of the unit. Fan blades shall be 20-1/2 inch diameter, balanced, and made of durable acrylonitrile butadiene styrene (ABS) polymeric resin.

b. Motors shall be designed to operate between 0 and 850 RPM in cooling and heating. Fans shall be driven by digitally controlled inverters that vary the fan speed. Motors shall be brushless, digitally controlled (BLDC) and have permanently lubricated and sealed ball bearings.
c. All outdoor units shall be controlled by an inverter drive mounted near the main microprocessor.
d. The outdoor unit fan speed shall be controlled using an algorithm that provides three pre-programmed fan speeds. DIP Switch adjustable settings shall limit nighttime (off peak) fan speed to reduce fan generated noise by up to 10 dB(A).

8. Outdoor Unit Controls

a. Outdoor units are factory wired with necessary electrical control components, printed circuit boards, thermistors, sensors, terminal blocks, and lugs for power wiring. The control wiring circuit shall be low voltage and include a control power transformer, fuses, and interconnecting wiring harness with plug connectors. Microprocessor based algorithms provide component protection, soft-start capability, refrigeration system pressure and temperature control, defrost, and ambient control. The unit shall be designed to provide continuous compressor operation from -9.9°F to 122°F in cooling mode.
b. When the system is started, the connected indoor units shall be automatically assigned an electronic address by the outdoor unit's microprocessor. Additionally, each indoor unit shall be capable of accepting a manual assignment of a secondary electronic address that, if used, shall provide unit tag identification when integrating with additional control devices.
c. While operating in Heating mode, the outdoor unit shall have a demand based defrost control algorithm and a refrigeration system pump down cycle designed to store refrigerant in the outdoor unit up to 4.4 lbs for the 2 ton unit, In heating mode, a cooperative control algorithm shall automatically balance, in real-time, the distribution of refrigerant to the indoor units when the system's refrigerant mass flow is insufficient to satisfy the demand of all indoor units when the system is called on to operate outside the system design parameters.
d. In 10-second intervals, the outdoor unit microprocessor shall record the last three minutes of system run-time data in non-volatile memory. Upon unit malfunction, or a power outage that results in a system shutdown, the stored system operational data shall be retrieved and analyzed to assist in diagnosing a system malfunction.
e. The outdoor unit microprocessor shall be provided with a three-digit, LED display that shall communicate active system information and/or malfunction codes. The microprocessor shall have an algorithm that actively verifies the operational condition of system sensors and thermistors. A refrigerant auto-trim-charge algorithm shall assist the installer with properly charging the system.
f. A power conditioning circuit shall be provided to protect the unit's inverter compressor and outdoor unit fan motors from phase failure, phase reversal, sense an under-voltage or over-voltage condition, and to prevent transmission of power irregularities to the supply power source. A snow throw algorithm shall be provided and designed to reduce snow buildup on the discharge side louvers at regular intervals.

2.5 TERMINAL EQUIPMENT (NOT USED)

2.6 HVAC PIPING AND SPECIALTIES

A. PIPING

1. Water, refrigerant, and HVAC drain piping shall be provided as specified below. Where options of different materials are given for the same service, contractor shall select materials and use them uniformly throughout the system. Contractor shall submit experience with all of the materials and joining methods specified.

2. Hot water piping:

a. Above ground

1) Type L copper (2 inch and under)
2) Schedule 40 threaded black steel (2 inch and under)
3) Schedule 40 welded black steel (2-1/2 inch and over)

3. Condensate drain piping:

a. Above ground (within building and plenum rated ceiling)

1) Type L copper

b. On rooftop and exterior to building

1) Schedule 40 PVC

4. Refrigerant piping:

a. Above ground

1) Copper Type ACR

5. Gas Piping:

a. Within building:

1) Schedule 40 black steel - screw fabricated (2 inch and under)
2) Schedule 40 black steel – welded (2-1/2 inch and over)

6. Drain piping in mechanical equipment rooms:

a. Above ground

1) Type L copper

7. Type L copper pipe shall conform to ASTM B42 and be assembled with wrought-copper soldering fittings using 95-5 solder or with press on fittings as specified herein.
8. Schedule 40 PVC pipe shall be assembled in strict accordance with manufacturer's instructions. Solvent cement shall conform to ASTM D2564.
9. Schedule 40 black steel pipe shall be fabricated by welding using Schedule 40 steel welding fittings conforming to ASTM A53.
10. ACR tubing shall be nitrogen-filled assembled with wrought-copper soldering fittings using silver solder.
11. Piping shall be run concealed, except where no ceiling is provided. Coordinate installation of piping with other disciplines. Locate all piping tight against structure where possible. No piping shall be installed below mechanical equipment, or within mechanical or electrical equipment clearance requirements.
12. All concealed condensate drain piping shall be labeled at its termination point to indicate whether the drain piping is connected to a primary or secondary (auxiliary) mechanical unit drain.

B. Pressurized Expansion Tanks:

1. Tanks shall be ASME Code construction for 125 psi service, of sizes indicated. Tanks shall be pre-charged bladder type. Tank shall be BELL & GOSSETT Series "B," ARMSTRONG "L Series," or TACO "CA."

    a. Expansion tanks are ASME rated pre-charged bladder-type pressure vessels designed to absorb the expansion forces of heating/cooling system water while maintaining proper system pressurization under varying operating conditions.
    b. Tank shall have a heavy-duty bladder to contain system water to prevent tank corrosion and water logging problems.
    c. Maximum working pressure shall be 125 PSI and maximum operating temperature shall be 240ºF.
    d. System connections shall be forged steel. Tank shell shall be carbon steel.
    e. Bladder shall be heavy duty butyl rubber.
    f. Tank shall be designed and constructed per ASME Section VIII, Division.
    g. Tanks shall be complete with system and drain connections, air charging valve connection, and lifting ring.
    h. Volume of tank indicated is acceptance volume.

C. Pressure Relief and Reducing Valves

1. Provide relief and reducing valves with fast fill feature. Construction shall be cast iron with brass seats and brass strainer. BELL & GOSSETT, or approved equal.

D. Air Eliminator and Dirt Separator:

1. Provide a full flow coalescing type combination air eliminator and dirt separator on the hot water system. Unit shall be SPIROTHERM "VDN," BELL & GOSSETT "SRS," or TACO "Series 4900."
2. Full flow coalescing type combination air eliminator and dirt separator shall be fabricated steel, rated for 150 psig working pressure, stamped, and registered in accordance with

ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles.

3. Selection shall be based upon system flow with pipe size as a minimum. In no case shall entering velocity exceed 10 feet per second.
4. Unit shall include internal structured elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements shall be fabricated by the manufacturer and consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.
5. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
6. Units shall include a side tap valve to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
7. Unit shall be manufactured with a removable lower head for internal inspection.

E. Air Vents:

1. Provide automatic air vents where indicated and at all high points in the hydronic system. Vents shall be BELL & GOSSETT “107A,” CALEFFI “MAXCAL,” or WATTS “DUOVENT.”

F. Thermometers

1. Thermometers shall be provided as indicated. Thermometers shall be WEKSLER “5AAE,” DWYER “BT,” or WEISS “5VBM.”
2. Thermometers in pipelines shall be separable socket 5" dial bi-metal insertion type, with scale suitable for temperature range of medium being measured. Thermometers shall be located to facilitate reading from floor. Angle-type shall be used where necessary to facilitate reading. Install in thermal well in flow of fluid.
3. Thermometer range shall be 0-150°F for chilled water and condenser water, and 30-240°F for hot water.

G. Pressure Gauges

1. Pressure gauges shall be provided on suction and discharge line of each pump and where indicated. WEKSLER “HA-14-4,” KOBOLD “MAN-R,” or WIKA “232.50.”
2. Gauges shall be bourdon spring type with 4-1/2" dial set in polypropylene case. Gauges shall be equipped with brass tee-handle shut-off cocks. Gauges shall have required range of 0-100 psig and not in more than 2 psi graduations.
3. Pressure gauges shall be located to facilitate reading from floor.

H. Test Stations – Pressure/Temperature (PT):

1. Install a 1/4" NPT fitting (Test Plug) of solid brass with brass chain at indicated locations. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Dual

seal core shall be neoprene for temperature to 200°F and shall be rated zero leakage from vacuum to 1,000 psig. IMI "SANA," PETERSON "Pete's Plug," NEXUS "PT," or equal.

2. One master test kit shall be provided to the Owner. Kit shall contain one 2-1/2" pressure gauge of suitable range, one gauge adapter 1/8" o.d. probe, and one 5" stem pocket testing thermometer 0° to 220°F.

I. Valves:

1. Valves 2" size and under shall be bronze with soldered ends, rough bodies, and finish trim. Valves 2-1/2" size and over shall be iron-body, bronze-mounted with flanged ends, except where specifically indicated. Valves on cold piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Catalog numbers indicated below are NIBCO. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

Size	Pipe Material	Check	Ball/Butterfly
2" and under	Copper	S-413-W	S-585-70-66NS
2-1/2" and over	Copper	F918-B	LC-3000
2-1/2" and over	Steel	F918-B	LC-3000

2. Check valves in pump discharge lines shall be NIBCO F-910-B-LF. Valve shall be flanged, cast iron, globe style, and constructed with lead-free bronze seat per ASTM B584 with Buna-N O-ring. Valve shall utilize stainless steel spring with aluminum bronze bushing. Acceptable alternate valves include MILWAUKEE "1800" or METRAFLEX "CV0900-125-12-DINC."
3. Balancing valves 2" and smaller shall be NIBCO S-585-70-66NS. Balancing valves 2-1/2" and larger shall be butterfly valves as specified below. Valves shall be complete with memory stops. Valves on cold piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Acceptable alternate valves include MILWAUKEE "BA-150S-MS," or APOLLO "70-200-27."
4. Butterfly valves used for balancing purposes shall be NIBCO "LD-3000." Valve shall be ductile iron, lug type and suitable for dead-end service, 250 psig, bubble-tight shutoff, and 250°F service. Disc shall be aluminum bronze with 416 stainless-steel extended shaft and copper or brass bushings. Seal shall be EPDM. Provide lever actuators with ten positions with memory stops. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Valves 6" and above shall be provided with gear operators. Acceptable alternate valves include MILWAUKEE ""ML333ES" or APOLLO "LD 141."
5. Pressure Relief Valves:
    a. Provide as shown on plans a diaphragm operated safety relief valve, ASME labeled for relieving pressure of 30 psig with a rating of 790,000 BTU/hr.
    b. The fluid shall not discharge into the spring chamber. The valve shall have a low blow-down differential.
    c. The valve seat and all moving parts exposed to the fluid shall be non-ferrous material.
    d. Provide BELL & GOSSETT "790-30", APOLLO "10-102," or ZURN "P1000AXL-30C."

J. Chemical Shot Filter Feeder:

1. Provide one feeder for each the hot water systems. Feeder shall be NEPTUNE "DBF," ADVANTAGE CONTROLS "BF," WESSELS "CPFTA," or equal.
2. Tanks shall be ASME Code construction for 125 psi service, 5-gallon chemical shot feeder. Feeder shall include funnel, isolation valves, and adjustable base legs.

K. Y-Strainers:

1. System strainers in mechanical rooms:

   a. "Y" Pattern pipeline strainers shall be installed where shown on plans or required by equipment manufacturers.
   b. Y Strainer shall be of the low pressure drop design with the following C_V values:

      (1) 4" Pipe: 460
      (2) 6" Pipe: 952
      (3) 8" Pipe: 1580

   c. Y Strainer shall be METRAFLEX "LPD," or equal.
   d. Strainer body shall be ASTM A126-B Cast Iron.
   e. Screens shall be Type 304 Stainless steel.
   f. Screen perforations shall be 0.125."
   g. Strainer shall have a screen pitch of 22.5°.
   h. Screens shall be removable via an access cover sealed with O-ring.
   i. Strainer shall be manufactured with .25" pressure differential ports, with one placed on each side of the screen.
   j. Strainer shall be equipped with a dry well port. Port shall be 1" for sizes 4" – 12".
   k. Strainer connection shall be 125 lb. class flange.
   l. Y Strainer shall be installed in accordance with manufacturer's recommendations and contact requirements.
   m. Provide valved blow-off outlet with hose connection and cap on each strainer. Blow-off connections shall be at bottom of strainer and shall be of size equal to 1/2 the pipe up to a maximum of 2".

2. Strainer for unitary coils

   a. Strainers shall be self-cleaning "Y" type, of same size as pipe in which it is installed.
   b. Provide valved blow-off outlet with hose connection and cap on each strainer. Blow-off connections shall be at bottom of strainer and shall be of size equal to 1/2 the pipe up to a maximum of 2".
   c. Screen perforations shall be suitable for intended service. Provide 50-micron mesh screen minimum for flushing of system.

L. Base Mounted End Suction Circulating Pumps (P-1 & 2):

1. Provide pumps with performance characteristics as shown on plans. Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow removal and service of the entire rotating assembly without disturbing the pump piping, electrical

motor connections or pump to motor alignment. Basis of design shall be BELL & GOSSETT "E-1510". Acceptable alternates include ARMSTRONG "4030" and TACO "FI".

2. Components

   a. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The impeller shall be a cast stainless steel enclosed type, balanced to ANSI/HI 9.6.4-2016 balance grade G6.3 and secured to the shaft by a locking cap screw or nut.
   b. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F. A replaceable stainless steel shaft sleeve shall completely cover the wetted area under the seal.
   c. Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge taps at the suction and discharge nozzles and vent and drain taps at the top and bottom.
   d. The pump vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2016 for recommend acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2016 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.
   e. Baseplate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff as to limit the susceptibility of vibration. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.8.2.1-2019 for grouted Horizontal Baseplate Design standards.
   f. A flexible type, center drop-out design coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupling sleeve. The coupling shall be shielded by a dual rated ANSI B15.1 & OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling.
   g. Motor shall meet NEMA and EISA 2007 (where applicable) specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned and shall be realigned by the contractor per factory recommendations after installation. Motor shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
   h. The pump shall conform to ANSI/HI 9.6.3.1-2012 standards for Preferred Operating Region (POR) unless otherwise approved by the engineer. Each pump shall be factory hydrostatically tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high-grade paint prior to shipment.
   i. The pump shall be manufactured, assembled, and tested in an ISO 9001 approved facility.

3. Provide suction diffusers matched to pump and system piping for end suction pumps.
4. Provide Aegis Shaft Grounding Rings on all pump shafts to extend the life of the bearings.
5. Pumps shall be grouted in accordance with manufacturer's recommendations.

M. Inline Circulating Pumps

1. Provide pumps with performance characteristics as shown on plans. Basis of design shall be BELL & GOSSETT "E-80". Acceptable alternates include ARMSTRONG "4380" and TACO "KV."

2. Components:

   a. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
   b. The pumps shall have a solid alloy steel shaft that is integral to the motor. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
   c. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.
   d. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a stainless-steel housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
   e. Pump shaft shall connect to a stainless-steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.-2016. The allowable residual imbalance conforms to ANSI grade G6.3, keyed to the shaft and secured by a stainless-steel locking cap screw or nut.
   f. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
   g. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
   h. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have heavy-duty grease lubricated ball bearings to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
   i. Pumps shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the Engineer.
   j. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
   k. Pump manufacturer shall be ISO-9001 certified.
   l. Each pump shall be factory tested and name-plated before shipment. Pump shall be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

N. Suction Diffusers

1. Suction diffusers shall be provided at the suction side of pumps as indicated on the drawings. Suction diffusers shall be BELL & GOSSETT "Suction Diffuser Plus," ARMSTRONG "SG," or TACO "SD."
2. Units shall consist of angle type body, flanged system connection, integrated flow cone, stainless steel straightening vane, and combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection. The unit shall include a disposable fine mesh strainer which shall be removed after system startup.
3. Unit shall have pressure/temperature ports at the suction and discharge to allow for measurement of differential pressure across the unit.
4. Orifice cylinder shall be designed to withstand pressure differential equal to the pump shut-off head and have a free area equal to five times the cross-section area of pump suction opening. Vane length shall be no less than 2-1/2 times the pump connection diameter. Unit shall be provided with adjustable support foot to carry the weight of suction piping.
5. Unit shall be rated for 175 psi maximum working pressure and 250°F maximum working temperature.
6. Diffuser manufacturer shall be responsible for any reduction in pump performance or damage due to high pressure drops, internal failures of components or harmonic oscillations caused by the diffuser.

O. Flexible Pipe Connectors (Pumps)

1. Provide spool-type expansion joint, standard single-arch type, on suction and discharge piping of base-mounted pumps, and where indicated. KEFLEX "Series S," METRAFLEX "100 HT," LINK-FLEX "Style 75," or equal.
2. Joints shall be constructed of abrasion-resistant rubber compounds, reinforced with steel rings and high-tensile strength fabrics. Flanges shall be steel.
3. Joints shall be installed so that they carry no piping load. Misalignment of piping shall not exceed 1/8".
4. Control rods shall be installed at each joint. Rods shall be attached with neoprene bushings to prevent transmission of noise and vibration.

