Hartsfield-Jackson Atlanta International Airport

City of Atlanta

Department of Aviation

Office of Infrastructure Planning & Development

Airport Facilities Landside/ Airside New Construction and Modifications

Design Standards

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Design Standards

Mechanical Engineering

1.0 Purpose

A. The purpose of this document is to outline the minimum design standards and installation requirements for mechanical systems (HVAC, plumbing and fire protection), which are installed to serve various spaces through the Central Passenger Terminal Complex (CPTC) at Hartsfield-Jackson Atlanta International Airport (H-JAIA or "Airport").

2.0 Codes and Standards

A. All construction documents shall be by professional engineers registered in the discipline specific to the trade work indicated on the contract drawings.

B. All governing codes and standards indicated in the trade sections of this document will be adhered to by the designers of record for all new construction and renovation projects initiated on any facility inside the bounds of H-JAIA or under the jurisdiction of DOA.

C. A&E firms shall design to the most current codes adopted by the City of Atlanta and State of Georgia. Code conflicts shall be resolved by using the more stringent applicable code. Notify DOA-P&D of any substantive discrepancies between various codes or with any of these standards.

D. Applicable Codes (Building Codes and regulations as adopted by the State of Georgia with amendments)

1. International Plumbing Code (With Amendments)
2. International Building Code (With Amendments)
3. International Fuel Gas Code (With Amendments)
4. International Mechanical Code (With Amendments)
5. International Energy Conservation Code
6. National Fire Protection Association (NFPA) Codes
7. NFPA 70 National Electrical Code
8. NFPA 90A Standard for the Installation of Air Conditioning and Ventilation Systems
9. NFPA 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems
10. NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
11. NFPA 101 Life Safety Code
12. NFPA 13 Standard for the installation of Sprinkler Systems
13. NFPA 14 Standpipe and hose systems
14. NFPA 20 Installation of stationary pumps
15. Standard Building Code

E. Standards

1. AATC Building Automation Systems Standard -- Version 2.0
2. ANSI American National Standards Institute

3. ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality
4. ASHRAE 90.1 Energy Standard for Buildings
5. ASME American Society of Mechanical Engineers
6. National Green Building Standards
7. Bureau of Watershed, Grease Interceptor design

3.0 General Drawing Requirements

A. Drawing layouts shall be neat, orderly and complete, showing all information required to convey the scope of work to general contractors or reviewing entities. Drawings will be prepared under the supervision of a Georgia state licensed professional engineer and shall bear his/her seal.

B. Mechanical plans, (HVAC, Plumbing, and Fire Protection) shall be consistent with the Architectural plans (e.g., same scale, match lines, common graphic standards) as the base set of documents. Part plans for mechanical equipment rooms, restrooms, kitchens and all rooms shall be provided where the density of support equipment prohibits clear documentation of the systems serving the space at the architectural base scale.

C. Provide all necessary drawing conventions to aid in the easy identification and location of spaces within the CPTC, Items shall include, but not be limited to project north indicators, column lines and call outs, room identification (rm number and/or function/name as space allows)

4.0 Trade Specific Drawing Requirements:

A. HVAC

1. Show all primary and secondary ductwork and major HHW/CHW piping using double line graphic standards. HVAC plan drawings shall be 1/8” or larger.
2. Provide sections as required to show inter-trade coordination in space restricted areas (i.e. ceiling plenums, mechanical chases, baggage handling areas, etc.)
3. Provide mechanical enlarged part plans as required to show equipment, ductwork, and piping in mechanical rooms. Enlarged plans shall be ¼" scale.
4. Provide riser diagrams for CHW, HHW, outside air, and exhaust air as required.
5. Provide HVAC installation details, as required, for major equipment and devices that have complex installation requirements.
6. Provide schedules for all HVAC equipment
7. Provide air flow balance summations for space (or building) as required to indicate/validate positive pressure relationship between critical building components.
8. Provide Control schematic diagrams for all equipment tied to DDC system or under stand-alone control. Provide I/O summary and written sequence of operation on drawings.
9. Provide HVAC calculations (Bldg. load, OA requirement, pump, fan, air flow balance, etc.) for review.
10. Provide specifications using standard division nomenclature with all sections required to describe all equipment and all construction methods utilized.
11. See Table 1 for Operating Parameters.

B. PLUMBING

1. Large scale plumbing plans shall be 1/16” scale plans. Coordinate with DOA if the project requires the use of a different scale. Use 1/8” scale plans (as a minimum) for all restrooms and food service areas.
2. Piping systems shall be shown on the plan background that corresponds to the level on which the piping is to be installed. (i.e- sanitary piping that serves a boarding level FD will show up on the apron level plan in the ceiling plenum)
    a. Backgrounds should clearly indicate where designated electrical rooms, communications rooms control rooms and IT (MDF/IDF) rooms are located. Piping should not route thru theses rooms. If piping must run thru theses spaces, show major equipment in the room(s) and indicate provisions to protect and critical equipment below.
    b. EOR must coordinate pipe routing with other major systems that support ramp services. Show systems like baggage handling conveyors and carousels, tug lanes, electrical gear and any item that needs O&M clearance to operate on plans and indicate provisions for maintenance.
3. Provide riser diagrams for all sanitary waste and vent, grease waste, domestic water systems, and natural gas systems.
4. Provide schedules for all major plumbing devices including but not limited to, water heaters, pumps, air compressors, etc. Example:
    a. Plumbing Fixture Schedule with Mark, description, pipe connection sizes, manufacturer, model number and description as a minimum.
    b. Water Heater Schedule with location, make and model number, gallons, number of elements Voltage and delivery temperature.
    c. Pump Schedule with Mark, manufacturer, model number electrical, RPMGPM, Head Description as a minimum.
    d. Drain Schedule with mark, manufacturer, model number, and description as a minimum.
    e. Equipment schedule, Mark description, manufacturer, model number, description, etc.
5. Indicate clearly locations and line sizes of all connections to existing systems. (coordinate with civil drawings and DOA master utility locations)
6. Provide detail sheets with detail that are edited for the specific project.
7. Indicate rainfall rate used for design and indicate roof square footage for each roof drain and pipe.
8. Calculations (Fire Protection)
    a. Provide Hydraulic calculations on all major designs and renovations.
9. Specifications using standard division nomenclature with all sections required to describe all equipment and all construction methods utilized.
10. Demolition Drawings
    a. Provide demo drawings as shown on architectural drawings. (Size, scale, area)
    b. Show existing utilities that are being demoed.
    c. Provide scope for provision to connect in future or remove abandoned piping.

C. FIRE PROTECTION

1. Provide design criteria drawings, 1/8” scale or larger with existing and new sprinkler head locations, lights and diffusers (for coordination), Hazard classification, including density and remote square footage and location of same for all spaces within a design.
2. Provide piping layout plans for major renovation projects and new construction.
3. Provide specifications including but not limited to, piping, sprinkler heads, equipment, ETC. Provide specifications using standard (xxx) division nomenclature with all sections required to describe all equipment and all construction methods utilized.
4. Provide hydraulic calculations with shop drawings done by a certified fire protection system designer. Sprinkler shop drawings and as-built drawings are to be submitted to DOA in an approved format.
5. Provide fully coordinated RCP’s showing sprinkler head locations and types. RCPs shall show ceiling types, light and diffuser locations for coordination.
6. Calculations

5.0 Primary Utilities Overview

A. Central Plant Configuration

1. The majority of the CPTC is served by two Central Utility Plants (CUP’s). The T-CUP plant is located at the east end of the Main Passenger Terminal on the Apron level between the center spine roads. The E-CUP plant is located at the west end of E concourse on the Pedestrian Mall (Plane-Train) level next to the Bombardier train maintenance shop.
2. Chilled Water (CHW) and Heating Hot Water (HHW) are distributed thru a traditional four pipe system. Because of environmental requirements we are not allowed to operate boilers during summer months (approx. May- September). As an energy savings measure, we shut down the chilled water system based on OA temp. (typically when OA temp falls below 60 degrees. Neither CUP has water side economization. EOR’s should consider the CUP’s as functioning as 2-pipe systems with the exception of limited periods during shoulder seasons when OA temperatures dictate the energization both chillers and boilers.