P. Automatic Balancing Valves

1. Provide automatic measuring and balancing valves where indicated for pipe sizes 1/2" to 12". Valves shall be NUTECH "AB," IMI "AC," or CALEFFI "Series 121" for valves ½" through 2". Valves 2-1/2" and larger shall be NUTECH "AW," IMI "WS," or HCI "AT."
2. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified amount.
3. For 1/2" - 2", the flow cartridge shall be removable from the Y-body housing without the use of special tools to provide access for cartridge change out, inspection, and cleaning without breaking the main piping. (Access shall be like that provided for removal of a Y-strainer screen).
4. True operating range of 2 - 32 psid required. The design flow should be achieved at the minimum psi differential. A 50% safety factor applied to the lower operating range is not acceptable.
5. Each valve shall have two P/T ports.

6. All automatic flow control devices shall be supplied by a single source.
7. Five-year product warranty and free first year cartridge exchange.
8. The internal wear surfaces of the valve cartridge shall be Ultrason composite or stainless steel.
9. The flow cartridge design shall incorporate a stainless-steel spring which requires no adjustment screw or shims. A crimped sheet-metal design is not acceptable.
10. The internal flow cartridge shall be permanently marked with the GPM.
11. For 1/2" through 2" pipe sizes: The valve shall consist of a brass Y-type body, O-ring-type union, and integral brass body ball valve with memory stop. The ball valve ID shall be minimum standard port (one size smaller than valve connection size) Reduced port valves are not acceptable.
12. For 2-1/2" and larger flanged connections: Ductile-iron body suitable for mounting wafer style between standard 150# or 300# flanges. The long flange bolts and nuts shall be provided with each automatic flow control valve.
13. All valves shall be factory leak tested at 100 psi air underwater.

14. Ratings: 1/2" through 2" pipe size: 600 psig at 250°F
    2-1/2" through 12" pipe size: 600 psig at 250°F

15. Where indicated on the plans, the differential pressure across the automatic flow control valve shall be measured for flow verification and to determine the amount of system over-heading or under-pumping. Where over-heading exists the ball valve shall be throttled to bring the flow cartridge back within the control range. The valve memory stop shall be set so the valve can be used for isolation and reopened to the balanced position.
16. The flow shall be verified by measuring the differential pressure across the coil served or the wide-open temperature control valve and calculating the flow using the coil or valve C_v.
17. A differential pressure test kit shall be supplied to verify flow and measure over-heading. The kit shall consist of a 4-1/2" diaphragm gauge equipped with 10-foot hoses and P/T adapters, all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0-65 PSID for 5-60 PSI range.
18. Install automatic flow control valves on the return lines of coils as indicated on the plans. Balancing valve on supply side is not acceptable. Submit proposed piping arrangement for approval by the Engineer.
19. The standard ports and handles shall clear 1" thick insulation. Handle and port extensions are required for over 1" thick insulation.
20. Install, on the supply side of coils, a Y-strainer with a brass blow-down valve with 3/4" hose end connection with cap and chain.

Q. Manual Venturi Flow Measuring and Balancing Valves:

1. Provide manual venturi flow measuring and balancing valves where indicated. For pipe sizes 1/2” to 2”, valves shall be NUTECH “MB,” IMI “UA,” or BELL & GOSETT “MV.” For pipe sizes 2-1/2” and larger, valves shall be NUTECH “MF,” IMI “AF,” or BELL & GOSSETT “MVF.”
2. Balancing valves 1/2” through 2” shall be constructed of bronze or brass. Valves shall be rated for 600 psi at 250°F. The valve ball ID shall be minimum standard port (one size smaller than valve connection size) Reduced port valves are not acceptable.
3. Sizes 2-1/2” and larger venturi flow meter and butterfly balancing valve shall be constructed of cast carbon-steel ASTM A120 with accurately machined throat. Sizes 8” and larger shall

be fabricated carbon-steel with carbon steel insert. Provide 150-pound ANSI B16.5 flanged connections. Valves shall be rated at 200 psig at 250°F.

4. Butterfly valve shall be constructed of ductile-iron, lug-type body, ANSI Class 125/150, with EPDM seat and gasket, 416 stainless-steel stem, bronze sleeve bearing and aluminum/ bronze disk. The butterfly valve shall have a 2" extended neck above the flange to accommodate insulation thickness. The valve handle shall have infinite flow positioning plate which allows the valve to be closed without the need to unlock the valve or losing the balancing position valve sizes 2" through 6". Gear operator shall be supplied with valve sizes 8" and larger.
5. Venturi section shall be low loss with a minimum accuracy of 3% of rate.
6. Valves shall be provided with pressure/temperature ports and memory stop. Valves shall be equipped with metal tag and chain. Valves shall be supplied with extended handles and PT ports to clear insulation on chilled water service.
7. Valves shall be sized as indicated or as recommended by valve manufacturer for intended flow capacity.
8. Total pressure drop shall not exceed one foot.
9. Flow rate increments shall be suitable for the indicated flow rate.

2.7 AIR DISTRIBUTION

A. Ductwork

1. Provide all ducts, plenums, connections, dampers, and related items required to form a complete system as indicated on drawings and specified herein.
2. All ductwork shall be constructed of sheet metal unless otherwise indicated.
3. Sheet-metal ducts shall be fabricated from G90 galvanized-steel sheets, 304 stainless steel, or 3003 aluminum, and shall be of gauges called for and as detailed in 2020 SMACNA Manual, HVAC Duct Construction Standards (Metal and Flexible). All ductwork pressure class construction shall be as indicated on the drawings and shall be single wall rectangular or single wall round. Rectangular ductwork shall be single-wall construction unless otherwise indicated except ductwork exterior to the building shall be double wall with 3” insulation encapsulated between inner and outer sheet metal shells.
4. Duct sealing requirements shall be Class A for all ductwork.
5. Round duct and fittings shall be manufactured by a company for whom the manufacture of spiral duct and welded fittings has been a principal business for at least 15 years. Contractor fabricated round spiral duct and fittings shall not be acceptable.

6. All companies being considered as potential suppliers of duct and fitting components shall submit drawings and dimension data for approval. These submittals will serve as a basis for acceptance or rejection of product.

    a. All fittings furnished for use on a project must be identical to the approved submittal data.
    b. Any fittings rejected by the project engineer shall be replaced with fittings equal to the original approved submittals. All expenses incurred in the replacement of fittings that do not conform to these requirements shall be the responsibility of the installing contractor.

7. All medium pressure supply duct shall be of round spiral lockseam or rectangular construction where indicated. Steel round duct shall be of standard spiral with 2C corrugations for all duct greater than 14" diameter (without intermediate ribs) or single-rib construction and shall be provided with gauges according to the following 2020 SMACNA HVAC DCS, except no 28 gauge material is allowed:

Diameter (inches)	Standard Spiral Gauge		Single-Rib Spiral Gauge
	0-2" w.g.	2-10" w.g.	0-10" w.g.
3-8	28	26	--
9-14	28	26	28
15-26	26	24	28
27-36	24	22	28
37-42	22	20	28

8. Duct shall be provided in continuous, un-joined lengths wherever possible. Except when interrupted by fittings, round spiral duct sections shall not be less than 12 feet long. Round spiral pipe and fittings greater than 24" diameter, will have flanged connections. Flanges for dual wall duct must also hold the inner liner of dual wall duct concentric without the use of additional couplings or spacers.
9. Double-wall round and rectangular ductwork shall be used where indicated. Double wall round shall be of spiral lockseam construction. Double wall round and rectangular shall have an airtight outer pressure shell, a 2" thick insulation layer, and a solid inner liner that completely covers the insulation throughout. Fittings to have solid inner liner. Ductwork above the roof shall have a 3" thick insulation layer.
10. Unless otherwise specified, all double-wall duct and fittings shall be a minimum G-90 galvanized sheet metal. All spiral pipe used for inner and outer shells shall have 3 intermediate ribs and be fabricated in accordance with ASTM A525 and A527 specifications in the following minimum gauges:

Nominal Duct Size	Inner/Outer Shell (Gauge)	Inner Shell (Gauge)
3-24	26	26
25-34	24	26
35-42	22	26

11. Fittings shall be of the following minimum gauges:

Nominal Duct Size	Inner/Outer Shell (Gauge)	Inner Shell (Gauge)
3-34	22	24
35-48	20	22

12. Round fittings may be spot welded and bonded.

13. Insulation shall have the following UL rating:

Flame Spread	10-20
Fuel Contributed	10-15
Smoke Developed	0-20

14. Round fittings shall be UNITED MCGILL CORPORATION, VORTEX METAL MANUFACTURING, HAMLIN SHEET METAL, SEMCO MANUFACTURING, LINDAB, INC or EASTERN SHEET METAL.
15. Ductwork shall not be delivered to the job site until just prior to erection. Ductwork with dents or other damages shall not be accepted. Double-wall acoustically-lined ductwork shall be removed from the job site and shall not be used if liner is allowed to become wet to any degree.
16. Rectangular low velocity ductwork shall be constructed from galvanized steel sheets of lock form quality per ASTM A653 with a G90 zinc coating (0.60 oz/ft^2), unless otherwise shown on the contract documents. Sheets shall be free of pits, blisters, slivers, and un-galvanized spots.
17. Insulated-flexible acoustical air ducts shall be FLEXMASTER USA TYPE 1M, THERMAFLEX Type M-KE, or approved equal, suitable for up to 10" w.g. positive pressure and rated velocity of 5500 FPM. Flexible ductwork shall meet NFPA 90A standards, conform to UL standard 181, and be ETL listed Class 1 air duct. Flexible duct shall have a flame spread of less than 25 and smoke developed of less than 50. Flexible ductwork shall be fabricated with a polyethylene or chlorinated polyethylene inner film, wrapped in 2" thick with a thermal conductance of R-6 fiberglass insulation, with an outer reinforced metallized vapor barrier. The inner film shall be supported by a corrosion resistant galvanized steel helix formed and mechanically locked to the polyethylene fabric. The inside bend radius shall be 1/2 x inside diameter in all sizes. Flexible branch ductwork to diffusers shall be limited to maximum length of 5 feet long and maximum velocity of 600 feet per minute. Flexible duct connections at variable air volume terminals shall be a maximum of 3 feet long. Contractor to provide proper flex duct size to ensure velocity limit is not exceeded. Support flexible ducts a minimum of every 4 feet. Supports shall not compress or constrict the flexible duct. Refer to the diffuser installation details on the drawings.
18. Provide flexible connections of fiberglass between ducts and rooftop unit and air-handling unit connections, fan coil units, and exhaust fans. Connector shall be constructed using double lock gripping fingers at metal to fabric contact. Connector shall be rated airtight and watertight up to 10" w.g. positive to 10" w.g. negative pressure. Provide flexible connections, not less than 4 inches wide, constructed of approved fireproof, waterproof, non-asbestos, glass fabric, at the inlet and outlet connection of each fan unit, securely fastened to the unit and to the ductwork by a 24 gauge galvanized steel band provided with tightening screws. There shall be no metal-to-metal contact at flexible connections. There shall be no stretching of the flexible material at flexible connections. The connection shall be UL listed, to meet NFPA 90A and 90B requirements and the following applications:

    a. Indoor: Neoprene coated glass fabric, minimum 30 oz./sq.yd.
    b. Outdoor: U.V. resistant Hypalon coated glass fabric, minimum 24 oz./sq.yd.

c. Flexible connections shall be DUCTMATE "ProFlex," DURODYNE "Flexible Duct Connector," KINETICS "KINFLEX," or equal.

19. Space roof mounted duct supports and suspended duct hangers every 4 feet, maximum. Insulated duct shall have saddle hangers. Suspended duct hangers attached to the side of the ductwork are acceptable.
20. Fabricate ductwork with airtight joints, presenting smooth surface on inside, neatly finished on outside. Unless otherwise indicated, provide square or rectangular elbows and provide double wall turning vanes in all elbows. Deflecting vanes shall be double wall blades, fit into side rails, and screw or rivet to duct elbow in field. Blades and side strips shall be small or large double vanes as detailed in SMACNA Duct Manual. Turning vanes shall be DUCTMATE "ProRail," AERODYNE "H-E-P Turning Vanes," DURODYNE "Vane and Rail" or equal.
21. Construct, brace, and support ducts and air chambers in a manner that they will neither sag nor vibrate to any perceptible extent when fans are operating at maximum speed or capacity.
22. Provide sandwich type or square framed access doors for service temperature and pressure required, where indicated and where not indicated, in locations and of sizes which shall afford easy access to multi-blade dampers, smoke detectors, fire dampers, and other equipment and devices requiring inspection and servicing. Access doors shall be installed to avoid lights, piping, conduit, ceiling grid, etc., to provide unobstructed access. Access doors shall be installed on the underside of the ductwork. Access doors shall be a minimum of 24" x 18" where possible. Access doors in all factory fabricated ductwork shall be factory installed and sizes and locations shall be identified on the ductwork shop drawing submittal. Duct access doors shall be DUCTMATE "Sandwich Access Door," GREENHECK "CAD-10," ACUDOR "CD-5080," or equal.
23. Connect ductwork to intake and discharge louvers, dampers, and other work installed in various trades requiring sheet-metal connections.
24. Make sheet-metal connections to masonry work airtight and watertight in approved manner.
25. Provide opposed-blade dampers for control of air volume and for balancing system, where indicated or required. Dampers shall be of sheet metal at least one gauge heavier than duct and reinforced; shall be installed in an accessible location. Provide indicating quadrant and locking device for adjusting and locking dampers in position. Provide extended shafts on all volume dampers greater than the thickness of the insulation to provide free movement of damper positioner. Stiffen duct at damper location, install damper in manner to prevent rattling.
26. Where dampers are located above inaccessible ceilings, provide remote cable operated volume damper for control and balancing of air volume. The damper shall be constructed of galvanized steel. The inner wire of the casing shall be stainless steel with tensile strength of 260,000 lbs. For application where the diffuser or grille is installed in hard ceiling below 16'-0" AFF, the adjustable controller shall be installed on either the diffuser or grille face, or mounted to the ceiling surface. Otherwise, provide 50' cable and locate adjustable controller concealed in wall with 3-3/4" cover plate. A list of acceptable manufacturers is listed below:

Manufacturer	Damper Model	Diffuser/Ceiling Mounted Controller	Wall Mounted Controller
UNITED ENERTECH	BO-RI	BO-150	BO-702
DURODYNE	DuroZone	CSB	WSB
METAIRTECH	RT-250	RT-CCM	RT_CCS

27. Provide square to round transition fittings with balancing damper at all round-duct take-offs to supply diffusers and registers.
28. Provide access doors in building walls and ceilings where damper quadrants are concealed in shafts or above non-accessible ceilings.
29. Duct sizes are inside free area. Increase duct sizes as required.
30. Ductwork and accessories shall not be delivered to the job site until just prior to erection and must be stored in an approved manner.
31. All new ductwork shall be internally cleaned by vacuuming prior to installation.
32. All new and existing ductwork open ends shall be sealed with polyethylene and duct tape during construction after hanging.
33. Refer to Specification Section 230885 Duct Cleaning and notes on the drawings for existing ductwork cleaning requirements. All existing ductwork shall be internally cleaned in accordance with Specification Section 230885.

B. Grilles, Registers and Diffusers

1. Refer to drawings for types, material, models, finishes, and manufacturers. Air devices shall have performance characteristics (throw, noise, and pressure drop) equal to air devices scheduled on the drawings. Provide performance data with submittal. PRICE, TITUS, GREENHECK, or equal. Grille and register frames and louvers shall be one-piece construction.
2. Paint interior surfaces of ducts behind grilles and registers with flat black enamel.

2.8 VIBRATION ISOLATION

A. Mechanical equipment indicated below shall be isolated from the structure by resilient vibration and noise isolators. Equipment to be isolated includes, but is not limited to, the following: Rooftop Units (RTUs).

1. Vibration Isolation Rail System:

a. Curb mounted rooftop equipment shall be mounted on vibration isolation rails that fit on top of the steel framing and under the isolated equipment. Curb mounted isolation rails shall be Type CMAB as manufactured by MASON INDUSTRIES, INC. or approved equal. Isolation rail system shall be stamped by a registered professional engineer employed by the manufacturer.
b. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal.
c. Aluminum members shall house powder coated springs selected for 0.75” minimum deflection. Travel to solid shall be 1.5” minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be

provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds. Manufacturer's self-adhering closed cell sponge gasketing shall be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM duct-like closure.

2. Hanger and Guide Supports:

   a. All ductwork and piping connected to equipment that has been vibration isolated (RTUs) shall be isolated from the building structure with ceiling spring hangers. Hangers shall be MASON "W30," VIBRO-ACOUSTICS "SHCH," KINETICS "MUTA," or equal.
   b. Spring isolators shall include springs that are seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

B. Neoprene Isolation Pads

1. For all equipment with a fan and/or compressor and mounted on a concrete pad, provide 3/4" (19mm) thick neoprene pads consisting of 2" (50mm) square waffle modules separated horizontally by a 16 (1.5mm) gauge galvanized shim. At a minimum, pads shall be provided under all corners of the equipment, but quantities shall be increased in accordance with the equipment manufacturer's recommendations. Load distribution plates shall be used as required. Pads shall be MASON "SW," VIBRO-ACOUSTICS "Neo +," KINETICS "RSP," or equal.