B. CHW Distribution

1. The CHW system is a Primary/Zoned Pumping system. With a cross connection that allows concourses loads (specifically C& D CON’s) to be feed from either CUP. T-CUP serves the North & South Terminal, the Atrium and CON’s T-D. The piping system in the main utility tunnel was originally designed to serve A-D Concourses from T-CUP and Concourses E & F from E-CUP. The cross connection is valved and sized to allow both C&D CON’s (as a pair) to be fed from either CUP.
2. Primary Pumps circulate CHW thru the chillers within the CUP. Primary Pumps are paired with the chillers and sized to pump the chiller and charge the main loop. Each plant typically has at least N+1 redundancy for major equipment.
3. Zone Pumps are located within each concourses’ individual pump room and are sized to circulate CHW thru the tunnel the full distance back to the CUP, for CON’s T-D. Main Terminal pumps are in T-CUP. Concourse E&F zone pumps are in E-CUP. There are typically 2 zone pumps per concourse sized at 50% of full load. (note: DOA usually requires the selection each zone pump to handle 60-

70% of full load by riding the curve) Consult with P&D whenever a Concourse addition adds a significant amount of load to the CHW system, as pump replacement will need to be evaluated by the EOR

C. HHW Distribution

1. The HHW system is a Primary/Secondary/Tertiary Pumping system. T-CUP serves the North & South Terminal and CON's T-D while HHW for Concourses E & F are served from E-CUP
2. Primary Pumps circulate HHW thru the boilers within the CUPs. Primary Pumps are paired with the boilers and sized to pump the boiler and charge the main loop. Each plant typically has at least N+1 redundancy for major equipment
3. Secondary Pumps are typically located in the CUPs and are sized to circulate HHW thru the facility loop
4. Tertiary Pumps are located within each concourses' individual pump room and are sized to circulate HHW thru the concourse, for CON's T-D. The pumps that serve the various Main Terminal tertiary loops are located in the T-CUP. Concourse E&F Tertiary pumps are in E-CUP. There are either 2 or 3 Tertiary pumps per concourse. For Concourses with 2 pumps each pump is sized at 100% of full load. For Concourses with 3 pumps, each pump is sized for 50% of full load flow. Consult with P&D whenever a Concourse addition adds a significant amount of load to the HHW system, as pump replacement will need to be evaluated

D. Domestic Water Configuration

1. Water is supplied from Hapeville and College Park. The airport is looped with water mains.
2. Each concourse is fed with one domestic water and a combination domestic and fire service.
3. The water pressure is at or above 80PSI and requires a PRV.

E. Sanitary Sewer Configuration

1. Sanitary sewers run North and South toward the center point
2. Each concourse has 4" and 6" laterals connecting the concourse waste to the mains.
3. Grease Waste from large food and Beverage areas require Grease Waste, (GW), to discharge into one or two 1,500-gallon underground grease interceptors or a 1,500 or a 3,000 gallon above-ground grease interceptor.

F. Natural Gas Distribution

1. Natural Gas is supplied by Atlanta Gas Light.
2. Gas piping is routed underground between the taxi way and the NLVR with a branch off to the south side of each concourse.
3. Piping is regulated to 5PSI or higher on the roof
4. Gas piping for Concourse E and F is routed inside each building and on the roof
5. Gas piping for T-CUP is fed from the 6" gas main on the roof of Concourse-T.
6. The Food & Beverage Concessions service to each space is metered

G. Fire Protection Configuration

1. Each concourse is equipped with a 750 GPM fire pump and jockey pump.

2. Each fire pump room is equipped with a double check valve assembly, alarm check valves, (Dry or wet), controllers, test headers, Fire and Jockey pumps, fire department connections, distribution piping and a fire hydrant in the area.
3. There are Fire Valve Rooms on the Apron Level with FDC and alarm valves, (Wet or Dry).
4. The existing sprinkler system is designed at a minimum design density of Ordinary Hazard Group I. (Any new systems are to be designed at a minimum of Ordinary Hazard Group I)
5. Critical Rooms and MDF rooms are to be protected with clean agent fire suppression systems.
6. Areas that are subject to freezing are protected with a dry sprinkler system or NFPA approved Heat Trace and insulation.
7. Parking Structures are protected with a manual dry standpipe system, and with wet sprinklers in any office areas.

6.0 Space Specific System Descriptions (HVAC)

A. Large CPTC Public Spaces HVAC

1. Spaces which fall under this heading are free of interior partitions, relatively large volumes which can either be interior zones or combination interior/exterior zones with the provision that both thermal and air diffusion through the space is relatively uniform and unencumbered. Spaces which generally fall under this category include (but are not limited to) Terminal ticketing and baggage claim areas, Large Terminal Atria, Public seating & Circulation areas, TSA and Concession Cue areas
2. Large CPTC Public spaces are to be served by medium and low pressure VAV Roof Mounted units RMU's (or RTU's) wherever possible. VAV indoor AHUs can be used as an alternate, when practical, provided a clean source for OA can be routed to the interior mechanical room. Sufficient space for 100% economizer and relief air must also be provided. Separated ductwork and motorized damper for minimum and economizer outside air shall be provided. Outside air and return air in mechanical rooms shall be ducted to AHUs.
3. Provide Single Zone VAV RMU's or AHUs for these large-open volume public spaces which have relatively uniform heating and cooling load distributions. These AHUs/RMU's will utilize chilled and hot water from the central plant water loops.
4. Distribution ductwork in these spaces need to ensure very good air circulation to minimize the chance of hot or cold spots.

B. Zoned CPTC Public Spaces HVAC

1. Spaces which fall under this heading are located adjacent to each other but have varying load profiles due to external heat gains, or differences in internal space utilization. Spaces which generally fall under this category include (but are not limited to) Concourse main circulation corridors, Hold Rooms, smaller Concourse Atria, Food Courts, and Concession, Tenant Cue areas, General Office and Back of House spaces.
2. Zoned CPTC Public spaces are to be served by medium and low pressure VAV Rooftop RTUs (RMU's) wherever possible. VAV indoor AHUs can be used as an alternate, when practical, provided a clean source for OA can be routed to the interior mechanical room. Sufficient space for economizer and relief air must also

be provided.

3. Provide VAV AHUs/RMU's for these spaces. These AHUs/RMU's will utilize chilled and hot water from the central water loops. Provide VAV terminal units with hydronic heating.
4. Use of Fan powered terminal units/powered induction units (PIUs) is discouraged in the CPTC base systems. Coordinate with DOA/AATC to receive prior approval before using PIUs in any special applications.

C. Computer Rooms

1. AIS has several server rooms located throughout the facility. Main server rooms utilize dedicated "Leibert Type" CRU's. The main train control server rooms are conditioned with similar CRU's.
2. In the future, on a case-by-case basis, we will have different types of equipment based on the critical nature of the equipment being cooled.
3. Typical systems run from DX cooling split systems or package thru-wall systems up to chilled water or air-cooled computer room units. Special care must be used for rooms conditioned from the base building system as the central plant is de-energized when the OA temp. is below 60 degrees F.

D. Transformer, Substation & Switchgear Room

At a minimum**,** provide ventilation as the load dictates, eight (8) to ten (10) air changes per hour is considered minimum ventilation for typical CPTC applications. Base building air conditioning can be used in lieu of ventilation where existing RTU's/ AHU's have sufficient AC spare capacity to all rooms, GA Power separate. No plumbing shall be run through these rooms whenever possible. If plumbing routing through the room is unavoidable, provisions shall be made to protect equipment from water. If plumbing routing through the room is unavoidable, provisions shall be made to protect equipment from water.

E. Apron Level Support Areas

1. Areas with heavy tug traffic that is exposed to outside air, (under the terminal) need to provide exhaust and fresh air (cross-ventilation) fan systems. Heated ventilating units may be required if large amounts of un-tempered outside air are needed to ventilate a given Apron level space.
2. In locations where baggage handling operators are located for extended periods of time, (i.e. make up stations) provide supplemental heating systems (typically, radiant heat) for operator comfort.

F. Communication Closets

1. Type of AC is dependent on location and critical nature of application. If base building AC is available, it is acceptable to use a dedicated VAV terminal unit.
2. If the application is critical, a backup fan may be required to provide ventilation in case of a system failure.
3. Where Base Building AC is not available, (typical on Apron level), provide DX unit or split system AC systems.
4. In critical spaces, two DX units or back up fan ventilation systems may be required.
5. Water source heat pump tied into domestic water system is not allowed under any circumstances.
6. AGT Level Communication Rooms: Due to the location of these communication rooms, heat rejection is problematic. Use DX split systems to condition space

Reject heat into the closest AGT Mechanical Room, only if a path to the apron level cannot be created.

G. Restrooms

1. Public Restrooms will be directly exhausted to the exterior of the building. Provide heating and cooling VAV terminal units to condition the space. Provide transfer air duct systems to allow make-up air into any restroom if required.
2. Back of House Restrooms will be directly exhausted to the exterior of the building. Provide heating and cooling VAV terminal units to condition the space as required. Provide transfer air duct systems, or door grilles, to allow make-up air into any restroom.

H. Hold Bag Screening Facilities

1. Screening Rooms: These spaces are where the large CTX automated baggage screening systems are located along with the associated baggage handling conveyer systems. These spaces are considered critical application spaces, with high heat output equipment.
2. These spaces are to be served by medium and low-pressure single zone AHUs. Provide a clean source for OA to the mechanical room. Sufficient space for economizer and relief air must also be provided.
3. Provide Single Zone VAV AHUs for these large-open volume spaces which have relatively uniform cooling load distributions. These AHUs will utilize chilled and hot water from the central water loops. Provide hot water pre-heat coils for freeze protection as required.

I. Spaces requiring Major Equipment Replacement

1. When a space requires a straight one for one replacement of a major piece of equipment, the EOR shall, at a minimum, be sure to coordinate the following:
   a. Current manufacturers can provide the same features as the original manufacturer.
   b. Equipment dimensions can be made to work in the existing space allocated for the original equipment.
   c. Existing structure can accommodate the new equipment weight.

7.0 Space Specific System Descriptions (Plumbing)

Water Service rooms for new development shall be sized to accommodate all required assets.

A. Infrastructure consists of domestic water supplied from the city water system at a pressure of 60 to 70 pounds. There is a sanitary sewer system at each concourse and terminals. There is natural gas supplied on the roof of concourse T, A, C, D, and inside E and F. Gas is routed to concourse B but not installed on the roof. The natural gas is for limited use mainly for cooking by concession with a separate meter. T CUP gas is supplied from piping routed from the south end of concourse t on the roof to the center point. E CUP gas is supplied from piping in the tunnel between concourse E and F.

B. Restrooms

1. Public restrooms shall be ADA accessible with touch free metering low flow fixtures (Per IPC).
2. All public restrooms shall have floor drains in each fixture area.

3. All accessible toilet chases will have floor drains.
4. All public restroom areas will be equipped with a janitor closet with an electric water heater with mixing valve, floor drain and a mop sink as a minimum.

C. Back of House Restrooms

1. Restrooms shall be ADA accessible with low flow fixtures (per IPC)
2. Restrooms shall have floor drains.

D. Back of House Break Rooms

1. Break rooms with sinks can use storage heaters or instant electric water heaters
2. If cooking is required or a dishwasher is required, a grease trap or interceptor may be required.

E. Apron Level Support Areas

1. If cooking is required or a dishwasher is required a grease trap or interceptor may be required.

F. Parking decks

1. Storm Drainage, Top Level and exterior ramps shall be designed per IPC Rainfall Criteria for City of Atlanta.
2. Lower levels are to be designed for minimum run-off from cars and blowing rain.
3. Elevator Penthouse and stair towers roofs are to be designed with primary, and overflow drains or scuppers.
4. Parking deck entrance will be designed to capture runoff from cars only unless exterior grade requires more rainfall rate.
5. Drainage and pipe calculations shall be noted on each deck drain and trench drain on top level, (Square footage, area and GPM), will be noted on each deck drain and trench drain on top level, all vertical and horizontal piping along with pipe size.
6. Domestic Water, (If required), entrance will be in heated space in a secure box or with heat trace and insulation, shut-off valve and drain. Hose bibbs will be equipped with a vacuum breaker. Maximum flow of 10GPM unless approved by DOA.

8.0 Space Specific Systems Descriptions (Fire Protection)

A. Infrastructure, Fire protection is supplied by a fire pump or pumps and jockey pump or pumps on each concourse and terminals. Dry pipe systems or heat trace and insulation are provided where fire protection is subject to freezing.

B. Design Criteria, all areas in the CPTC are to be designed to Ordinary Hazard Group I as a minimum.

C. Accessible toilet chases will have sprinklers.

D. Large CPTC Public spaces and zoned CPTC public spaces, including restrooms shall have All sprinkler heads be concealed type with color to match ceiling cover.

E. Back of House Areas Back of house areas will be protected with concealed heads or semi-recessed where lay-in ceiling is installed. Areas without ceiling will be protected with upright heads.

F. Freeze Protection Exposed Apron level spaces

1. Areas subject to freezing will be dry pipe system or be heat traced and insulated.

G. MDF/T-3 Das – Clean Agent Fire Protection System

1. MDF/T-3 DAS and other critical computer rooms will be protected with a Clean Agent Fire Suppression System.

9.0 HVAC Materials and Equipment

A. Roof-Mounted Air Handling Units (RMU)

1. Roof-Mounted air handling units shall be custom built and sized to meet the cooling, heating and ventilation needs of the spaces it will serve. The requirements are application specific and will be coordinated with P&D-E during the validation and /or early (30%) design phase. Typical features include:
2. RMU's shall be all aluminum construction including unit base rails.
3. RMU's shall include (as required by application) chilled water-cooling coil section, hot water pre- heat coil section, supply fan, mixing section with dampers, Return section, discharge section and access sections between coils and between filters. RMU's shall have interior access corridor (min 54" clear width). Outside air dampers shall be split into a section for minimum requirements and a section for economizer outside air. Minimum outside air sections shall be configured to allow MFG required installation and proper operation of the flow meter at all velocities.
4. Camfil Merv 14 high flow bag filters, 30% efficient pre-filters.
5. Provide UV light assemblies as a means of coil sterilization
6. Provide relief fan section for odor and (nonlife safety) smoke purge to be used after a fie event occurs on a given concourse.
7. Where required by extensive return air duct runs, units shall be provided with return fans and relief dampers.
8. Where possible RMU's will utilize fan array assemblies to increase reliability.
9. Provide variable frequency drives on all VAV RMU's, mounted inside the unit. Provide redundant variable frequency drives on all critical RMU's,
10. Interior lights and service receptacles shall be wired to a junction box for single-point 120-volt feed that can be powered when the main unit components is de-energized.