C. Rooftop Acoustical Systems: Provide acoustical material inside the roof curb as indicated on the Contract Drawings. Acoustical material shall be furnished by the isolation curb manufacturer, and consist of the following:

1. Vibration Isolation Rail System: Provide 2 layers of moisture resistant 5/8" gypsum board on top of 3/8" x 1-3/4" foam pads. Foam pads shall be mounted on 2" aluminum channel that extends the width of the curb rail. The aluminum channel shall be installed above the spring isolator to attenuate acoustical vibrations translated through the roof curb.
2. Provide 2" thickness ROCKWOOL "AFB," OWENS-CORNING "705," or JOHNS MANVILLE "Insul-SHIELD" acoustic batt insulation with 2.8 lbs./sf density on top of the gypsum board.

2.9 MEASUREMENT AND CONTROL

A. Variable Frequency Drives

1. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.

2. Provide variable speed frequency drive (VFD) units for the following equipment:

    a. Pumps (P-1 through P-6)
    b. Rooftop Units and Air Handling Units (when not provided by the unit manufacturer.

3. Acceptable VFD manufacturers are ABB, DANFOSS, TOSHIBA, or equal.
4. The VFD package as specified herein shall be enclosed in a UL Listed Type 1 enclosure for indoor applications, completely assembled and tested by the manufacturer in an ISO9001 facility.

    a. Environmental operating conditions: VFDs shall be capable of continuous operation at 32 to 120 F ambient temperature or VFD must be oversized to meet these temperature requirements.
    b. Enclosure for indoor applications shall be rated UL Type 1, Enclosures for outdoor applications shall be UL Type 3R. All enclosures shall be UL listed as a plenum rated VFD.

5. All VFDs shall have a Short Circuit Withstand Rating of not less than the rating of the connected equipment in accordance with UL508.

6. All VFDs shall have the following standard features:

    a. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference.
    b. There shall be a built-in time clock in the VFD keypad.
    c. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up.
    d. The VFD shall have cooling fans that are designed for easy replacement.
    e. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.
    f. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
    g. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients.
    h. The input current rating of the VFD shall be no more than 3% greater than the output current rating.
    i. The VFD shall include a coordinated AC transient surge protection system.
    j. The VFD shall provide a programmable loss-of-load Form-C relay output.
    k. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of mechanical failure / jam condition causing motor overload

l. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
m. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user.
n. Door interlocked, pad lockable molded case switch that will disconnect all input power from the drive and all internally mounted options.

7. All VFDs to have the following adjustments:

a. Three (3) programmable critical frequency lockout ranges.
b. Two (2) PID Set point controllers allowing pressure or flow signals to be connected to the VFD.
c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e., valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
d. Two (2) programmable analog inputs shall accept current or voltage signals.
e. Two (2) programmable analog outputs (0-20ma or 4-20 ma).
f. Six (6) programmable digital inputs for flexibility in interfacing with external devices.
g. Three (3) programmable, digital Form-C relay outputs.
h. Run permissive circuit - There shall be a run permissive circuit for damper or valve control.
i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active.
j. Seven (7) programmable preset speeds.
k. Two independently adjustable accel and decel ramps with 1 - 1800 seconds adjustable time ramps.
l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise.
m. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
n. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD.
o. The VFD shall include password protection against parameter changes.

8. The Keypad shall include a backlit LCD display. All VFD faults shall be displayed in English words. The keypad shall include the following assistants:

a. Start-up assistant
b. Parameter assistants
c. Maintenance assistant
d. Troubleshooting assistant

e. Drive optimizer assistants

9. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times:

a. Output Frequency
b. Motor Speed (RPM, %, or Engineering units)
c. Motor Current
d. Motor Torque
e. Motor Power (kW)
f. DC Bus Voltage
g. Output Voltage

10. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed. 2) Operate in a specific fireman's override PID algorithm. The mode shall override all other inputs except customer defined safety run interlocks, and force the motor to run in one of the two modes above.

11. Serial Communications

a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.
b. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

1) Data Sharing - Read Property - B.
2) Data Sharing - Write Property - B.
3) Device Management - Dynamic Device Binding (Who-Is; I-Am).
4) Device Management - Dynamic Object Binding (Who-Has; I-Have).
5) Device Management - Communication Control - B.

c. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

d. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
e. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function.
f. The VFD shall include an independent PID loop for customer use.

12. EMI / RFI filters. All VFD's shall include EMI/RFI filters.
13. All VFD's through 75HP at 480 V shall be protected from input and output power mis-wiring.

14. Bypass Controller

a. A complete factory wired and tested bypass system shall be provided with the following operators:

1) Bypass Hand-Off-Auto
2) Drive mode selector
3) Bypass mode selector
4) Bypass fault reset

b. The bypass shall include an LCD display that allows the user to access owner requested data including but not limited to fails, bypass power (KW), and energy savings.
c. The following indicating lights (LED type) or keypad display indications shall be provided.

15. Emergency Stop Function

a. An emergency stop function shall meet all of the following requirements:

1) The function shall override all other functions and operations under all conditions.
2) Reset must not initiate a restart.
3) An emergency stop shall operate in such a way that, when it is activated, the hazardous movement of the machinery is stopped and the machine is unable to start under any circumstances, even after the emergency stop is released. Releasing the emergency stop only allows the machine to be restarted.
4) The emergency stop shall stop hazardous movement by applying a stop category 0.

a) Emergency stop category 0 (according to EN 60204-1) means that the power to the motor shall cut off immediately. Stop category 0 is equivalent to the safe torque off (STO)function, as defined by standard EN/IEC 61800-5-2.

16. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
17. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current.
18. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.
19. The VFD Product Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

B. Bipolar Ionization

1. This section describes the design, performance, and installation of a needlepoint bipolar ionization (NBPI) air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details, and equipment schedules.
2. Project Design

a. Maximum ozone emissions shall be in accordance with limits stated in UL 2998. Provide products listed as UL2998-compliant.
b. Provide ionization device that does not require preheat protection when relative humidity of entering air exceeds 85%. Device shall be suitable for relative humidity from 0-100%, condensing, without causing damage, deterioration, or dangerous conditions within air ionization system.
c. Provide systems that produce positive and negative ions. Unipolar ionization devices are unacceptable.
d. Device shall be tested by UL, proving compliance with UL 2998 ozone standard when tested using UL 867 (5^{th} edition) methodology. Perform large chamber testing and peak ozone test for electronic devices in accordance with UL 2998.

1) Demonstrate interior ion concentration levels, both positive and negative collectively, to minimum 2000 ions/cc measured 5 ft from floor where air is delivered from the duct system
2) Provide ionization systems suitable for air exchange rates through full operating range of constant volume or variable air volume (VAV) system.
3) Minimum air velocity: 300 fpm

e. Provide ionization device enclosures constructed of corrosion-resistant, non-metallic materials. Configure enclosure without thermal bridging. Provide units certified to UL 2998.

f. Provide ionization units having manufacturer's recommended number of electrodes and power generators, sized to system air flow.
g. Electrodes shall consist of carbon fiber clusters having minimum 45000 needles each.
h. Ionization system shall be energized continuously.
i. Additional Design Requirements for Non-Auto Coil Cleaning Installations:

1) Multi-voltage input shall allow 24V or 110-240VAC power supply.
2) Provide magnets for mounting ionization system to fan inlet.
3) Provide integral alarm dry contacts, SPST (NO), rated 0.3 A at 125VAC.

j. Additional Design Requirements for Auto Coil Cleaning Installations:

1) Provide electrodes in six-inch sections for field assembly by installer to cover entire finned width of coil.
2) Provide one modular ionization bar for ever 5ft. of coil height.
3) Electrode spacing shall be 0.5 to 1 inch apart.
4) Output shall be 140 million ions/cc per inch of bar, measured 1 inch from carbon fiber brushes.
5) Ionization Bars:

a) Length shall be 12 ft. maximum
b) Provide ac power supply for field installation, capable of powering four ionization bars requiring 20W each.
c) Include integral on/off switch and LED “power on” light.
d) Include BAS interface alarm dry contacts, SPST (NO), rated 1A at 250VAC.
e) Power source shall be 24VAC, 110VAC, or 208-240VAC.
f) Power supply enclosure class shall be NEMA 250, Type 4.

k. NPBI devices shall be provided with internal short-circuit protection, overload protection, and automatic fault reset circuit breakers.

3. General Installation

a. Position each electronic air cleaner unit with clearance for service and maintenance. Anchor electronic air cleaners to substrate.
b. Install air cleaner devices between upstream filter and cooling coil. Where unit configuration does not allow this installation location, air cleaner devices shall be installed upstream or downstream of supply fan.

4. Factory-fabricated, modular bipolar ionization device

a. Subject to compliance with requirements, provide GPS “i-MOD,” PHENOMENAL AIRE “Series C Universal,” ATMOSAIR “ActiveOx R” or equal.
b. Capacity and Characteristics

1) Materials: Composite and carbon fiber
2) Capacity: 50 to 250 cfm per inch of length
3) Voltage selector switch and illuminated on-off switch

4) LED operational status light
5) Six high-voltage output connections
6) Alarm contacts: SPDT, dry
7) Auxiliary terminals for connections of remote ion sensor
8) Temperature range: -40°F to 140°F
9) Relative humidity range: 0-100%
10) Power Entry: UL listed, line cord with three-prong plug
11) Power unit dimensions: 9" L x 3.25" W x 4.75"H
12) Ionizer bar dimensions: 1.6"H x 0.75" W

a) Length per section: 6 inches, having nine brushes per section
b) Maximum assembled bar length: 144 inches
c) Provide rare earth magnets for mounting

13) Power unit weight: 4.63lb
14) Ionizer bar weight: 0.24lb per 6-inch section

c. Electrical Characteristics

1) Electrical Listings: UL/ETL
2) Compliance and Certifications: IAQP, UL 867, UL 2043, UL 2998
3) Input voltage: 24V AC or DC, 110VAC, 240VAC
4) Amperes: 0.5A at 24V, 01.12A at 110V, 0.1A at 240V
5) Output power: 5 kV RMS
6) Total ion output: 140 million ions/cc per inch of bar, measured 1 inch from carbon fiber brushes

d. Provide ion sensor compatible with ionization device.
e. Provide one ionization bar assembly on each coil up to 60 inches in height. Space bars maximum 60 inches apart. Install bar to cover entire finned width of coil to nearest 6 inches without exceeding finned width of coil.

5. NPBI device for unit mounting

a. Subject to compliance with requirements, provide GPS "FC3-BAS," ATMOSAIR "ActiveOx FC," PHENOMENAL AIRE "Series D 3.2" or equal.
b. Capacity and Characteristics

1) Materials: Carbon fiber ion emitters
2) Capacity: 0 to 1200 cfm
3) Provide integral alarm dry contacts, SPST (NO), rated 0.1A at 24VAC.
4) Temperature range: -40°F to 140°F
5) Relative humidity range: 0-100%
6) Unit dimensions: 2.6" L x 1.9" W x 1.3"H
7) Unit weight: 0.23lb

c. Electrical Characteristics

1) Electrical Listings: UL

2) Compliance and Certifications: IAQP, UL 867, UL 2998
3) Input voltage: 24V AC or DC, 110VAC, 240VAC
4) Power Consumption: 1.2W
4) Output power: 2 kV RMS
6) Total ion output: 35 million ions/cc per foot, measured 1 inch from carbon fiber brushes

d. Install ionization emitter perpendicular to air flow direction. Mount so ion emitters are exposed to, and perpendicular to, airstream. Mount ion emitters so airflow passes between them.

C. Low Voltage Condensate Overflow Shut-off Switch

1. Low voltage condensate overflow shut-off switches shall be installed on all condensate drain pans as manufactured by RECTORSEAL "AquaGuard," LITTLE GIANT "ACS-2," ASURITY "CC-1," or equal.
2. Mechanical equipment without adequate pan clearance to install a primary drain pan switch shall provide a switch installed on the primary drain pan outlet. The condensate shut-off switch shall detect downstream clogs in condensate drains and interrupts the thermostat circuit to shut off the unit before flooding occurs. Switch shall be RECTORSEAL "Safe-T-Switch," LITTLE GIANT "ACS-5," ASURITY "CS-1," or equal.
3. The condensate shut-off switch shall detect rising water in condensate drain pans and interrupts the thermostat circuit to shut off the unit before flooding occurs. The device shall be installed on the primary drain pan rim with a two-piece clamp system that does not require drilling.
4. The switch shall incorporate a high capacity 5-amp, 24-volt AC magnetic float switch in a fully housed protective cover. The housing shall include a pull up test knob for functional testing of system.
5. The switch shall include an alarm wire to connect to the BAS. The switch shall send an alarm signal to the BAS front-end workstation. The mechanical contractor shall be responsible for coordinating the switch connections with the controls contractor.
6. The switch shall be UL Listed to comply with UL 508.

PART 3 - EXECUTION

3.1 TESTS

A. Refer to Section 230593 "Testing, Adjusting and Balancing" for related requirements.

B. At their discretion the Owner shall be represented at all tests. Contractor shall provide 48 hours' notice to the Owner prior to the tests unless otherwise specified.

C. Before insulation is installed and before piping is concealed, test water piping hydrostatically and prove tight under 100 psig pressure. Test pressure shall be held for minimum of 8 hours. An air test in lieu of water may be used when danger of freezing is possible and when approved.

D. Refrigerant piping shall be tested with dry nitrogen and trace of refrigerant at test pressures recommended by equipment manufacturer. After system has been proven tight under test pressure, it shall be evacuated to a pressure 2.5 mm Hg absolute. The refrigerant compressor shall not be used for evacuating the system. Vacuum shall be checked by use of a mercury manometer.

E. Coupled pumps shall be field aligned in accordance to the manufacturer's recommended procedures, alignment completed prior to shipment is not acceptable. After the equipment has been aligned, the contractor shall provide a written report verifying that the pumps vertical and horizontal angularity and parallel offset gap are within one of the following tolerances:

1. Pump parallel offset gap shall be within 1/64" at operating speed and pump angularity shall be within 1/64" per inch of coupler radius.
2. The manufacturer's recommended tolerance for the application and with the Engineer's approval.

F. Test all gas piping at 50 psig with oil-free compressed air for 2 hours with no loss in pressure.

3.2 EQUIPMENT COORDINATION

A. The Prime contractor shall conduct an HVAC Coordination meeting after submission of the HVAC equipment, fire alarm, and controls submittals to the Engineer, and prior to the return of the reviewed controls submittal to the Prime Contractor. The Prime Contractor shall coordinate the meeting time, date, and location with all parties, provide a written agenda, provide written meeting minutes, and provide a detailed issues summary (if unresolved issues remain open after the meeting).

B. The Prime Contractor shall provide follow-up action as required with the following in mandatory attendance:

1. Prime Contractor Project Manager and Project Superintendent
2. Equipment manufacturer technical services representative (not a sales representative)
3. Controls contractor technical services representative (not a sales representative)
4. Mechanical engineer
5. Owner's representative
6. Fire alarm system representative

C. The purpose of this meeting is to review equipment, control sequences, and the selected manufacturer's available control points. Upon completion of this meeting, the General Contractor shall be required to submit a meeting report detailing all discussed issues and coordinated solutions. Any unresolved issues shall require another mandatory meeting to ensure all items have been considered and coordinated prior to construction.

END OF SECTION 230500

SECTION 230900 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, Section 230100, “Mechanical General Provisions,” and Section 230500 “Heating, Ventilating, Air Conditioning” apply to this section.

B. Original construction drawings shall be made available by the Owner upon request of the Contractor. Existing BAS record drawings can be found in Appendix A.

C. Intended modifications to be made to the existing building controls architecture are shown on Contract Drawings M-501 through M-507.

1.2 WORKMANSHIP

A. Workmanship shall be first class and of best quality in accordance with approved contemporary construction practices. Defective equipment and materials, or material damaged in the course of installation and tests shall be replaced or repaired in an approved manner.

1.3 APPROVAL OF MATERIALS AND EQUIPMENT

A. Within 30 days after award of the Contract and before any purchases are made, submit for approval a complete list of materials and equipment proposed, together with names of manufacturers and catalog numbers for each Specification Section. Furnish other detailed information where directed. No consideration will be given to partial lists submitted from time to time. Approval of materials shall be based on manufacturer’s published ratings. Materials and equipment listed which are not in accordance with specified requirements shall be rejected. Contractor shall make resubmission of items not approved within 30 days from date of rejections. Submission shall be complete with description, ratings, dimensions and related items and any additional information required by the Engineer.

B. Materials and equipment shall be new, conforming to these Specifications.

1.4 SUPERVISION

A. The controls contractor shall maintain a competent foreman on the job at all times to supervise the work and coordinate with other trades for the installation of the system.