B. Interior Modular Air Handling Units (AHU)

1. Interior air handling units shall be modular, double-wall units and shall include (as required by application):
   - chilled water-cooling coil, hot water pre-heat coil,
   - Camfil Merv 14 high flow bag filters, 30% efficient pre-filters.
   - Provide UV light assemblies as a means of coil sterilization
   - Utilize Fan array or centrifugal supply fan, depending on unit size.
   - Mixing box section with dampers and interior lights.
   - Where required by extensive return air duct runs, units shall be provided with. return fans and relief dampers.
   - Variable air volume units shall be provided with variable frequency drive.
   - Interior lights and service receptacles shall be wired to a junction box for single-point 120-volt feed.
   - AHU shall be able to operate in 100% outside air economizer mode.

2. Outside air intake location shall be analyzed for requirement of including carbon filtration. Dedicated OA injection fan may be required to ensure minimum required OA is achieved if OA route pressure drop is larger than 0.75” W. C.’1.

C. Variable Air Volume Boxes (VAV)

1. VAV Boxes shall be single-duct terminal unit complete with modulating damper, airflow measuring sensor, and internally insulated casing. Reheat boxes shall be provided with hot water reheat coils. DDC controls and damper actuator will be provided by Controls contractor.

2. Power wiring for damper actuators shall be provided for in design.

10.0 Ductwork

A. Ductwork shall be galvanized steel sheet metal designed and constructed per SMACNA duct construction standards. Fiberboard duct is not permitted. Main duct trunks shall be located over common areas or corridors whenever possible. Balancing dampers shall be provided at proper locations to allow balancing of systems. Provide turning vanes to help system balance and minimize effect.

a. Flex duct run outs to diffusers shall not be longer than 6 feet. Flex duct shall not be used in exhaust systems.

b. Coordinate RCP to ensure access to all devices located above hard ceilings.

B. Duct Insulation

1. Duct insulation for supply air, return air, and outside air ducts above ceilings shall be fiberglass blanket wrap, 2” thick, 1.5 lb./cu.ft. density with a factory-applied FSK vapor barrier. Insulation thermal conductivity at 75^0F shall be 0.27 BTU-in./hr./sq.ft./^{0}F. On rectangular ducts 24 inches wide and larger, apply stick pins and washers on 18-inch centers on bottom side of duct.

2. Duct insulation for supply air, return air, and outside air ducts in exposed unconditioned spaces shall be rigid fiberglass board insulation, 2.5” thick, 3 lb./cu.ft. density with factory-applied FSK vapor barrier.

3. All insulation R-values shall meet the current energy code requirements.

C. Air Distribution Devices

1. Air distribution devices selected shall match the style of devices in existing areas and in new facilities. Devices shall be provided with dampers and shall be selected based on throw and noise criteria. Linear slot diffusers shall be used at large glass areas on exterior walls.

D. Controls

1. Controls for all new equipment installations and renovation of old systems shall be DDC and shall be fully BACnet IP compatible. Systems shall connect and be fully integrated with the existing Niagara system frontend. Maintained and operated by AATC. Graphics shall be seamlessly integrated into the Niagara front end for end user ease of use.

2. Multizone AHU programming shall comply with Multizone Standard Sequence (see appendix A). Single zone AHU programming shall comply with Single Zone Standard Sequence (see appendix B). Terminal Units shall comply with Terminal Unit Standard Sequence (see appendix C).

3. The BACnet points required for the BMS shall be configured, exposed, and viewable from the base building BMS front end and comply with the BMS Points. Standard List for naming conventions and descriptions (see appendix D).

4. Zone temperature thermostats shall be networked type sensors, communicating on either the SA or BACnet bus.

E. Test and Balance

1. All HVAC systems shall be tested and balanced upon completion of installation. The TAB services shall be performed by an AABC-certified contractor.

F. Utility Piping

1. Chilled Water and Heating Hot Water pipe shall be ASTM A-53 Grade B pipe carbon steel. Piping 2-1/2” and smaller shall be threaded and coupled with 150 lb. threaded fittings. Piping 3" and larger shall be plain end pipe with 150 lb. butt-welded fittings. *Welded or threaded fittings shall be used on all CHW & HHW piping in the following locations:*
    - *CUP’s*
    - *Utility tunnels*
    - *Ceiling plenums or chases that will be difficult to access*. Coordinate with DOA to evaluate accessibility thresholds.

2. Other piping materials and joining methods are allowed outside of these three specific areas as indicated below:
    a. Type L hard-drawn copper with solder joint fittings may be used for piping 2 - 1/2” and smaller. (This is typically for HHW distribution piping to TU’s and possibly on CHW & HHW in mechanical rooms)
    b. Mechanical joining systems pressed joint & grooved-joint systems may be used in mechanical spaces, (AHU rooms, RMU Piping vestibules, etc) exterior or exposed spaces and on distribution piping where reasonable access is assured.
    c. Mechanical joint systems may be used for piping 2 ½” thru 8”. Couplings 2 ½” through 8” to be of installation-ready design (requiring no disassembly to install)
    d. Gaskets for mechanical joint systems on hydronic services shall be EPDM. The gasket material shall be suitable for the fluid service type and temperature.
    e. Quality assurance- The EOR shall coordinate their specification with the mechanical joint manufacturer to ensure the performance of the system meets the products intended use. A factory-trained representative (direct-employee of the MFG) shall periodically visit the job site and review installation. The mechanical joint manufacturer will train the mechanical contractor’s field and fabrication shop installers in accordance with proper piping practices and manufacturer’s recommended installation methods. Mechanical Subcontractor shall use only manufacturer’s approved mechanical joining tools, equipment and methodology for all piping installed in a system.
    f. Mechanical Subcontractor shall use the same mechanical joining method for all piping installed in a system.
    g. Provide adequate valving to ensure major runs of mechanically joined piping can be isolated. *At a minimum, provide isolation valves on all CHW & HHW piping mains (regardless of joining method-welding included) where these systems cross a building expansion joint*.

h. Piping headers shall be routed over corridors or common areas for access where possible. Route piping as to not impede access to existing or new equipment that may be installed above. Minimize piping runs over escalator wells and other spaces that cannot be accessed from a standard scissor lift.

i. Cooling coil condensate will be routed to sanitary system (floor sinks, hub drains or mop sinks). Condensate piping shall be type L copper.

j. Refrigerant piping shall not be assembled using any mechanical pipe joining methods.

k. Pipe insulation shall be rigid fiberglass pipe insulation with all-service jacket vapor barrier. Piping located outside and in unconditioned areas (typically found on ramp, apron, baggage and train levels) shall be closed cell covered with aluminum jacketing.

l. New piping shall be thoroughly cleaned and flushed before placing into service.

m. Avoid routing CHW/HHW piping in electrical and MDF-IDF rooms. No mechanical joints on any piping that must run thru critical IT and electrical rooms

n. Labeling: Provide color coded labeling with directional arrows for all CHW & HHW piping

11.0 Plumbing Materials and Equipment

A. Sanitary, Storm and Kitchen Waste and Vent Piping

1. Sanitary waste and vent and storm piping shall be service weight cast iron pipe and fittings with factory asphalted coating.

a. Underground piping shall be hub and spigot with push-on compression joints with neoprene gaskets.

b. Above ground piping shall be no-hub joints with stainless steel bands and neoprene sealing sleeve.