1.5 NOTICES AND FEES

A. Give all required notices, obtain all necessary permits and pay all required fees.

1.6 DEFINITIONS

A.	TRIDIUM:	American engineering hardware and software company and developer of Niagara Framework.
B.	NIAGARA:	Universal software infrastructure developed by Tridium Inc. that allows building controls integrators to build custom, web-enabled applications for accessing, automating and controlling smart devices in real-time via local network or over the Internet.
C.	BACnet:	Communications protocol for Building Automation and Control (BAC) networks which provides mechanisms for building automation devices to exchange information, regardless of the particular building service they perform.
D.	JACE:	Java Application Control Engine. A JACE is a mechanism/device that provides connectivity to systems within a building via the Niagara framework, and can connect common network protocols (BACnet, Modbus, etc.) to provide a seamless, unified controls system.
E.	DDC:	Direct digital controls system. A building DDC system, typically hierarchical, consists of terminal controllers (typically factory-provided and shipped with equipment), system/field controllers (typically provided and installed by controls contractors), and a central workstation to provide a user interface for the various building controls.
F.	Front End:	System/building level controller(s) that receive data from terminal controllers throughout the building control system.
G.	Controls Integration:	The process of providing a Niagara-based front end, to which all other existing terminal controllers communicate.
H.	Controls Replacement:	The process of providing new system/building level controllers, as well as providing new terminal controllers for all building HVAC equipment. All new controllers shall be open protocol and capable of communicating with the Niagara N4 supervising server located at NNPS plant

1.7 SYSTEM DESCRIPTION

A. Overview: NNPS has standardized on the Tridium Niagara N4 (or later Tridium version) platform for its user interface and building controllers for all new and existing building control systems. The controls contractor shall provide new BACnet compatible controllers for all new HVAC Equipment and existing VAV's at Menchville High School. All new and existing equipment controllers shall be integrated into the Tridium Niagara N4 system architecture for Menchville High School. The open protocol Direct Digital Controls (DDC) controllers provided by the controls contractor and/or the HVAC equipment manufacturers shall be connected to the

Niagara N4 platform. The controls contractor is responsible for integrating new controls at Menchville High School with the Niagara N4 supervising server located at NNPS plant. **All HVAC equipment, including equipment not being replaced, shall be fully commissioned. Equipment must operate in accordance with the original or revised sequence of operations. Refer to Appendix A for existing sequences**.

B. Protocols: NNPS standard is to utilize BACnet protocol within the building control system. BACnet factory supplied onboard controllers shall be in their "native" open protocol, avoiding the need for gateways or translators. There may be some instances where a gateway or translator is the only method to integrate a controller, but those shall be submitted to and approved by the consultant engineer on a case-by-case basis.

C. DDC Controllers: The building control system will consist of DDC controllers that can stand-alone operate each piece of HVAC equipment (existing and new) or an HVAC system (existing and new) without the use of more than one (1) controller per equipment or system. The DDC controllers will be a combination of factory supplied controllers and control contractor provided and field installed controllers. The coordination of factory controllers vs. field controllers, sensors and integration will be the responsibility of the controls contractor to coordinate with the HVAC equipment providers. Reuse existing controllers where possible. Refer to Appendix A in this section for existing controls record drawings to be used as a basis of system architecture and organization.

D. Factory Installed Controllers: When a factory installed controller is provided with the HVAC equipment, the manufacturer is required to expose all functional and operational points within that controller to the open protocol communication port on the controller. This may require the manufacturers to create "shadow points" that mirror internal points within the onboard controller. The intent is not to display every point on the user interface graphics, but to ensure that all points are accessible to the building control system. The controls contractor shall coordinate with the equipment supplier to ensure the hand-shake between the building control system and the factory supplied controller is 100% accurate and reliable information. The controls contractor shall be responsible for all field installation of sensors and control wiring for factory supplied controls.

E. Building Controllers: The controls contractor shall furnish and install Building Controllers to incorporate all the existing and new DDC controllers and factory controllers into one seamless harmonic building control system. The Building Controllers shall be based on the Niagara 4 Framework and "open licensed" so that any Niagara approved and qualified contractor can fully access and support the building control system. The controls contractor shall provide the number of DDC controllers needed to fully implement the sequence of operation, regardless of license pricing limitation thresholds.

F. Network Communication: NNPS will provide a network communication port in a local data closet. The controls contractor shall furnish & install a CAT5 communication cable from each Building Controller to the designated port on the IT switch. Additionally, the controls contractor shall provide NNPS with the Building Controller's MAC address and location identifier. The JACE passwords shall be provided by NNPS to the Contractor. There shall be no other passwords or access to the JACE other than as provided by NNPS.

G. Server: NNPS has an established and designated server that is running the Niagara N4 Framework. The server applications to be applied by the controls contractor for this project are as follows:

1. User Login Credentials: are synchronized via the NNPS Active Directory where access privileges are assigned by a designated staff person. The controls contractor shall review & incorporate these user privileges in the building control system as to prevent lower-level users from obtaining specific features that are above their level of authority. Note: these access groups & privileges are well defined on the server.
2. Point Mapping: Every point in the building control system shall be mapped to the server by the controls contractor.
3. Graphics: The control contractor will be responsible for developing and populating color graphics on the server for the Menchville High School that are in accordance with NNPS standards.
4. Schedules: The control contractor will be responsible for linking existing schedules from the server to the appropriate areas of the building.
5. Trending: The control contractor will be responsible for mapping and archiving all trended points to the server with uploading to the server every 2 hours. NNPS will provide to the controls contractor the trend intervals for all point types.
6. Alarming: The control contractor will be responsible for developing "smart alarms" which are critical alarms that get transmitted via email and/or text message to designated NNPS staff. Note: the smart alarm schedule and distribution list is currently setup on the server.

H. User Interface: The controls contractor is not required to provide any user interface products such as computer workstations, laptop computers, notebook computers or panel mounted displays. NNPS will utilize its existing user interface products to access the building control system through the NNPS network.

I. Software Editing Tools:

1. Each JACE or equivalent controller shall have embedded work bench software to permit programing changes without the use of the above Niagara Engineering Tool.

J. The installation of the control system shall be performed under the direct supervision of the controls contractor including; shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation.

K. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project.

L. The controls contractor shall be responsible for all Building Automation Systems (BAS), temperature control, 120 volt and low-voltage control wiring for the mechanical system, including interlock wiring for non DDC controlled equipment, for a complete and operable system. Control wiring shall be done in accordance with the specifications, NNPS standard practices, and all local and national codes.

M. The controls contractor shall purchase one (1) 5 year maintenance support agreement for a total of 5 years of coverage, to begin after the initial 18 month support agreement expires. The agreement ownership shall be transferred to NNPS.

N. Existing Overrides and Side-Loops:

1. It shall be noted that scheduling and sequences of operation for miscellaneous unitary equipment (exhaust fans serving gang toilets, split systems, etc.) may currently reside on Building Controllers or DDC Equipment Controllers. Upon replacement of Building Controllers or DDC Equipment Controllers, all existing schedules and sequences shall be re-written.

O. All legacy controls, components, and accessories removed or replaced during the course of work shall be turned over to the Owner for use as spare parts. The Contractor shall ensure these items are labeled, organized, and delivered in good condition.

1.8 QUALITY ASSURANCE

A. The DDC system shall be designed and installed, commissioned and serviced by manufacturer / factory trained personnel. The controls contractor shall have an in-place support facility within 100 miles of the project site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

B. The controls contractor shall provide a dedicated and experienced Tridium Niagara N4 certified project manager for this work, responsible for direct supervision of the installation, start up and commissioning of the building control system.

C. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

D. All Building Controllers and DDC controllers shall be UL Listed under Standard UL 916.

E. All programmers working in the N4 platform shall be Niagara 4 certified.

F. Prior to submitting shop drawings, the Controls Contractor shall lead a coordination meeting between General Contractor, Engineer and Owner to plan the integration of all new system, building, and DDC controllers into the control system. Every control point and startup responsibilities shall be reviewed for a smooth integration process. Meeting minutes shall be prepared and forwarded to participants by the Controls Contractor.

G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

H. The lead programmer shall operate the controls the entire duration of the Commissioning process.

I. The naming conventions used for this project are provided in Appendix A. No deviations are permitted without express approval of the Engineer.

1.9 WORK BY OTHERS

A. The Automatic Temperature Controls Contractor shall provide the required branch circuitry (conduit and conductors) between each HVAC Control Panel and electrical panels with spare breakers labeled as “HVAC Controls”. The Automatic Temperature Controls Contractor shall

coordinate this work with the electrical contractor. Termination at circuit breakers shall be performed by the electrical contractor.

B. All control and power wiring required for temperature control system and all interlocking and accessory control wiring required for equipment installed under Division 23 Sections shall be installed by the Temperature Control Contractor.

C. The Electrical Contractor shall be responsible for wiring of any electrical sub-metering devices furnished by BAS manufacturer.

1.10 SUBMITTALS

A. Submit three complete sets of documentation in the following phased delivery schedule:

1. Equipment data cut sheets
2. System schematics, including:

    a. Sequence of operations
    b. Point names
    c. Point addresses
    d. Interface wiring diagrams
    e. Panel layouts
    f. System riser diagrams
    g. Auto-CAD compatible record drawings

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:

1. Index sheet, listing contents in alphabetical order
2. Manufacturer's equipment parts list of all functional components of the system
3. Auto-CAD disk of system schematics, including wiring diagrams
4. Description of sequence of operations
5. As-Built interconnection wiring diagrams
6. Operator's Manual
7. Trunk cable schematic showing remote electronic panel locations and all trunk data
8. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
9. Conduit routing diagrams
10. Backup Niagara logic files for all JACE and Drivers for this project.

C. Niagara 4 Technical Certification Program (TCP) certificate for all integrating and on-site programmers.

D. The input setup data for equipment manufacturer provided programmable controllers shall be included in the O&M manual or controls as-built documents. This may take the form of screen shots for each input screen for each controller.

1.11 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the DDC system for a period of one year after project acceptance.

B. The adjustment, required testing, and repair of the system includes all new computer equipment, transmission equipment and sensors and control devices.

C. The on-line support services shall allow the local Controls Contractor to remote-in over the customer's LAN/WAN via secure connection to monitor and control the facility's DDC system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

D. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the Controls Contractor shall dispatch the appropriate personnel to the job site to resolve the problem within 2 hours of the time that the problem is reported.

PART 2 - PRODUCTS

2.1 PRE-APPROVED CONTROL CONTRACTORS

A. Subject to compliance with requirements of the project documents to provide a complete building control system by one of the following preferred licensed Authorized Control Integrator (ACI) contractor companies:

1. Honeywell (by Chesapeake Controls)
2. Johnson Controls (by the local branch office of Johnson Controls)
3. Siemens (by the local branch office of Siemens Building Technology)
4. Trane (by Damuth Trane)
5. Mid-Atlantic
6. ACES

B. No additional control contractors will be considered.

C. Pre-approved controls contractors shall also have completed two projects of similar scope to the HVAC Replacement at Menchville High School. Upon request, contractor shall submit a summary of similar completed projects along with the contact information for an Owner's Representative who can serve as a reference.

D. All equipment with on-board controllers shall be Honeywell BACnet Optimizer T1L or BACnet MSTP compatible. Additionally, provide Niagara N4.414 Version 4.8.0.110 on all JACEs or Honeywell CIPer controllers.

2.2 DDC EQUIPMENT

3. Operator Work Station: This project will utilize existing workstations owned and maintained by NNPS.

3. Server: This project will utilize an existing server and software applications owned and maintained by NNPS.

3. Building Controllers: Provide an adequate number of Building Controllers to achieve monitoring and control of all data points specified and necessary to satisfy the sequence of operation for all mechanical systems shown on the plans. Refer to Appendix A in this section for existing data points. Building Controllers shall be provided as required to accomplish the sequence of operation regardless of software licensing pricing limitations. Each Building Controller shall be connected to the NNPS network via Ethernet connection to an IT switch port located in a nearby data closet.

D. DDC Controllers: Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications and standard control applications. DDC Controllers shall be provided for; RTUs, AHUS, VAV Terminal Boxes, and other applications as shown on drawings or identified in the points list.

1. DDC Controllers shall monitor and/or control each input/output point; process information; and provide at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.
2. Capable of stand-alone mode control functions operate regardless of network status.
3. Have a local operator interface port for program download from portable workstation.
4. Shall communicate with the Building Controller using BACnet protocol.

2.3 CONTROL PANELS

3. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

3. Fabricate panel's 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's
standard shop-painted finish.
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Power Supplies: Provide power supplies that have the line-voltage (120V) totally enclosed as to ensure Arch-Flash Compliance. Only low-voltage shall be exposed within any control panel.
4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

2.4 CONTROL CABLE

3. Network communication cable shall be plenum rated CAT5.

2.5 RACEWAYS AND CONDUITS

3. Raceways shall be provided for all surface-mounted control wiring.

3. If existing control wiring above ceilings is installed in conduits, all new control wiring above ceilings shall also be installed in conduits.

3. J hooks shall be utilized in running control wiring above ceilings and mechanically fastened to walls or hung from supports unless existing architectural or structural conditions do not allow for mechanical fastening.

2.6 CONTROL VALVES (PACKAGED AND UNITARY EQUIPMENT)

3. Valve housing shall consist of forged brass rated at no less than 360 psi at 250°F. Standard valve ball shall consist of chemical nickel-plated brass. Valve shall have a blow-out proof stem with two EPDM O-rings with minimum 600 psi rating. Valve stem assembly shall be of a pack-less design and be field-replaceable without removing the valve body from the piping. Manufacturer shall be able to provide glass-filled polymer ball insert to make flow control equal percentage. Valves shall be HONEYWELL “VBN” or equal.

3. 2-way valves shall have EPDM O-rings behind ball seals to allow for a minimum close-off pressure of 100 psi with actuator which provides 35lb-in. torque for ½ to 3 in. sizes. Valve shall be available with a minimum of 53 unique Cv values. Valve shall be available with threaded (FNPT) end connections.

3. 3-way valves shall be installed in a “T” configuration with actuator perpendicular to the shaft. Valve shall not require elbows of any kind. The 3-way valves shall have EPDM O-rings behind ball seals to allow for a minimum close-off pressure of 40 psi with an actuator that provides 35 lb-in. torque for 1/2 to 2-1/2 in. sizes. The 3-way valves must be available in both mixing and diverting configurations and shall be available with a minimum of 42 unique C_v values. Valve shall be available with threaded (FNPT) end connections.

3. Direct coupled actuator shall accept analog modulating (0-10Vdc) signal as indicated in the control sequences. Actuators shall be HONEYWELL “MN7507” or equal. Actuators shall provide minimum torque required for full valve shutoff position. Wiring terminals shall be provided for installation to control signal and power wiring. Actuators shall be provided with identification tags indelibly marked with C_v, model number, and tag location.

2.7 CONTROL DAMPERS

3. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
3. Damper shaft bearings shall be as recommended by manufacturer for application.
4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 4 CFM per square foot at 1.0" w.c. differential pressure.
5. All leakage testing and pressure ratings will be based on AMCA Standard 511.
6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

3. Control dampers shall be parallel or opposed blade types.

2.8 ELECTRIC DAMPER AND VALVE ACTUATORS

3. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces).

    1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
    2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
    3. Spring-Return Motors for Valves Larger than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.
    4. Nonspring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

3. Spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

3. Electronic Damper and Valve Actuators: Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve.

    1. Coupling: V-bolt and V-shaped, toothed cradle.
    2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
    3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
    4. Actuators shall have the ability to be tandem mounted.
    5. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
    6. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
    7. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
    8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

9. Temperature Rating: -22°F to 140ºF.
10. Run Time: 200 seconds open, 40 seconds closed.
11. All actuators shall have a 5-year warranty.
12. Automatic Control Valves for Large Hydronic Equipment (Boilers, Pumps, etc.):

    a. Provide BRAY SERIES 30/31 control valves.
    b. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
    c. Valve and Actuators shall come from the factory fully assembled.
    d. Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.

2.9 FIRE PROTECTION DEVICES

A. Smoke detectors shall be furnished by division 28 and installed by the mechanical contractor. Smoke detectors shall be wired to the fire alarm control panel by division 28. Provide interlock wiring to disable supply fan upon a detection of smoke.

B. Power wiring to the smoke detector and signal wiring from the smoke detector to the fire alarm control panel shall be furnished under division 28. Unit shutdown wiring and control shall be the responsibility of the automatic temperature controls contractor.

2.10 SENSORS

3. Electronic Temperature Sensors: Vibration and corrosion resistant for wall, immersion, or duct mounting as required.

    1. Temperature sensors shall be platinum Resistance Temperature Device (RTD) or 10,000 ohm Thermistor.
    2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 2 feet in length.
    3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
    4. Space sensors shall be equipped with software limited set-point adjustment +/- 3 degrees), override switch, and communication port.
    5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.2°F.
    6. Space sensor guards unless noted otherwise, provide lockable cast aluminum guards for sensors located in the gymnasium, and cafeteria. Provide lockable clear plastic guards in all public areas.
    7. Low-Voltage Space Thermostats shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented cover
    8. Line-Voltage Space Thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid state type, with heat anticipator, UL listing for electrical rating, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented cover.
    9. Low-Limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 ft long. Element shall sense temperature in each 1 ft section and shall respond to lowest sensed temperature. Low limit thermostat shall be manual reset only.