B. Kitchen (greasy) waste, from dishwasher, floor drains, floor sinks, three compartment sink, mop sink and food grinder wastewater to exterior grease interceptor shall be stainless steel piping with hub and spigot DWV fittings with push on joints. Provide joint restraints as recommended by the manufacturer.

C. Domestic Water Piping

1. Potable water piping shall be type “L” copper.

2. Fittings 4” and smaller shall be solder using 95/5 lead free solder or press fittings with neoprene “0” ring.

3. Fittings larger than 4” shall be rolled groove.

4. Fittings 4” and less shall be press fitting with neoprene “0” ring.

D. Natural Gas Piping

1. Above ground gas piping shall be schedule 40 black steel.

a. Gas piping in return air plenum and larger than 2” shall be welded.

b. Gas piping 2" and smaller shall be threaded.

c. Above ground piping exposed outdoors shall be coated and wrapped or painted with a minimum two coats of yellow epoxy paint.

2. Underground gas piping.
    a. Outdoors at building entrance, schedule 40 black steel piping with threaded or socket welded fittings and coated with protective coating and wrapping.
    b. In concealed locations shall not have unions, fittings or couplings unless tubing is brazed, piping is welded, or fittings are listed for use in concealed spaces.
    c. Below slab piping shall be installed in a trench or be contained with containment piping vented to the exterior.

E. Insulation
1. Domestic cold water, 1” thick fiberglass pipe insulation
2. Domestic hot and hot water return, 1” thick fiberglass pipe insulation.
3. Domestic water piping exposed in kitchen or wash down areas shall be “1” for cold and 1" for hot and hot water return closed cell insulation with aluminum jacket.
4. Domestic water piping exposed outdoors will be heat traced and insulated with a minimum of 1” insulation and aluminum jacket.
5. Roof drain body and horizontal piping 1/2” duct wrap.6’
6. Sanitary drainage, p-trap and horizontal piping, serving HVAC condensate, ice machines and ice boxes, shall be insulated the same as roof drains and horizontal piping.
7. P-traps, sanitary piping, and kitchen piping, (GW), exposed to freezing shall be heat traces and insulated with aluminum jacket.

F. Water Heaters
1. Water Heaters shall be electric where possible or approved by DOA

12.0 Fire Protection Materials and Equipment

A. Fire Protection Piping
1. All components of the fire protection systems and installation shall meet NFPA 13 requirements.
2. Underground piping shall be ductile iron with mechanical joint fittings and thrust blocks or tie-rods.69
3. Above ground sprinkler piping shall be schedule 40 carbon steel with welded or threaded joints and schedule 10 rolled grooved. Fittings shall be UL-listed and FM-approved for fire protection service. Mechanical Grooved fittings and couplings which are UL-listed and FM-approved are permitted.
4. All dry pipe sprinkler systems shall be schedule 40 galvanized steel.

B. Fire Protection Equipment
1. Wet sprinkler systems shall be designed through an alarm check valve in lieu of a straight way check valve with flow switch.
2. Dry sprinkler system shall be designed through a dry alarm valve with air compressor.

C. Sprinkler heads
1. Concealed type sprinkler heads shall be in sheet rock ceilings and 2X4 lay-in

ceiling (at 1/2 points).

2. Semi-recessed heads shall be used in 2X4 lay-in ceiling (at 1/2 points)
3. Upright heads shall be used for areas without ceiling or for dry systems.
4. Concession can use any UL, FM approved head in their space, except sprinkler heads designated for residential applications

Appendix A - Standard Multizone Sequence

1.0 Standard Multizone Sequence

All setpoints, values, and time delays referenced are initial values that must adjustable

A. Occupied-unoccupied mode control:

1. Air handling unit (AHU) default is a 24/7 run schedule, where supply fan runs continuously.

B. Start-stop control:

1. Provide hand-off-auto switch. In auto position, the air handling unit shall start. Upon receiving a start command, the smoke damper shall open, and minimum outside air damper shall open to its minimum position. After the smoke damper and either the maximum outside air or return air damper are proven open via end switches, the supply fan shall start.

C. Warm up mode control:

1. The space temperatures shall be monitored and compared to the warmup setpoint (65 °F). The air handling unit will enter in warm up mode if more than 25% of zones are lower than warm up setpoint. It will remain in warm up mode until less than 15% of the boxes are less than warm up setpoint. In morning warm up mode. The air handling unit's minimum and maximum outside air dampers, relief air damper, and chilled water valve will be closed the return air damper and the preheat valves shall remain open.

D. Minimum outside air damper control:

1. Each AHU shall be provided with a minimum outside air flow (OAF) controller consisting of an air flow measuring station with active damper control.
2. Each AHU shall regulate OAF SP between two outside air cfm setpoints, from minimum occupancy/ building minimum ventilation up to maximum occupancy OAF cfm. Refer to the AHU schedule for the two minimum OAF cfm setpoints for each AHU.
3. When not in warm up or cool down mode, the minimum outside air control shall initially open to building minimum of scheduled outside air.
4. Upon a rise in any of the critical space or return CO2 sensors above setpoint (initially 900 ppm), the minimum OAF SP shall modulate between minimum and maximum values to maintain CO2 setpoint.
5. The minimum outside air damper modulates to maintain OAF at OAF SP.
6. The controls will have a building pressure control enable selector. Only if enabled, if building space static pressure falls to -0.02 in wc for more than 5 minutes, the minimum outside air flow setpoint shall be overridden between minimum and maximum OA cfm setpoint as required to maintain a positive building space static pressure setpoint of 0.02 in wc.

E. Discharge air temperature setpoint control (DAT SP):

1. The discharge air setpoint will be reset from a minimum of each unit's scheduled "duct supply temperature" (typically 52 F) to 65 F maximum based on the cooling demand of the associated terminal units.
2. If greater than 30 % of associated terminal units have flow set points that are within 95% of cooling maximum flow set point, then the discharge air setpoint will be decreased 1 deg. F every 10 minutes. If less than 20% of associated terminal

units have flow set points that are within 95% of cooling maximum flow set point, then the discharge air setpoint will be increased 1 deg. F every 10 minutes.

3. If outside air temperature (OAT) is greater than 75 F, DAT SP is set to minimum setpoint.
4. When counting terminal units, boxes serving exclusive or sensitive areas shall be given a weight of 1.5. Terminal units feeding open common areas shall be given a weight of 1.
5. If return air humidity rises above 60% for 10 minutes the discharge air setpoint will be overridden to minimum cooling temperature. When return air humidity is less than 58% for 10 minutes, the normal discharge air temperature control will resume.

F. Discharge air temperature control modes:

1. Economizer mode (maximum outside air damper):
   a. Whenever the OAT is below the economizer switchover setpoint of 65°F the unit shall operate under the economizer mode
   b. The economizer outside air damper modulates as the 1st stage of cooling control for discharge air temperature (DAT) to meet discharge air temperature setpoint (Econ mode). If the economizer damper is at 100% and the chilled water system is enabled, the chilled water valve will modulate as the 2nd stage of cooling if required (Econ + mech mode).
   c. A mixed air low limit program will modulate the maximum outside air damper to closed position on a fall in mixed air temperature below setpoint of 45 deg. F.
   d. The economizer damper shall be interlocked via hard wired connection with the freeze-stat to cut the power off for the spring return actuated damper in case temperature falls below 40°F.
2. Cooling mode
   a. When economizer is not enabled, economizer damper is closed and chilled water modulates for DAT to meet DAT SP.
1. Heating mode
   a. If economizer is active, but the damper is closed and discharge air falls below DAT SP, preheat valve will begin to control to DAT SP.
   b. The pre-heat coil hot water valve will be modulated as required to maintain a preheat discharge air setpoint above 45 deg. F. This control is always active, even during fan shutdown as a freeze protection measure.

G. Return damper and fan control:

1. Return damper position equals 100% minus the economizer damper position.
2. If a return fan exists, it will control to a plenum pressure determined at test and balance.

H. Discharge Air Pressure Setpoint Control (DAP SP)

1. Max duct pressure set point will be determined by test & balance and is the initial setpoint when the unit starts. The minimum duct pressure setpoint is 0.2 in wc.
2. The effective setpoint will modulate between the minimum and maximum to maintain all zones under 74 °F and no more than 3 zones “starved” (greater than 90% damper position).

a. If fewer than 3 zones are starved, and no zone is over 75 °F, then the duct pressure setpoint shall decrease by 0.05” every 2 minutes.

b. If greater than 3 zones are starved, or a single zone is over 75°F, than the duct pressure shall increase by 0.06” every two minutes.

c. If neither condition is true, setpoint remains unchanged.

d. Zone temperatures over 82°F are assumed to be bad readings and terminal unit is ignored in the count.

e. When counting terminal units, boxes serving exclusive or sensitive areas shall be given a weight of 1.5. Terminal units feeding open common areas shall be given a weight of 1.

I. AHU supply fan control:

1. Supply fan speed shall modulate for supply air pressure to meet DAP SP.

J. Relief fan and damper control:

1. If the building pressure control selector is enabled, upon a rise in building space static pressure above 0.05 in wc for more than 5 minutes, the relief damper shall open. After 10 minutes if space static pressure is still above 0.05 in wc and after limit switch proves the relief damper is open the relief fan shall start. The relief fan’s VSD will be modulated as required to maintain a positive static pressure discharge of 0.05 in wc. When the building space static pressure is less than 0.05-inch wc for 5 minutes, and the relief fan is at minimum speed, the relief fan will be stopped.

K. Purge mode control: (RMU units only)

1. The purge mode will be activated by a signal from the fire alarm system or manually commanded at the OWS. The minimum and maximum outside air dampers and the relief air damper will fully open, and the return air damper will fully close. Once the damper limit switches prove the OA and relief dampers are open, the supply and relief fans will be started and run at 100% speed. All VAV boxes will be open to 100%.

L. Fan shutdown:

1. The DDC controller shall verify the status of the supply fan and the relief fan via current sensing switches. Upon sensing that the supply fan is off, the DDC controller shall close the minimum and maximum outside air dampers, close the relief air damper, open the return air damper, close the chilled water valve, and send a 0% command to the supply and relief fan variable minimum and maximum outside air dampers, close the relief air damper, open the return air damper speed drives. The heating valve will continue to modulate as required to maintain a preheat discharge air setpoint of 45 deg. F.

M. Safeties:

1. A fire alarm shutdown relay will stop the unit upon receiving a signal from the fire alarm system.

2. A temperature low limit will stop the unit and open the hot water and chilled water valves upon sensing a fall in temperature below setpoint.

3. Static pressure high limit switches mounted in the supply and relief fa discharges shall stop the unit upon a rise in discharge static pressure above set point.

N. Hard wired interlocks:

1. The smoke detectors freeze protection thermostat; float switch and duct over-pressure switch shall be hard wired in the fan motor control circuit. These hardwire devices shall send a signal from an auxiliary contact to the DDC control system.
2. The smoke detectors and fire thermostat shall send a signal to the building fire alarm system. The smoke detector on the relief fan shall be hard wired to the fan motor control circuit.

O. Shutdown alarms:

The control system shall turn off the air handling unit supply fan and alarm the user interface whenever any of the following conditions occurs:

1. Motor current plus or minus 10% of full load amps for 2 minutes or longer. Full load current shall be as determined during test and balance.
2. No air flow for 2 minutes or longer.
3. Smoke or heat detected in the air handling unit.
4. Drain pan filled with condensate.
5. Freeze protection thermostat indicating freezing temperatures in air handling unit.
    a. The freeze stat should stop the supply fan, close all outside air dampers, open the hot water valve and chiller water valve.
6. Supply duct pressure exceeds 3.0 inches w.c. high limit

P. Non-shutdown alarms:

The control system shall alarm the user interface whenever any of the following conditions occurs:

1. Discharge air temperature +/- 5 deg F of setpoint for five minutes or longer.
2. Supply duct static pressure +/- 0.5 in w.c. of setpoint for 5 minutes or longer.
3. When the supply fan is operating in manual override as determined by fan operation outside the control of the control system.
4. Supply fan alarm

Appendix B - Single Zone AHU Standard Sequence

1.0 Single Zone AHU Standard Sequence

All setpoints, values, and time delays referenced are initial values that must adjustable

A. Start-stop control:

1. Provide hand-off-auto switch. In auto position, the air handling unit shall start. Upon receiving a start command, the smoke damper shall open, and minimum outside air damper shall open to its minimum position. After the smoke damper and either the maximum outside air or return air damper are proven open via end switches, the supply fan shall start.

B. Warm up mode control:

1. The space temperature shall be monitored and compared to the warmup setpoint (65 °F). The air handling unit will enter in warm up mode if the space temperature is below the warmup setpoint. The air handling unit's minimum and maximum outside air dampers, relief air damper, and chilled water valve will be closed the return air damper and the preheat valves shall remain open.

C. Minimum outside air damper control:

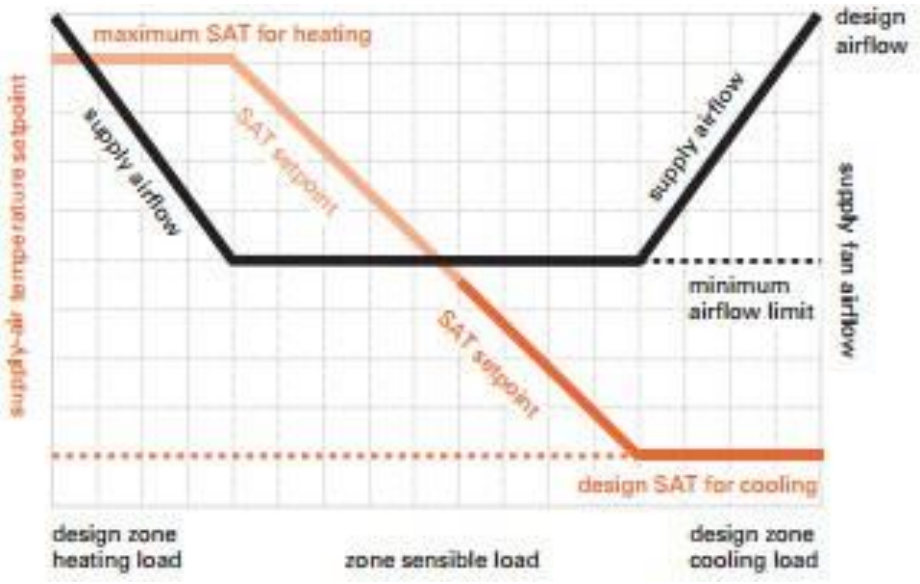
1. Each AHU shall be provided with a minimum outside air flow (OAF) controller consisting of an air flow measuring station with active damper control.
2. Each AHU shall regulate OAF SP between two outside air cfm setpoints, from minimum occupancy/ building minimum ventilation up to maximum occupancy OAF cfm. Refer to the AHU schedule for the two minimum OAF cfm setpoints for each AHU.
3. When not in warm up or cool down mode, the minimum outside air control shall initially open to building minimum of scheduled outside air.
4. Upon a rise in the return CO2 sensor above setpoint (initially 900 ppm), the minimum OAF SP shall modulate between minimum and maximum values to maintain CO2 setpoint.
5. The minimum outside air damper modulates to maintain OAF at OAF SP.
6. The controls will have a building pressure control enable selector. Only if enabled, if building space static pressure falls to -0.02 in wc for more than 5 minutes, the minimum outside air flow setpoint shall be overridden between minimum and maximum OA cfm setpoint as required to maintain a positive building space static pressure setpoint of 0.02 in wc.