3. Humidity Sensors: Bulk polymer sensor element

    1. Duct and room sensors shall have a sensing range of 0% to 100% with accuracy of ±3% R.H.
    2. Duct sensors shall be provided with a sampling chamber. Sensors shall be provided with element guard and mounting plate.
    3. Outdoor air humidity sensors shall have a sensing range of 0% to 100% R.H. It shall be suitable for ambient conditions of -20 F to 140°F. Sensors shall be provided with element guard and mounting plate.
    4. Humidity sensor's drift shall not exceed 1% of full scale per year.
    5. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
    6. Space sensor guards: Unless noted otherwise, provide lockable cast aluminum guards for sensors located in the gymnasium, and cafeteria. Provide lockable clear plastic guards in all public areas.

3. Carbon Dioxide (CO2) Sensors:

    1. Response time: 1 min.
    2. Operation: Non-dispersive infrared (NDIR)
    3. Sampling: Diffusion
    4. Range: 0 to 2000 ppm
    5. Accuracy: ± (30 ppm +2% of reading)
    6. Analog Output: 0-10 Vdc (Default: 2-10 Vdc, 500 to 1500 ppm)
    7. Relay: Normally open SPST (Default, close at 800 ppm)
    8. Space sensor guards: Unless noted otherwise, provide lockable cast aluminum guards for sensors located in the gymnasium, and cafeteria. Provide lockable clear plastic guards in all public areas.

3. Differential Pressure Sensors:

    1. Differential pressure switches shall be furnished as indicated for status purposes in air applications. Provide single pole single throw switch with fully adjustable differential pressure settings.
    2. Differential pressure transmitters shall be furnished as indicated for hydronic system control. Provide direct acting transmitters, with range suitable for system and proportional output 4 to 20 mA.

3. Equipment operation sensors as follows:

    1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 in. wc.
    2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
    3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

F. Static Pressure Sensors

    1. Sensor shall have linear output signal. Zero and span shall be field adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

G. Relays

1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

H. Transformers and Power Supplies:

1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
3. Unit shall operate between 0 C and 50 C.
4. Unit shall be UL recognized.

3. Current Switches:

3. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

J. Pressure Transducers:

1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

PART 3 – EXECUTION

3.1 EXAMINATION

3. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3. The controls contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

3. The controls contractor shall examine the drawings and specifications for other parts of the work.

If head room or space conditions appear inadequate, or if any discrepancies occur between the plans and the Contractor's work and the plans and the work of others, the control contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others.

3.2 PROTECTION

3. The controls contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.

3. The controls contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.3 COORDINATION

A. Site:

1. The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner, such as Mechanical Contractor, General Contractor, Construction Manager, Owner or Owner's representative as applicable.
2. The controls contractor shall follow prime contractor's job schedule and coordinate all project related activities through the prime contractor except otherwise agreed or in minor job site issues. Reasonable judgment shall be applied.
3. Where the work will be installed in close proximity to, or will interfere with, work of other trades, the controls contractor shall assist in working out space conditions to make a satisfactory adjustment.
4. If the controls contractor deviates from the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other trades, the controls contractor shall make the necessary changes to correct the condition without extra charge.
5. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals:

1. Refer to the "Submittals" paragraph in PART 1 of this Specification for requirements.

C. Test and Balance:

1. The controls contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
2. The controls contractor shall provide training in the use of these tools. This training will be planned for a minimum of 2 hours.

D. Coordination with controls specified in other Sections or Divisions of this Specification include controls and control devices that are to be part of or interfaced to the control system specified in this Section. These controls shall be integrated into the system and coordinated by the controls contractor as follows:

1. Each supplier of controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this Section.
2. The controls contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other Sections or Divisions of this Specification.
3. The controls contractor is responsible for providing all controls described in the Contract Documents regardless of where within the Contract Documents these controls are described.

E. The controls contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the Contract Documents.

3.4 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

A. Controls contractor shall have a 6 Sigma certified (or equivalent certification) quality manager on staff to inspect the project execution and to enforce quality standards.

B. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in PART 1 of this Specification.

C. Controls contractor shall continually monitor the field installation for code compliance and quality of workmanship.

D. Controls contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

3.6 WIRING

A. All control and interlock wiring shall comply with national and local electrical codes and Division

16 of this Specification. Where the requirements of this Section differ from those in Division 16, the requirements of this Section shall take precedence.

B. All NEC Class 1 (line voltage) wiring shall be UL-Listed in approved 3/4" conduit according to NEC and Division 16 requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub fused when required to meet Class 2 current limit.)

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL-Listed for the intended application. For example, cables used in ceiling plenums shall be UL-Listed specifically for that purpose.

E. All wiring in mechanical, electrical, or service rooms, or where subject to mechanical damage, shall be installed in conduit.

F. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

G. Do not install control wiring in conduit containing line voltage.

H. Where plenum-rated cable is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.

I. Where plenum-rated cable is used without conduit, it shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, piping, or ceiling suspension systems.

J. All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut.

K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers or interposing relays.

M. All plenum-rated wiring shall be installed as continuous lengths, with no splices permitted between termination points.

N. All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.

O. Maintain fire rating at all penetrations. Install plenum wiring in sleeves where it passes through walls and floors.

P. Size and type of conduit and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

Q. Include one pull string in each conduit 3/4 in. or larger.

R. Control and status relays are to be located in designated enclosures only. These enclosures can include packaged equipment control panel enclosures unless they also contain Class 1 starters.

S. Conceal all conduit, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).

T. Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

U. Adhere to this Specification's Division 16 requirements where conduit crosses building expansion joints.

V. The controls contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

W. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal conduit less than 1/2-inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

X. Conduit must be adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

A. The controls contractor shall adhere to the items listed in the "Wiring" paragraph in PART 3 of the Specification.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

C. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Controls contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

G. All runs of communication wiring shall be un-spliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 INSTALLATION OF SENSORS

A. General:

1. Install sensors in accordance with the manufacturer's recommendations.
2. Mount sensors rigidly and adequately for the environment within which the sensor operates.
3. Room temperature sensors shall be installed in existing junction boxes.
4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
5. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.

3.9 INSTRUMENTATION INSTALLED IN PIPING SYSTEMS

A. Actuators:

1. Electric/Electronic:

a. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.10 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic nameplates. Nameplates shall also include "Menchville High School, NNPS".

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors with nameplates.

F. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

3.11 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Point Naming standard shall be agreed upon between Owner and Controls Contractor. Refer to "Submittals" in PART 1.

C. Operator Interface:

1. Standard Graphics – Provide graphics for all mechanical systems and floor plans of the building. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points, such as setpoints.
2. Show Dashboard for all equipment on a "graphic" summary table. Provide dynamic information for each point shown.

3.12 CONTROL SYSTEM CHECKOUT AND TESTING

A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets that shall be submitted prior to acceptance testing. Commissioning work that requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the Owner and Construction Manager to ensure systems are available when needed. Notify the operating personnel, in writing, of the testing schedule so that authorized personnel from the Owner and Construction Manager are present throughout the commissioning procedure.

B. Phase I – Field I/O Calibration and Commissioning:

1. Verify that each control panel has been installed according to plans, specifications, and approved shop drawings. Calibrate, test, and have signed off each control sensor and device. Commissioning to include, but not be limited to:

a. Sensor accuracy at 10, 50 and 90% of range.
b. Sensor range.
c. Verify analog limit and binary alarm reporting.
d. Point value reporting.
e. Binary alarm and switch settings.
f. Actuator and positioner spring ranges if pneumatic actuation is utilized.
g. Fail safe operation on loss of control signal, pneumatic air, electric power, network communications, etc.

C. Phase II – System Commissioning:

1. Each DDC program shall be put online and commissioned. The controls contractor shall, in the presence of the Owner and Construction Manager, demonstrate each programmed sequence of operation and compare the results, in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and re-tested.

D. Phase III – Integrated System Program Commissioning:

1. Tests shall include, but not be limited to:

   a. Data communication, both normal and failure modes.
   b. Fully loaded system response time.
   c. Impact of component failures on system performance and system operation.
   d. Time/Date changes.
   e. End of month/end of year operation.
   f. Season changeover.
   g. Global application programs and point sharing.
   h. System backup and reloading.
   i. System status displays.
   j. Diagnostic functions.
   k. Power failure routines.
   l. Battery backup.
   m. Testing of all electrical and HVAC systems with other division of work.

2. Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracy and the system performance does not degrade over time.
3. Using the commissioning test data sheets, the controls contractor shall perform an audit comparison to confirm that all existing points have been integrated into the new Building Controller including but not limited to physical inputs and outputs, setpoints, alarm points, and virtual points. Controls contractor shall confirm that any and all slaved points residing on DDC controllers have been recreated in the new Building Controller.
4. The controls contractor shall supply all instruments for testing. Instruments shall be turned over to the Owner after acceptance testing.
5. All test instruments shall be submitted for approval prior to their use in commissioning.

   a. Test Instrument Accuracy:

      1) Temperature: 1/4°F or 1/2% full scale, whichever is less.
      2) Pressure: High Pressure (PSI): 1/2 PSI or 1/2% full scale, whichever is less.
      3) Low Pressure: 1/2% of full scale (in w.c.).
      4) Electrical: 1/4% full scale.

6. The controls contractor shall develop new user interface graphics for dynamic floor plans, dynamic HVAC unit schematics, dynamic central plant diagrams, lighting dashboard, HVAC dashboard, demand response dashboard, alarm console, zone schedules, and point trends.

3.13 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this Specification. These tests shall occur after the controls contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this Section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" paragraph in Section 3.12 of this Specification. The Engineer will be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in PART 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The controls contractor shall conduct a workstation only control point validation by searching for failed or erroneous values. Any and all failed or erroneous values shall be logged and reported to the Owner.
5. Demonstrate compliance with sequences of operation through all modes of operation.
6. Additionally, the following items shall be demonstrated:

    a. DDC control loop response: The controls contractor shall supply trend data output in a graphical form showing the step response of each DDC control loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
    b. Optimum start/stop: The controls contractor shall supply a trend data output showing the capability of the algorithm. The change-of value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
    c. Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Architect. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and electronic formats.

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

B. Acceptance:

1. All tests described in this Specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the controls contractor may be exempt from the completion requirements if stated as such, in writing, by the Engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in PART 1, "Submittals."

3.14 TRAINING:

A. The controls contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed. Factory employed/ certified instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 7:00 a.m. to 3:00 p.m. weekdays.

B. Provide a minimum combined 8 hours of on-site training / orientation session and classroom or on-line training session for personnel designated by the Owner. Coordinate training sessions with the owner.

3.15 EQUIPMENT COORDINATION.

A. The Prime contractor shall conduct an HVAC Coordination meeting after submission of the HVAC equipment, fire alarm, and controls submittals to the Engineer, and prior to the return of the reviewed controls submittal to the Prime Contractor. The Prime Contractor shall coordinate the meeting time, date, and location with all parties, provide a written agenda, provide written meeting minutes, and provide a detailed issues summary (if unresolved issues remain open after the meeting).

B. The Prime Contractor shall provide follow-up action as required with the following in mandatory attendance:

1. Prime Contractor Project Manager and Project Superintendent
2. Equipment manufacturer technical services representative (not a sales representative)
3. Controls contractor technical services representative (not a sales representative)
4. Mechanical engineer
5. Owner's representative
6. Fire alarm system representative

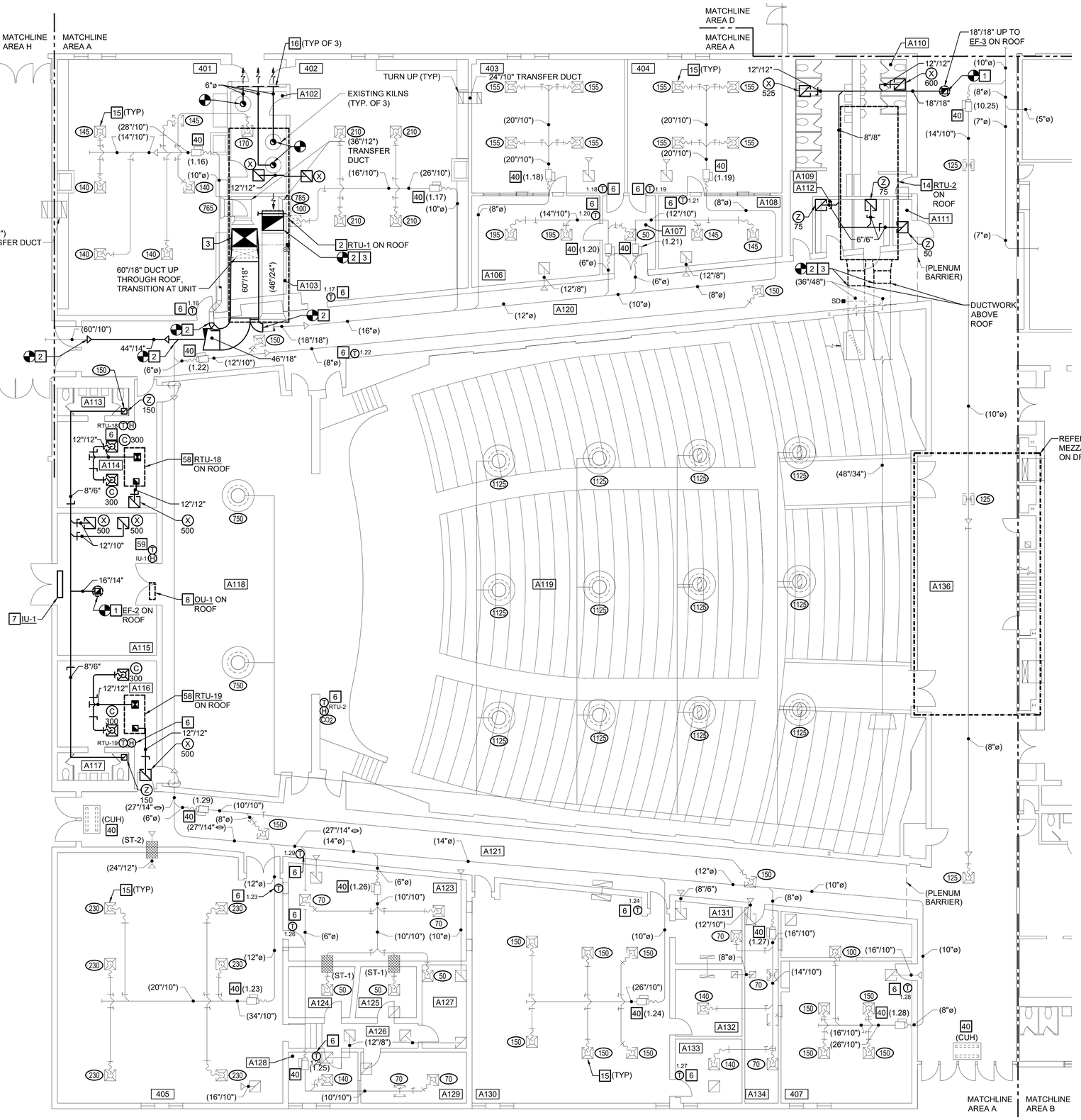
C. The purpose of this meeting is to review equipment, control sequences, and the selected manufacturer's available control points. Upon completion of this meeting, the General Contractor shall be required to submit a meeting report detailing all discussed issues and

coordinated solutions. Any unresolved issues shall require another mandatory meeting to ensure all items have been considered and coordinated prior to construction.

END OF SECTION 230900

APPENDIX A

EXISTING CONTROLS
RECORD DRAWINGS



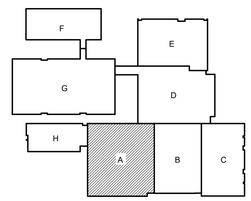
MECHANICAL FIRST FLOOR PLAN - AREA 'A' - NEW WORK

SCALE: 1/8" = 1'-0"

15 (XXX) BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.

40 TYPICAL ALL VAV'S

NEW WORK NOTES ☐	
NO.	DESCRIPTION
1	REFER TO "ROOF EXHAUST FAN DETAIL" ON DRAWING M-401.
2	MAKE CONNECTION TO EXISTING DUCTWORK AT POINT INDICATED. EXTEND DUCTWORK AS REQUIRED TO FACILITATE THE WORK.
3	MAKE DUCTWORK CONNECTION TO ROOFTOP UNIT USING FLEXIBLE CONNECTORS IN ACCORDANCE WITH SPECIFICATION 230100.
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
7	PROVIDE SPLIT SYSTEM INDOOR UNIT, CONDENSATE PUMP, SUPPORTS AND PIPING COMPLETE. MOUNT ABOVE DOOR WITH BOTTOM OF UNIT AT APPROXIMATELY 7'-4" AFF MINIMUM.
8	REFER TO "TYPICAL CONDENSING UNIT CURB DETAIL" ON DRAWING M-403.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
16	PROVIDE NEW 40" VENT-A-KILN SYSTEM MODEL "1544" WITH FAN, 5" FLEXIBLE EXHAUST DUCTWORK, OVERHEAD COUNTER-WEIGHT PULLEY SYSTEM, PLATE, CONTROLLER AND SWINGING WALL BRACKET ASSEMBLY FOR STAINLESS STEEL HOOD. ROUTE 5" FLEX TO 6" ROUND DUCT TO EXTERIOR WALL WITH SURFACE MOUNTED LOUVER WITH BIRDSCREEN.
2 40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.
58	REFER TO "ADAPTER CURB DETAIL" ON DRAWING M-402.
59	PROVIDE NEW WALL MOUNTED THERMOSTAT AND CONTROL WIRING.



KEY PLAN

NOT TO SCALE

1/8" = 1'-0"

SCALE 5' 0 5' 10' 15' 20' FEET

COMMONWEALTH OF VIRGINIA
KEVIN D. ALLEN
Lic. No. 023349
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MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
MECHANICAL FIRST FLOOR PLAN - AREA 'A' - NEW WORK

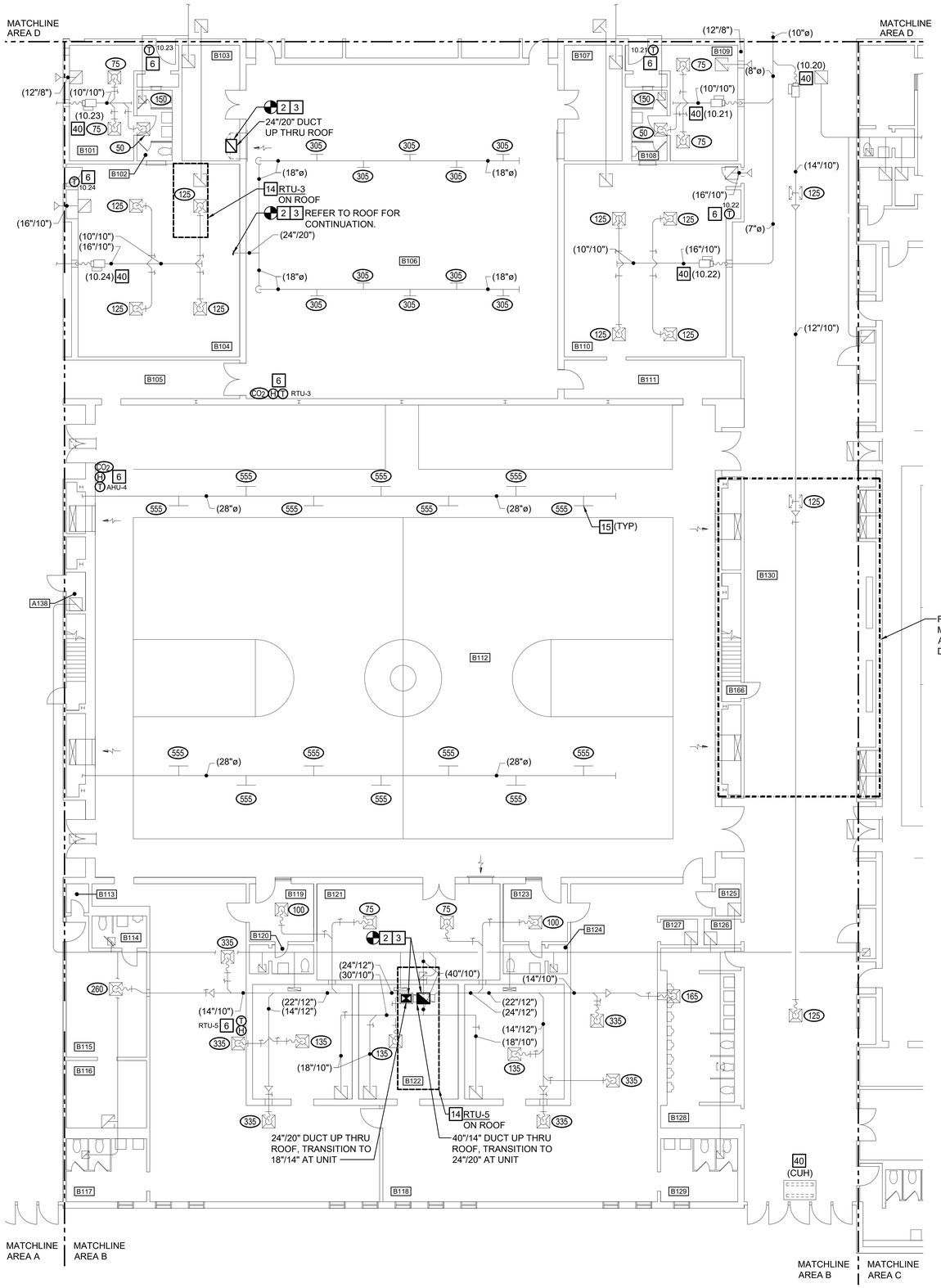
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-101

DATE: 09/08/2025



MECHANICAL FIRST FLOOR PLAN - AREA 'B' - NEW WORK

SCALE: 1/8" = 1'-0"

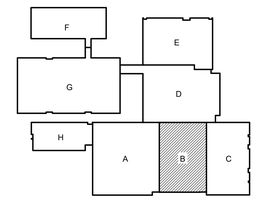
15 XXX BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.

40 TYPICAL ALL VAV'S

NEW WORK NOTES

NO.	DESCRIPTION
2	MAKE CONNECTION TO EXISTING DUCTWORK AT POINT INDICATED. EXTEND DUCTWORK AS REQUIRED TO FACILITATE THE WORK.
3	MAKE DUCTWORK CONNECTION TO ROOFTOP UNIT USING FLEXIBLE CONNECTORS IN ACCORDANCE WITH SPECIFICATION 230100.
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.

2



KEY PLAN

NOT TO SCALE

1/8" = 1'-0"

5' 0 5' 10' 15' 20'

SCALE FEET

COMMONWEALTH OF VIRGINIA
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MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
MECHANICAL FIRST FLOOR PLAN - AREA 'B' - NEW WORK

REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

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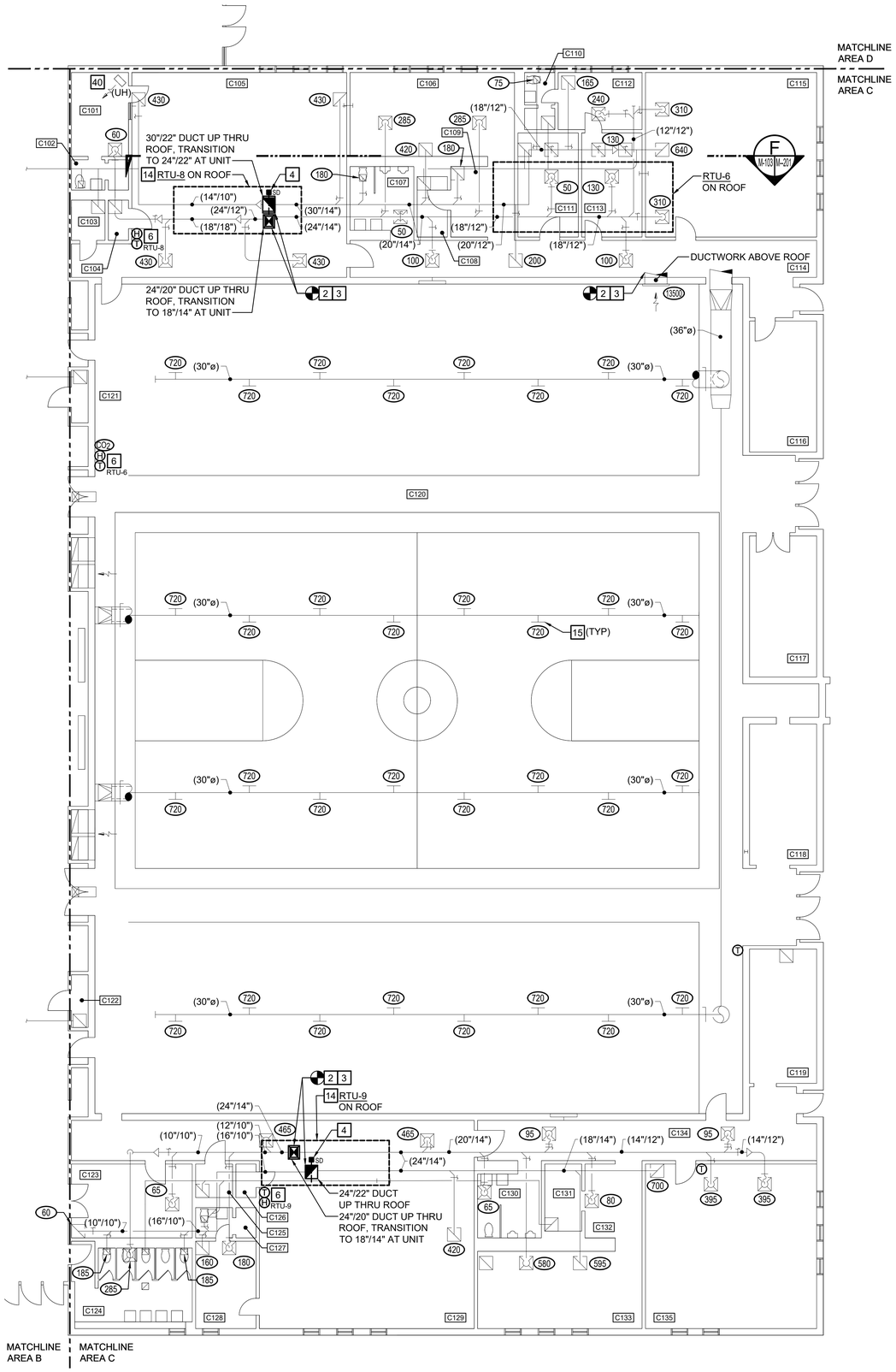
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-102

DATE: 09/08/2025



MECHANICAL FIRST FLOOR PLAN - AREA 'C' - NEW WORK

SCALE: 1/8" = 1'-0"

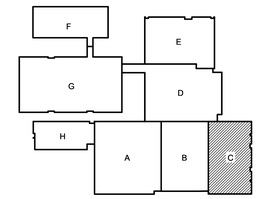
15 XXX BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.

40 TYPICAL ALL VAV'S

NEW WORK NOTES

NO.	DESCRIPTION
2	MAKE CONNECTION TO EXISTING DUCTWORK AT POINT INDICATED. EXTEND DUCTWORK AS REQUIRED TO FACILITATE THE WORK.
3	MAKE DUCTWORK CONNECTION TO ROOFTOP UNIT USING FLEXIBLE CONNECTORS IN ACCORDANCE WITH SPECIFICATION 230100.
4	REINSTALL DUCT DETECTOR SAVED FROM DEMOLITION. SMOKE DETECTOR SHALL BE INTERLOCKED WITH FIRE ALARM SYSTEM IN ACCORDANCE WITH THE SYSTEM SECTION 606.4.1 OF THE VIRGINIA MECHANICAL CODE. REFER TO DIVISION 26 FOR FURTHER INFORMATION.
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.

2



KEY PLAN

NOT TO SCALE

1/8" = 1'-0"

SCALE 5' 0 5' 10' 15' 20' FEET

COMMONWEALTH OF VIRGINIA
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TELEPHONE: (757) 599-4415 PROJECT NUMBER: 23-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT

NEWPORT NEWS, VIRGINIA

MECHANICAL FIRST FLOOR PLAN - AREA 'C' - NEW WORK

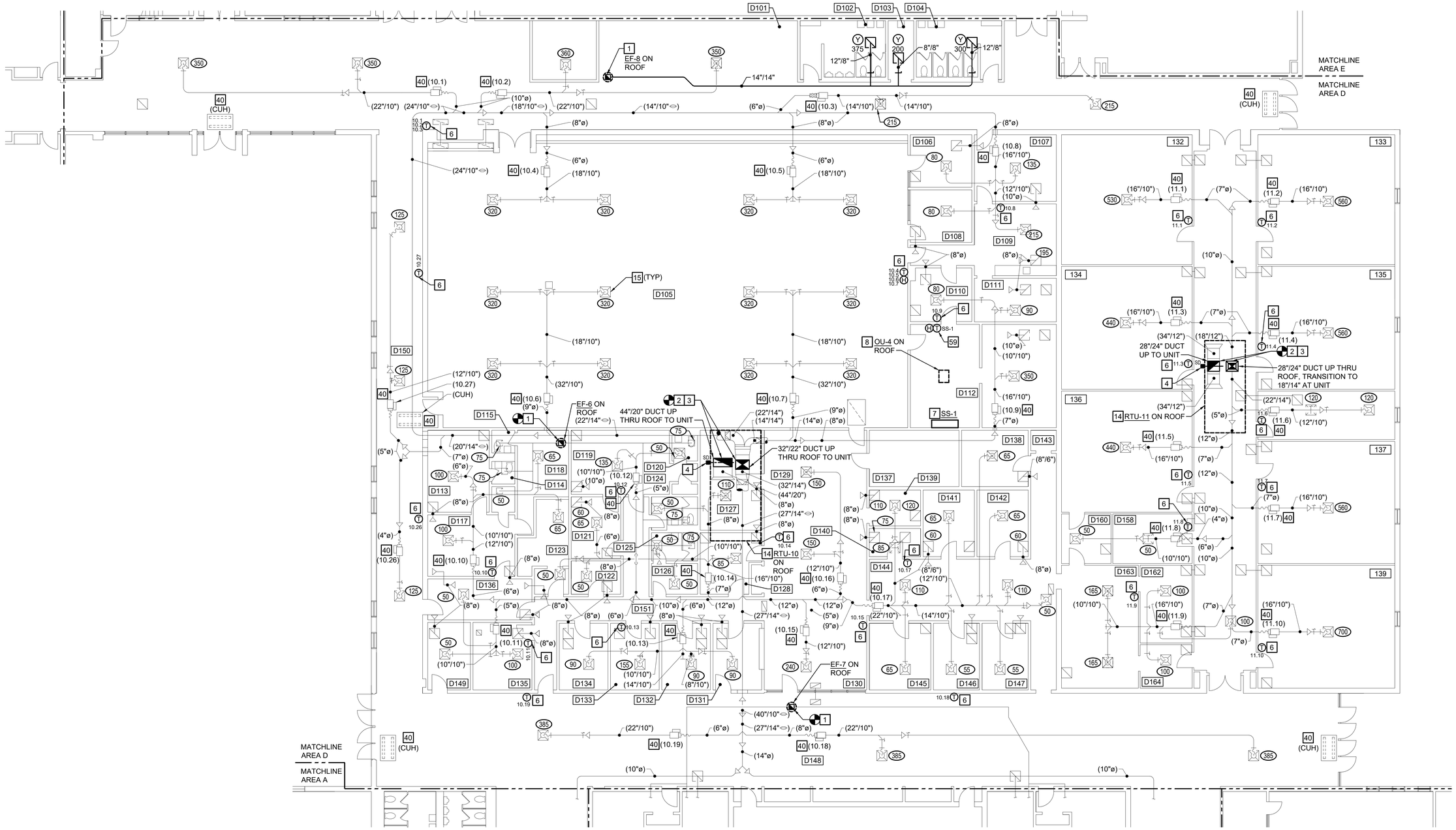
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-103

DATE: 09/08/2025



MECHANICAL FIRST FLOOR PLAN - AREA 'D' - NEW WORK

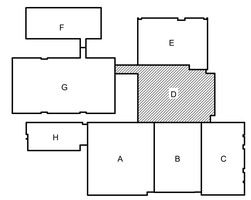
SCALE: 1/8" = 1'-0"

15 (XXX) BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.
40 TYPICAL ALL VAV'S

NEW WORK NOTES	
NO.	DESCRIPTION
1	REFER TO "ROOF EXHAUST FAN DETAIL" ON DRAWING M-401.
2	MAKE CONNECTION TO EXISTING DUCTWORK AT POINT INDICATED. EXTEND DUCTWORK AS REQUIRED TO FACILITATE THE WORK.
3	MAKE DUCTWORK CONNECTION TO ROOFTOP UNIT USING FLEXIBLE CONNECTORS IN ACCORDANCE WITH SPECIFICATION 230100.
4	REINSTALL DUCT DETECTOR SAVED FROM DEMOLITION. SMOKE DETECTOR SHALL BE INTERLOCKED WITH FIRE ALARM SYSTEM IN ACCORDANCE WITH THE SYSTEM SECTION 606.4.1 OF THE VIRGINIA MECHANICAL CODE. REFER TO DIVISION 26 FOR FURTHER INFORMATION.
6	PROVIDE NEW TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.