D. Return damper and fan control:

1. Return damper position equals 100% minus the economizer damper position.
2. If a return fan exists, it will control to a plenum pressure determined at test and balance.

E. Zone temperature control (heating/cooling valves and fan speed)

1. In this sequence, zone temperature can refer to return temperature OR zone temperature depending on the operator selection.
2. Graphically, the zone temperature control will operate per the below diagram and as described in this section:



F. Mode Selection and Operation:

1. Cooling Mode: The AHU will operate in cooling mode, when zone temperature is greater than cooling mode enable setpoint (73 °F).

   a. Discharge Air Temperature Setpoint:

      i. At minimum fan speed, the discharge air temperature setpoint will modulate between cooling minimum setpoint (52 °F) and heating maximum setpoint (90 °F) to maintain zone temperature at zone cooling effective setpoint (74 °F).

   b. Discharge Air Temperature Control:

      i. Whenever the outside air temperature is below the economizer switchover setpoint of 65°F the unit shall operate under the economizer mode.

      ii. The economizer outside air damper modulates as the 1st stage of cooling control for discharge air temperature (DAT) to meet discharge air temperature setpoint (Econ mode). If the economizer damper is at 100% and the chilled water system is enabled, the chilled water valve will modulate as the 2nd stage of cooling if required (Econ + mech mode).

      iii. A mixed air low limit program will modulate the maximum outside air damper to closed position on a fall in mixed air temperature below setpoint of 45 deg. F.

      iv. The economizer damper shall be interlocked via hard wired connection with the freeze-stat to cut the power off for the spring return actuated damper in case temperature falls below 40°F.

      v. When economizer is not enabled (mech mode), economizer damper is closed and chilled water modulates for discharge air temperature to meet setpoint.

      vi. The preheat valve discharge air temperature control is deactivated in cooling mode. However, the preheat valve control to maintain mixed air temperature above 45 °F always remains active in all modes.

c. Supply Fan Speed:

i. In cooling mode, the fan speed starts at minimum fan speed (50%). If the discharge air temperature setpoint has been at minimum (52°F) for 10 minutes, it will hold that minimum setpoint, and supply fan speed control will become primary control. It will modulate fan speed to maintain zone cooling effective setpoint (74°F).

ii. If load drops and fan speed remains at minimum for 10 minutes, fan speed control will return to being held at minimum speed, and discharge air temperature setpoint will return to the primary zone temperature control, modulating for zone temperature to equal 74 °F cooling setpoint.

iii. If a supply air flow station exists, the minimum and maximum fan speeds referenced in this sequence can instead be % of maximum air flow. In this case, the fan speed modulates to control actual supply flow to meet supply flow setpoint.

2. Heating Mode:

The AHU will operate in heating mode, when zone temperature is less than heating mode enable setpoint (69°F).

a. Discharge Air Temperature Setpoint:

i. At minimum fan speed, the discharge air temperature setpoint will modulate between cooling minimum setpoint (52 °F) and heating maximum setpoint (90 °F) to maintain zone temperature at zone heating effective setpoint (68 °F).

b. Discharge Air Temperature Control:

i. The economizer damper and chilled water valves are closed, and the return damper is open in heating mode.

ii. The preheat valve controls discharge air temperature to setpoint.

c. Supply Fan Speed:

i. In heating mode, the fan speed starts at minimum fan speed (50%). If the discharge air temperature setpoint has been at maximum (90°F) for 10 minutes, it will hold that maximum setpoint, and supply fan speed control will become primary control. It will modulate fan speed to maintain zone heating effective setpoint (68°F).

ii. If heating load drops and fan speed remains at minimum for 10 minutes, fan speed control will return to being held at minimum speed, and discharge air temperature setpoint will return to the primary zone temperature control, modulating for zone temperature to equal 69 °F heating setpoint.

3. Satisfied mode: The AHU will operate in satisfied mode if zone temperature is in between heating (69 °F) and cooling enable (73°F) setpoints.

a. In satisfied mode, the economizer damper, hot water valve, chilled water valve all remains closed. The return damper opens, and the fan runs at minimum speed setpoint (50%).

G. Unoccupied mode control

1. Unoccupied mode is scheduled during lower occupancy times of 11 PM to 4 AM.

2. Fan continuously runs with same sequence as occupied. Only difference is new set points:

a. Unoccupied cooling enable setpoint = 76 °F

b. Unoccupied effective cooling setpoint = 77 °F

c. Unoccupied heating enable setpoint = 68 °F

d. Unoccupied effective heating setpoints = 67 °F

e. Unoccupied minimum fan speed = 25%

H. Relief fan and damper control:

1. If the building pressure control selector is enabled (operator can adjust disable/enable mode), upon a rise in building space static pressure above 0.05 in wc. for more than 5 minutes, the relief damper shall open. After 10 minutes if space static pressure is still above 0.05 in wc. and after limit switch proves the relief damper is open the relief fan shall start. The relief fan's VSD will be modulated as required to maintain a positive static pressure discharge of 0.02 in wc. When the building space static pressure is less than 0.05 in wc, the relief fan is at minimum speed, the relief fan will be stopped. The relief air damper will be modulated as required to maintain the building space static pressure setpoint determined by the test and balance contractor.

I. Purge mode control: (RMU units only)

1. The purge mode will be activated by a signal from the fire alarm system or manually commanded at the OWS. The minimum and maximum outside air dampers and the relief air damper will fully open, and the return air damper will fully close. Once the damper limit switches prove the OA and relief dampers are open, the supply and relief fans will be started and run at 100% speed.

J. Fan shutdown:

1. The DDC controller shall verify the status of the supply fan and the relief fan via current sensing switches. Upon sensing that the supply fan is off, the DDC controller shall close the minimum and maximum outside air dampers, close the relief air damper, open the return air damper, close the chilled water valve, and send a 0% command to the supply and relief fan variable minimum and maximum outside air dampers, close the relief air damper, open the return air damper speed drives. The heating valve will continue to modulate as required to maintain a preheat discharge air setpoint of 45 deg. F.

K. Safeties:

1. A fire alarm shutdown relay will stop the unit upon receiving a signal from the fire alarm system.

2. A temperature low limit will stop the unit and open the hot water and chilled water valves upon sensing a fall in temperature below setpoint.

3. Static pressure high limit switches mounted in the supply and relief fa discharges shall stop the unit upon a rise in discharge static pressure above set point.

L. Hard wired interlocks:

1. The smoke detectors freeze protection thermostat; float switch and duct over-pressure switch shall be hard wired in the fan motor control circuit. These hardwire devices shall send a signal from an auxiliary contact to the DDC control system.

2. The smoke detectors and fire thermostat shall send a signal to the building fire alarm system. The smoke detector on the relief fan shall be hard wired to the fan motor control circuit.