NEW WORK NOTES	
NO.	DESCRIPTION
7	PROVIDE SPLIT SYSTEM INDOOR UNIT, CONDENSATE PUMP, SUPPORTS AND PIPING COMPLETE. MOUNT ABOVE DOOR WITH BOTTOM OF UNIT AT APPROXIMATELY 7'-4" AFF MINIMUM.
8	REFER TO "TYPICAL CONDENSING UNIT CURB DETAIL" ON DRAWING M-403.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.
59	PROVIDE NEW WALL MOUNTED THERMOSTAT AND CONTROL WIRING.

2



KEY PLAN
NOT TO SCALE

1/8" = 1'-0"
5' 0 5' 10' 15' 20'
SCALE FEET

COMMONWEALTH OF VIRGINIA
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TELEPHONE: (757) 599-4415, VA BEACH, VA 23452
PROJECT NUMBER: 25-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
MECHANICAL FIRST FLOOR PLAN - AREA 'D' - NEW WORK

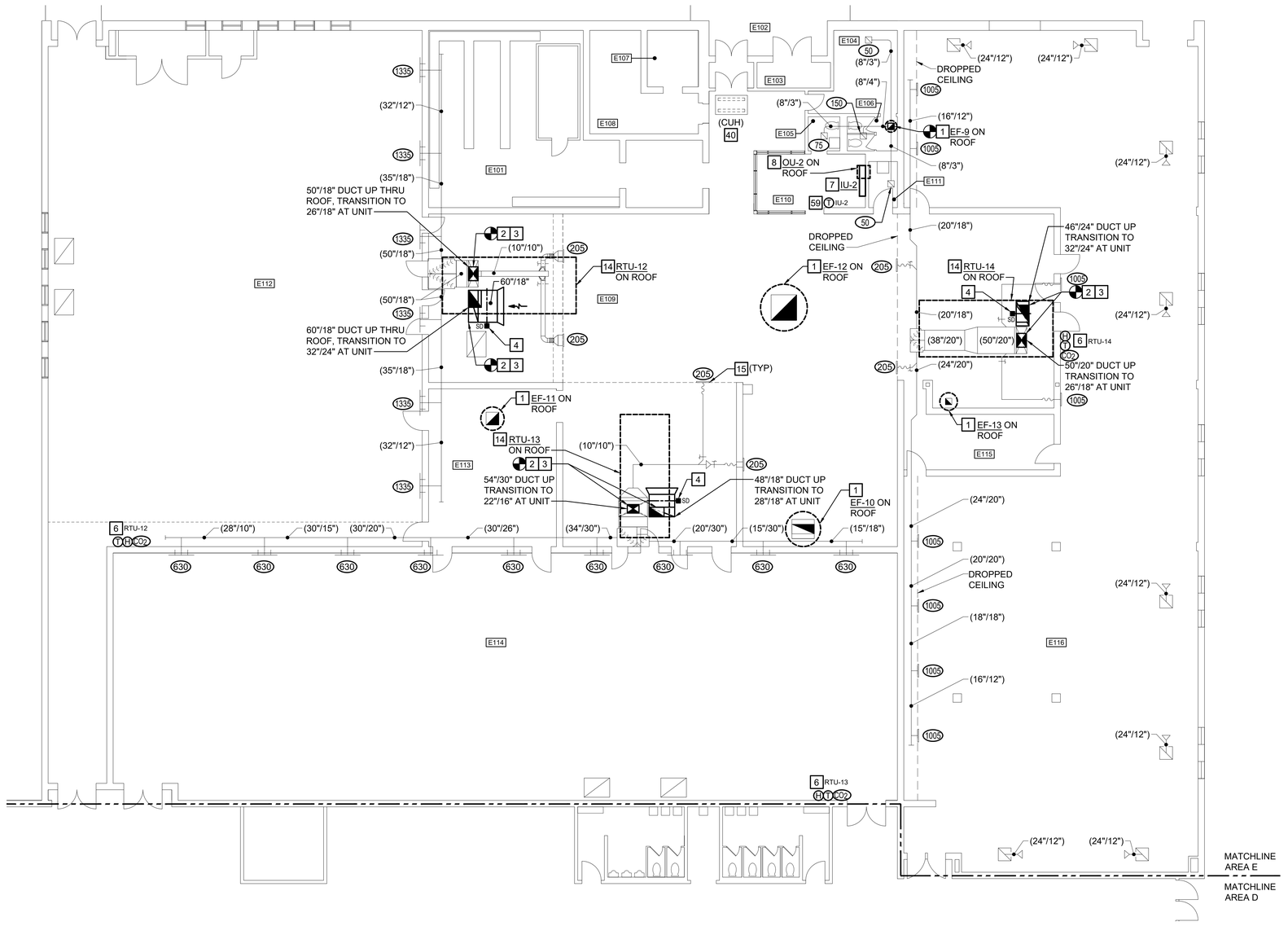
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-104

DATE: 09/08/2025

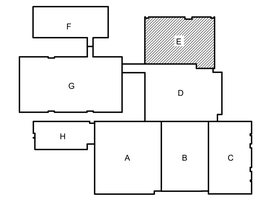


MECHANICAL FIRST FLOOR PLAN - AREA 'E' - NEW WORK

SCALE: 1/8" = 1'-0"

15 XXX BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.
40 TYPICAL ALL VAV'S

NEW WORK NOTES ☐	
NO.	DESCRIPTION
1	REFER TO "ROOF EXHAUST FAN DETAIL" ON DRAWING M-401.
2	MAKE CONNECTION TO EXISTING DUCTWORK AT POINT INDICATED. EXTEND DUCTWORK AS REQUIRED TO FACILITATE THE WORK.
3	MAKE DUCTWORK CONNECTION TO ROOFTOP UNIT USING FLEXIBLE CONNECTORS IN ACCORDANCE WITH SPECIFICATION 230100.
4	REINSTALL DUCT DETECTOR SAVED FROM DEMOLITION. SMOKE DETECTOR SHALL BE INTERLOCKED WITH FIRE ALARM SYSTEM IN ACCORDANCE WITH THE SYSTEM SECTION 606.4.1 OF THE VIRGINIA MECHANICAL CODE. REFER TO DIVISION 26 FOR FURTHER INFORMATION.
6	PROVIDE NEW TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
7	PROVIDE SPLIT SYSTEM INDOOR UNIT, CONDENSATE PUMP, SUPPORTS AND PIPING COMPLETE. MOUNT BOTTOM OF UNIT AT APPROXIMATELY 7'-4" AFF MINIMUM.
8	REFER TO "TYPICAL CONDENSING UNIT CURB DETAIL" ON DRAWING M-403.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
2 40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.
59	PROVIDE NEW WALL MOUNTED THERMOSTAT AND CONTROL WIRING.



KEY PLAN
NOT TO SCALE

1/8" = 1'-0"
5' 0 5' 10' 15' 20'
SCALE FEET

COMMONWEALTH OF VIRGINIA
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09-08-2025
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PROJECT NUMBER: 25-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
MECHANICAL FIRST FLOOR PLAN - AREA 'E' - NEW WORK

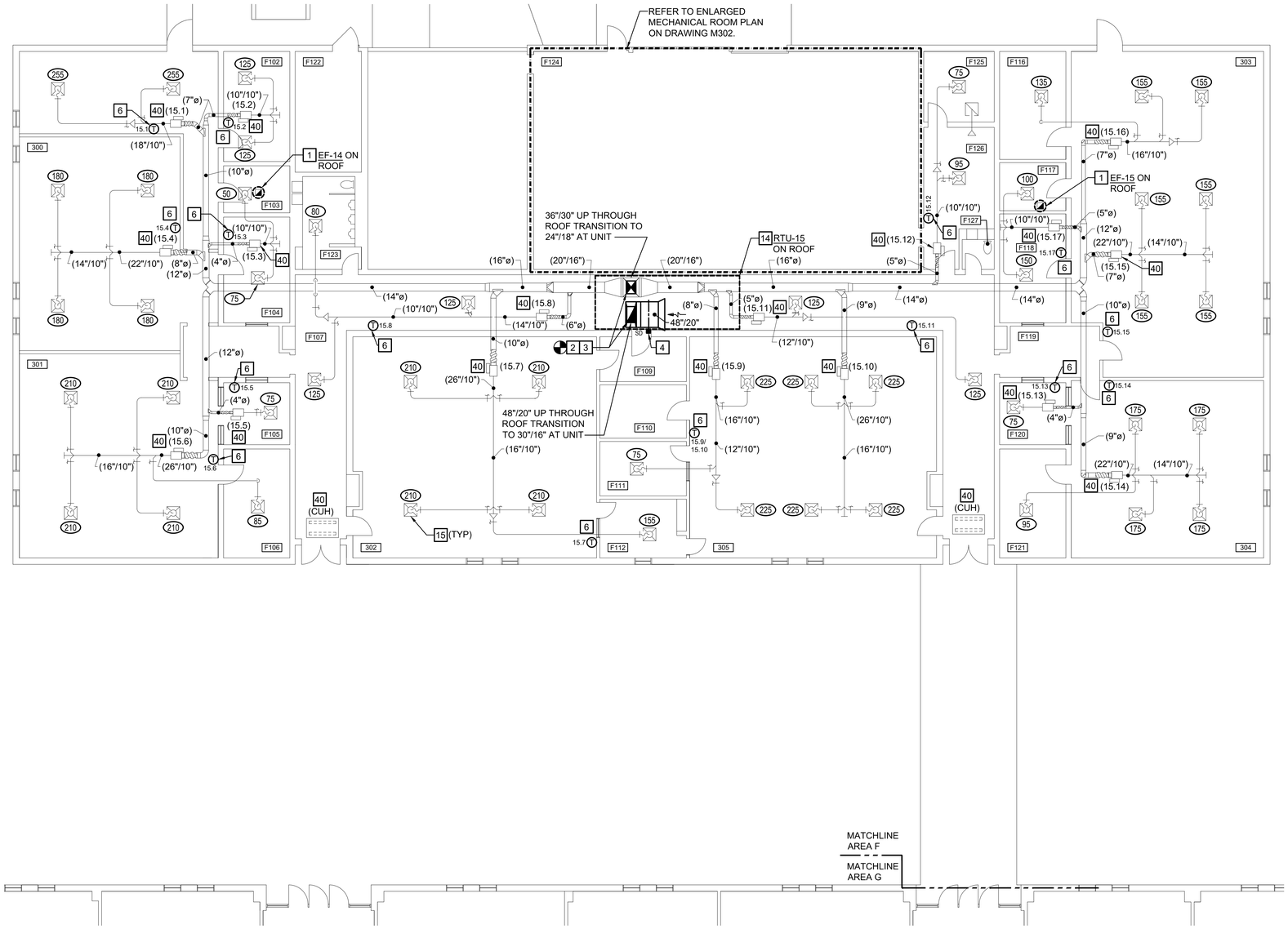
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-105

DATE: 09/08/2025



MECHANICAL FIRST FLOOR PLAN - AREA 'F' - NEW WORK

SCALE: 1/8" = 1'-0"

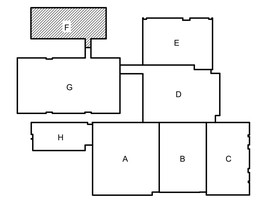
15 XXX BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.

40 TYPICAL ALL VAV'S

NEW WORK NOTES

NO.	DESCRIPTION
1	REFER TO "ROOF EXHAUST FAN DETAIL" ON DRAWING M-401.
2	MAKE CONNECTION TO EXISTING DUCTWORK AT POINT INDICATED. EXTEND DUCTWORK AS REQUIRED TO FACILITATE THE WORK.
3	MAKE DUCTWORK CONNECTION TO ROOFTOP UNIT USING FLEXIBLE CONNECTORS IN ACCORDANCE WITH SPECIFICATION 230100.
4	REINSTALL DUCT DETECTOR SAVED FROM DEMOLITION. SMOKE DETECTOR SHALL BE INTERLOCKED WITH FIRE ALARM SYSTEM IN ACCORDANCE WITH THE SYSTEM SECTION 606.4.1 OF THE VIRGINIA MECHANICAL CODE. REFER TO DIVISION 26 FOR FURTHER INFORMATION.
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.

2



KEY PLAN

NOT TO SCALE

1/8" = 1'-0"

5' 0 5' 10' 15' 20'

SCALE FEET

COMMONWEALTH OF VIRGINIA
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MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT

NEWPORT NEWS, VIRGINIA

MECHANICAL FIRST FLOOR PLAN - AREA 'F' - NEW WORK

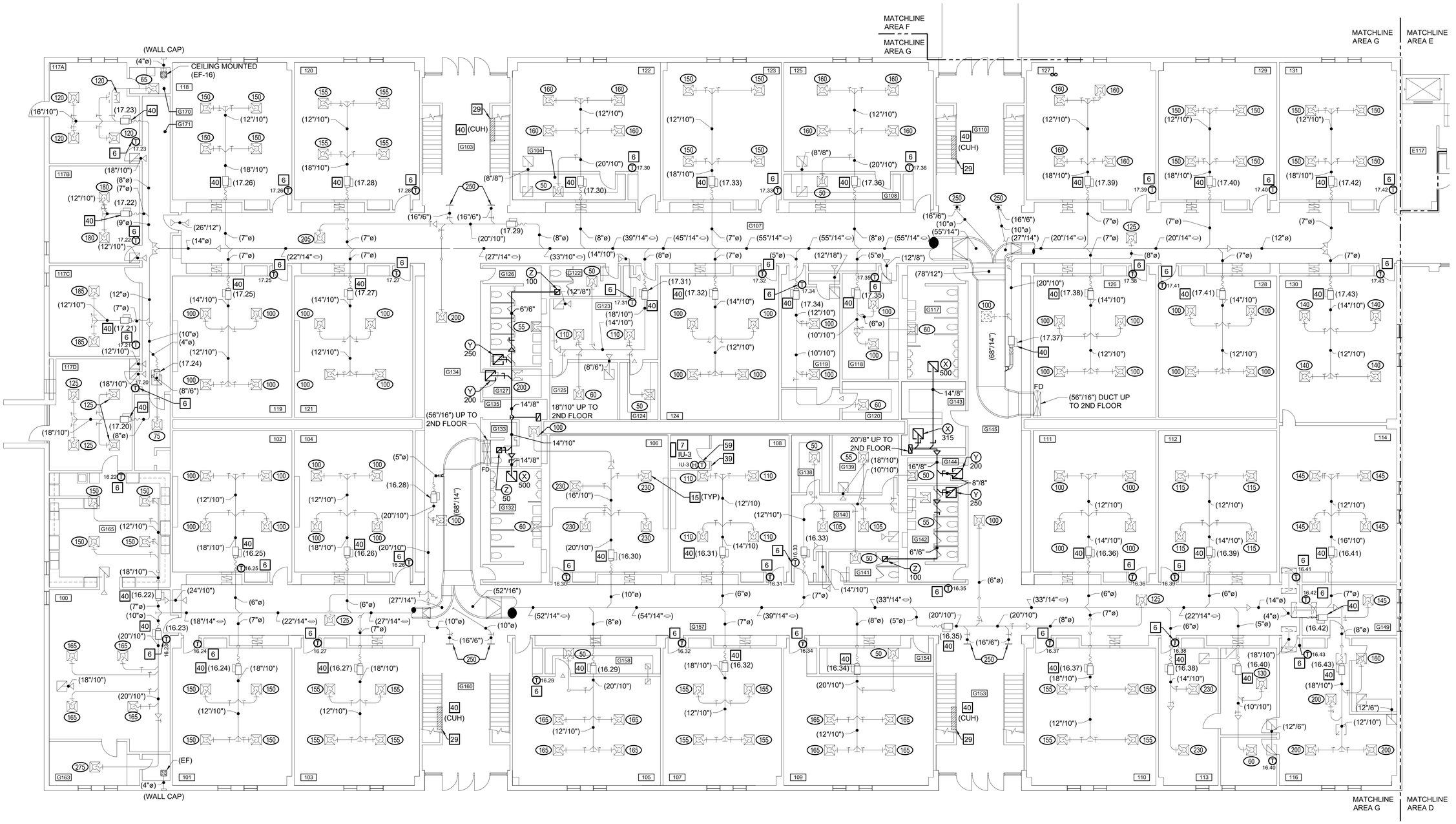
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-106

DATE: 09/08/2025



MECHANICAL FIRST FLOOR PLAN - AREA 'G' - NEW WORK

SCALE: 1/8" = 1'-0"

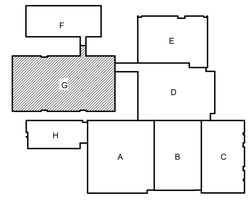
NEW WORK NOTES	
NO.	DESCRIPTION
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
7	PROVIDE SPLIT SYSTEM INDOOR UNIT, CONDENSATE PUMP, SUPPORTS AND PIPING COMPLETE. MOUNT ABOVE DOOR WITH BOTTOM OF UNIT AT APPROXIMATELY 7'-4" AFF MINIMUM.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
29	CONTRACTOR SHALL TEMPORARILY REMOVE ALL WALL-MOUNTED CABINET UNIT HEATERS TO BE PROPERLY RE-MOUNTED. CONTRACTOR SHALL PROVIDE ALL MANUFACTURER'S MOUNTING BRACKETS, ANCHORS, SCREWS, BOLTS, OR OTHER HARDWARE AS REQUIRED TO SECURELY FASTEN EQUIPMENT TO WALL.
39	CONTRACTOR SHALL EXTEND TOP OF WALL TO CEILING TO CREATE AN ENCLOSED SPACE FOR THE RACKS.

NEW WORK NOTES	
NO.	DESCRIPTION
40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.
59	PROVIDE NEW WALL MOUNTED THERMOSTAT AND CONTROL WIRING.

2

15 (XXX) BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.

40 TYPICAL ALL VAV'S



KEY PLAN

NOT TO SCALE

1/8" = 1'-0"

5' 0 5' 10' 15' 20'

SCALE FEET

COMMONWEALTH OF VIRGINIA
KEVIN D. ALLEN
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PROJECT NUMBER: 23-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT

NEWPORT NEWS, VIRGINIA

MECHANICAL FIRST FLOOR PLAN - AREA 'G' - NEW WORK

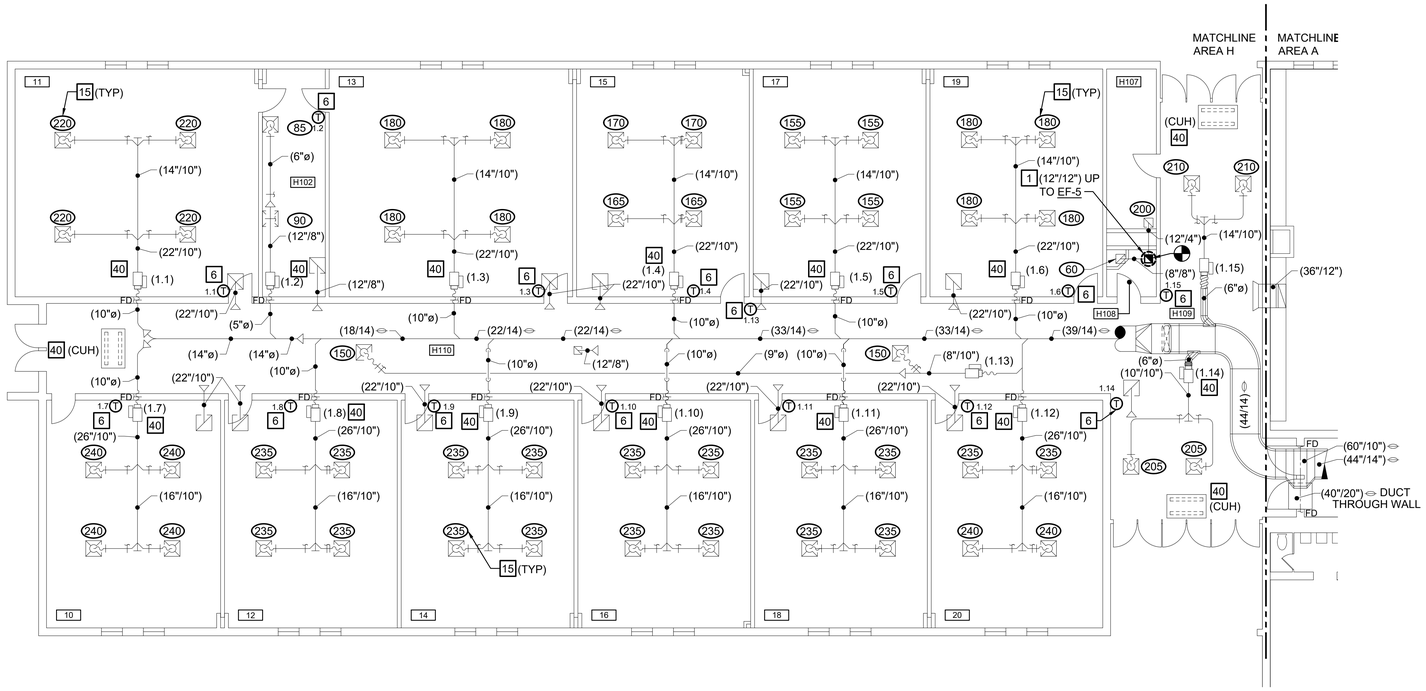
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-107

DATE: 09/08/2025



MECHANICAL FIRST FLOOR PLAN - AREA 'H' - NEW WORK

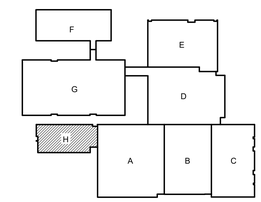
SCALE: 1/8" = 1'-0"

15 (XXX) BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.

40 TYPICAL ALL VAV'S

NEW WORK NOTES ☐	
NO.	DESCRIPTION
1	REFER TO "ROOF EXHAUST FAN DETAIL" ON DRAWING M-401.
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.

2



KEY PLAN

NOT TO SCALE

1/8" = 1'-0"

SCALE 5' 0 5' 10' 15' 20' FEET

COMMONWEALTH OF VIRGINIA
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VA BEACH, VA 23452
PROJECT NUMBER: 23-065

MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT

NEWPORT NEWS, VIRGINIA

MECHANICAL FIRST FLOOR PLAN - AREA 'H' - NEW WORK

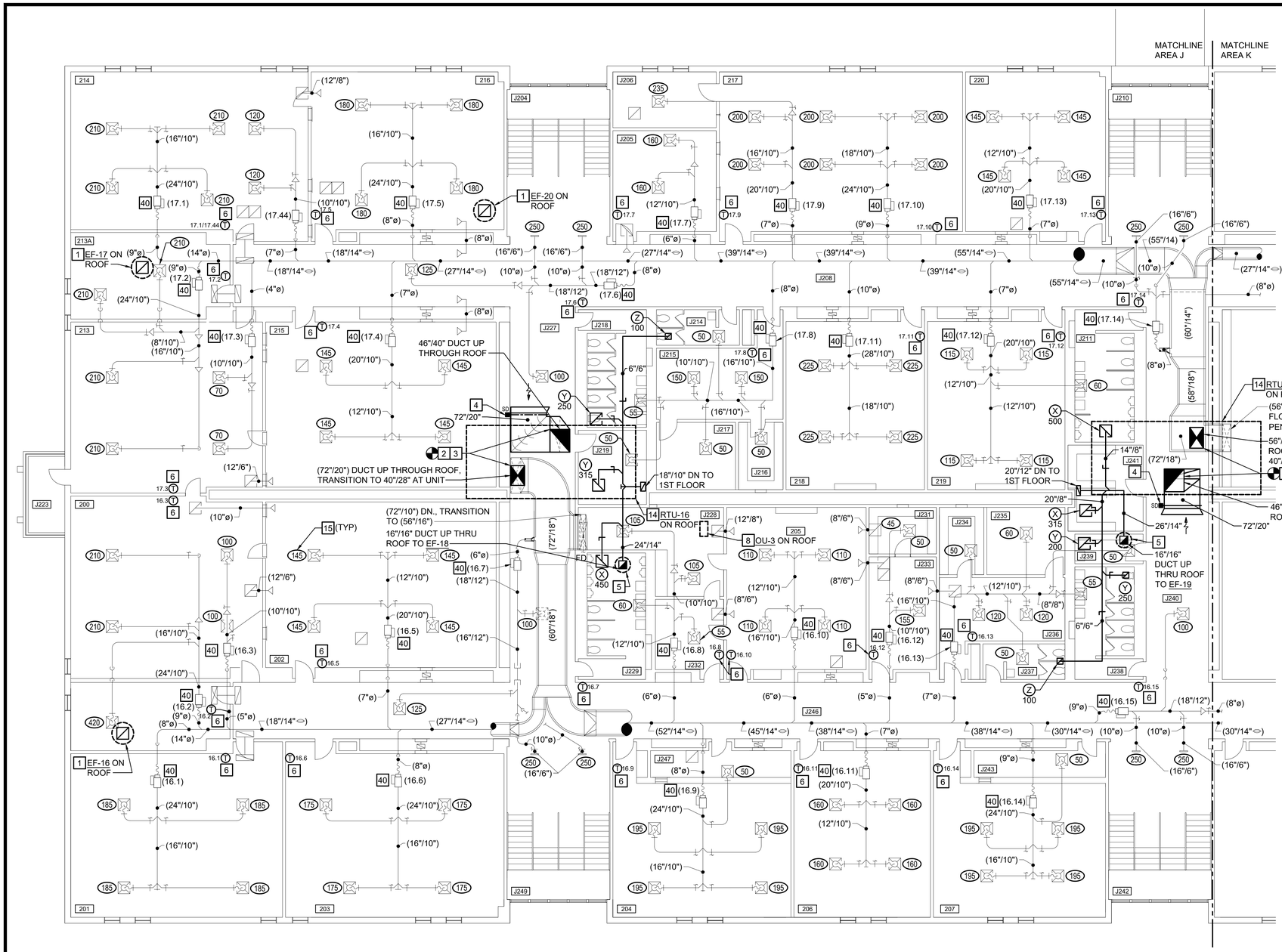
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-108

DATE: 09/08/2025



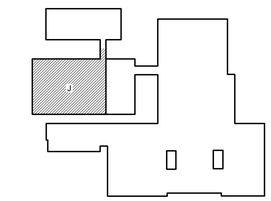
MECHANICAL SECOND FLOOR PLAN - AREA 'J' - NEW WORK

SCALE: 1/8" = 1'-0"

15 (XXX) BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.
40 TYPICAL ALL VAV'S

NOTE: EXISTING CONDITIONS ILLUSTRATED HAVE BEEN DETERMINED FROM ORIGINAL CONSTRUCTION DOCUMENTS AND LIMITED NON-INVASIVE FIELD INVESTIGATION. THE CONTRACTOR SHALL INVESTIGATE FIELD CONDITIONS PRIOR TO COMMENCEMENT OF WORK, COORDINATE AND MAKE ADJUSTMENTS AS NECESSARY.

NEW WORK NOTES	
NO.	DESCRIPTION
1	REFER TO "ROOF EXHAUST FAN DETAIL" ON DRAWING M-401.
2	MAKE CONNECTION TO EXISTING DUCTWORK AT POINT INDICATED. EXTEND DUCTWORK AS REQUIRED TO FACILITATE THE WORK.
3	MAKE DUCTWORK CONNECTION TO ROOFTOP UNIT USING FLEXIBLE CONNECTORS IN ACCORDANCE WITH SPECIFICATION 230100.
4	REINSTALL DUCT DETECTOR SAVED FROM DEMOLITION. SMOKE DETECTOR SHALL BE INTERLOCKED WITH FIRE ALARM SYSTEM IN ACCORDANCE WITH THE SYSTEM SECTION 606.4.1 OF THE VIRGINIA MECHANICAL CODE. REFER TO DIVISION 26 FOR FURTHER INFORMATION.
5	PROVIDE DUCTWORK, HANGERS, AND SUPPORTS COMPLETE TO POINT INDICATED. PROVIDE NEW GRILLE AS SCHEDULED.
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
8	REFER TO "TYPICAL CONDENSING UNIT CURB DETAIL" ON DRAWING M-403.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
2 40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.



KEY PLAN
NOT TO SCALE

1/8" = 1'-0"
5' 0 5' 10' 15' 20'
SCALE FEET

COMMONWEALTH OF VIRGINIA
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MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT
NEWPORT NEWS, VIRGINIA
MECHANICAL SECOND FLOOR PLAN - AREA 'J' - NEW WORK

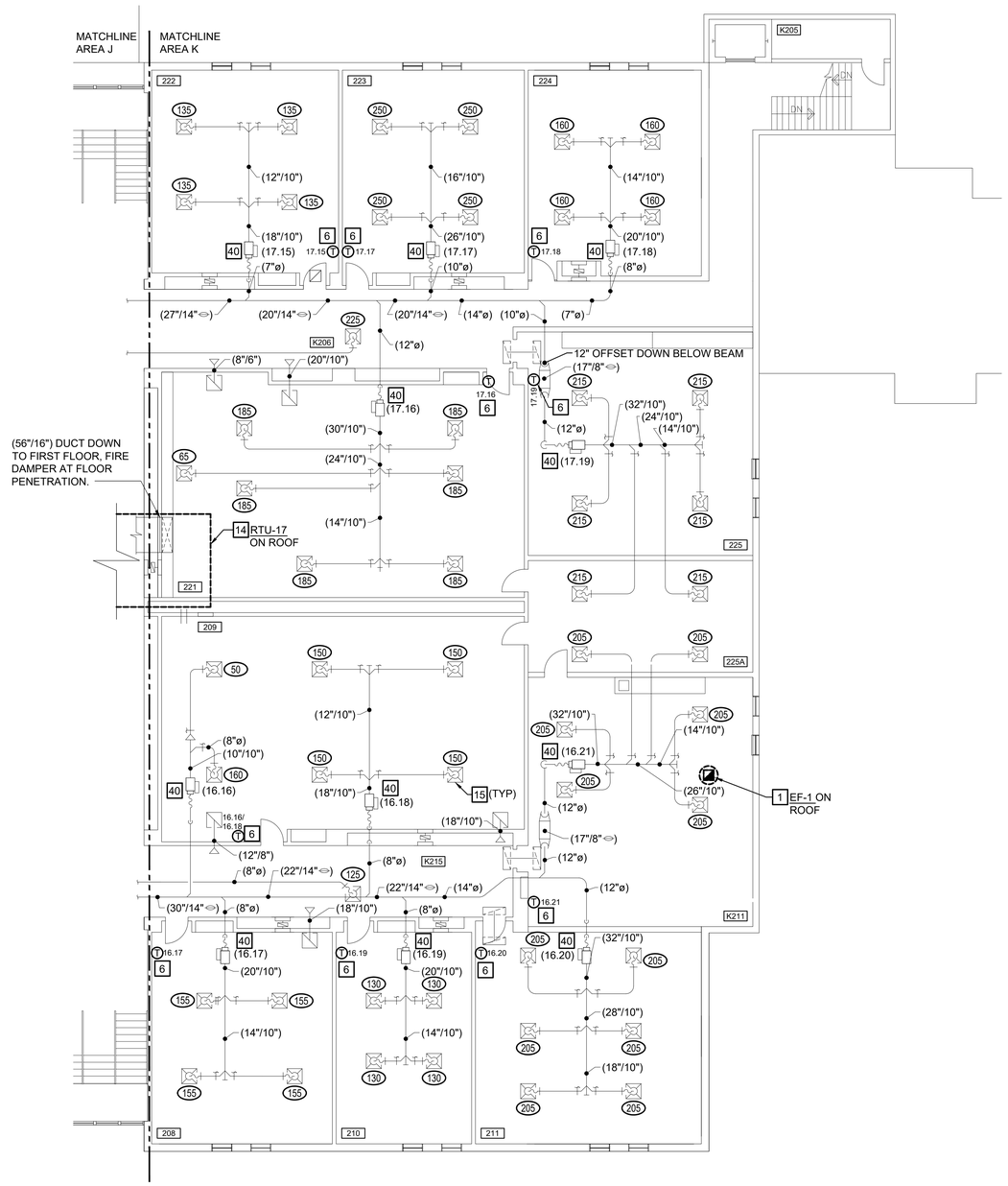
REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-109

DATE: 09/08/2025



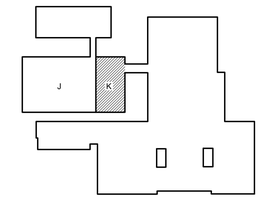
MECHANICAL SECOND FLOOR PLAN - AREA 'K' - NEW WORK

SCALE: 1/8" = 1'-0"

15 (XXX) BALANCE EXISTING AIR TERMINAL TO CFM INDICATED.

40 TYPICAL ALL VAV'S

NEW WORK NOTES ☐	
NO.	DESCRIPTION
1	REFER TO "ROOF EXHAUST FAN DETAIL" ON DRAWING M-401.
6	PROVIDE NEW MONITORING TEMPERATURE/HUMIDITY SENSOR AND CONTROL WIRING.
14	REFER TO "ROOFTOP UNIT SUPPORT AND VIBRATION DETAIL" ON DRAWING M-402.
15	REBALANCE EXISTING DIFFUSER TO CFM INDICATED.
2 40	PROVIDE NEW HONEYWELL "OPTIMIZER T1L" CONTROLLER COMPATIBLE WITH BUILDING AUTOMATION SYSTEM AND CONTROL VALVE ON ALL LEGACY CONTROLLERS. REFER TO CONTROL DRAWING FOR FURTHER INFORMATION.



KEY PLAN
NOT TO SCALE

1/8" = 1'-0"

5' 0 5' 10' 15' 20'
SCALE FEET

COMMONWEALTH OF VIRGINIA
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MENCHVILLE HIGH SCHOOL
HVAC SYSTEM REPLACEMENT

NEWPORT NEWS, VIRGINIA

MECHANICAL SECOND FLOOR PLAN - AREA 'K' - NEW WORK

REVISIONS

MARK	DESCRIPTION	DATE
2	ADDENDUM #2	09/26/2025

COMM. NO: 23-065
DESIGNED BY: SDH
DRAWN BY: JAR
CHECKED BY: KDA

M-110

DATE: 09/08/2025