M. Shutdown alarms: the control system shall turn off the air handling unit supply fan and alarm the user interface whenever any of the following conditions occurs:

1. Motor current plus or minus 10% of full load amps for 2 minutes or longer. Full load current shall be as determined during test and balance.
2. No air flow for 2 minutes or longer.
3. Smoke or heat detected in the air handling unit.
4. Drain pan filled with condensate.
5. Freeze protection thermostat indicating freezing temperatures in air handling unit.
    a. The freeze stat should stop the supply fan, close all outside air dampers, open the hot water valve and chiller water valve.
6. Supply duct pressure exceeds 3.0 inches w.c. high limit

N. Non-shutdown alarms:

The control system shall alarm the user interface whenever any of the following conditions occurs:

1. manual override as determined by fan operation outside the control of the control system.
2. Supply fan alarm
3. Zone temperature +/- 3 deg F of setpoint.

Appendix C - Standard Terminal Unit Control Sequence

1.0 Standard Terminal Unit Control Sequence

2.0 Zone temperature sensor shall modulate terminal unit air damper between scheduled maximum and minimum primary cooling air flow in response to space cooling setpoint, initially 74 °F.

3.0 On fall in space temperature below 68 °F after minimum cooling air flow has been reached, the terminal unit hot water valve shall modulate open to maintain heating setpoint (initially 68 °F). If scheduled minimum heating cfm is greater than scheduled minimum cooling cfm, increase VAV box cfm to minimum heating cfm setpoint after heating valve is activated.

4.0 DDC system will prevent the terminal unit from going to heating flow or opening the hot water valve if secondary hot water system is not enabled.

5.0 The zones will be scheduled unoccupied between 11 pm and 4 am. They will follow the same sequence but control to unoccupied cooling SP (77 °F) and unoccupied heating SP (67 °F) and separate unoccupied cooling min cooling air flow and unoccupied heating air flow.

A. Note:

   In order for the air handlers to properly respond to terminal units, there are several air handler logic tables and interlock programming that must be updated on the Johnson Controls NAEs even if one terminal unit is installed or upgraded. The corresponding terminal unit points must be added to the below:

B. VAV Counts LCT

C. Purge-INT

D. HTGMODE (Interlock)

E. Warmup-LCT

F. Schedule-INT

G. Zone temp warnings for 2.5 deg above effective cooling setpoint or below effective heating setpoint

H. Delete any no longer in service boxes from the system

I. Update all graphics including floor plans

J. Ensure that key flow and temperature setpoints for occupied and unoccupied are exposed. Refer to typical points list and naming convention.

K. All terminal unit point names must have the air handler and box number included. For example:

   1. RMU-95A-BL-V04.ZN-T or RMU-95A-BL-V04.EFFCLG-SP

      a. Points labeled as only ZN-T and EFFCLG-SP without the prefix is not acceptable.

Appendix D - BMS Points Standard Lid Details

Naming convention example	Description	Additional Parameters
VVR-MT-01-2-01-AL.HTG-EN	Box Heating Enable Command	
VVR-MT-01-2-01-AL.CLG-MAXFLOW	Cooling Max Flow Setpoint	
VVR-MT-01-2-01-AL.SA-F	Supply Air Flow	
VVR-MT-01-2-01-AL.ZN-T	Zone Temperature	
VVR-MT-01-2-01-AL.EFFHTG-SP	Effective Heating Temp Calc Setpoint	
VVR-MT-01-2-01-AL.DA-T	Discharge Air Temperature	
VVR-MT-01-2-01-AL.DPR-O	Supply Air Damper Output	
VVR-MT-01-2-01-AL.SAFLOW-SP	Supply Air Flow Calculated Setpoint	
VVR-MT-01-2-01-AL.EFFCLG-SP	Effective Cooling Temp Calc Setpoint	
VVR-MT-01-2-01-AL.OCC-SCHEDULE	Occupancy Schedule	
VVR-MT-01-2-01-AL.SYSTEM-MODE	System Mode	Cool only, heat only, purge, etc.
VVR-MT-01-2-01-AL.ZNT-SP	Common Setpoint	
VVR-MT-01-2-01-AL.ZN-Q	Zone Quality	CO2
VVR-MT-01-2-01-AL.ZNQ-ALMSP	Zone Quality Alarm Setpoint	
VVR-MT-01-2-01-AL.HTG-O	Heating Output	
VVR-MT-01-2-01-AL.CLGOCC-SP	Occ Cooling Setpoint	
VVR-MT-01-2-01-AL.CLGUNOCC-SP	Unocc Cooling Setpoint	
VVR-MT-01-2-01-AL.HTGOCC-SP	Occ Heating Setpoint	

VVR-MT-01-2-01-AL.HTGUNOCC-SP	Unocc Heating Setpoint	
VVR-MT-01-2-01-AL.CLGOCC-MINFLOW	Occ Cooling Min Flow Setpoint	
VVR-MT-01-2-01-AL.HTGOCC-MINFLOW	Occ Heating Min Flow Setpoint	
VVR-MT-01-2-01-AL.WC-C	Warmup Cooldown Status	
VVR-MT-01-2-01-AL.TUNING-RESET	Application Tuning Reset	
VVR-MT-01-2-01-AL.AUTOCAL-C	Autocalibrate Commnad	
VVR-MT-01-2-01-AL.UNITEN-MODE	Unit Enable Mode	
VVR-MT-01-2-01-AL.ZNT-STATE	Zone Temperature Status	Cooling, heating, satisfied, etc.
VVR-MT-01-2-01-AL.CLGUNOCC-MINFLOW	UnOcc Cooling Min Flow Setpoint	
VVR-MT-01-2-01-AL.HTGUNOCC- MINFLOW	UnOcc Heating Min Flow Setpoint	
VVR-MT-01-2-01-AL.WC-ADJ	Warm Cool Adjust	

Table 1 – Passenger Terminals – HVAC Operating Parameters

Table 1 – Passenger Facilities – HVAC Operating Parameters

Passenger Facilities
HVAC Operating Parameters

Space/Function	Indoor Design Condition				HVAC Load Data			
					People	Outside Air	Lights	Equipment
	Summer- ⁰F	% RH	Winter- ⁰F	% RH	FT^2/PPL	CFM/PPL	Watts/FT^2	Watts/FT^2
Hold Rooms	74	50	70	-	200 PPL/Gate	10	1.5	2.0
Interior Corridors	74	50	70	-	100 FT^2/PPL	10	1.5	1.5
Concessions (Restaurant)	74	50	70	-	30 FT^2/PPL or Count	10	3.0	10.0
Concessions (Retail Store)	74	50	70	-	45 FT^2/PPL or Count	10	6.0	3.0
Crown Room	74	50	70	-	45 FT^2/PPL or Count	20	3.0	3.0
Break Room/ Group Room	74	50	70	-	100 FT^2/PPL or Count	10	1.5	1.5
Office/ Administration	74	50	70	-	100 FT^2/PPL or Count	20	1.5	1.5
Third Level Tenant Space	74	50	70	-	100 FT^2/PPL	20	2.5	2.5
Smoking Room	74	50	70	-	15 FT^2/PPL	60	1.5	1.5
Apron Level (Air Conditioned Spaces)	74	50	70	-	100 FT^2/PPL or Count	20	2.5	1.5
Classroom/Training/Conference	74	50	70	-	30 FT^2/PPL or Count	20	2.5	1.5
Toilet Room/Locker Room	74	50	70	-	0	0	1.5	0.0
Storage Area	74	50	70	-	0	0	1.5	1.0

OUTDOOR DESIGN CONDITIONS

Summer 94 ⁰F DB/ 74 ⁰F WB

Winter 17 ⁰F DB

Cooling Supply Air Design

Supply air Delta T (Space Temp- Leaving Coil Temp): 23 ⁰ F

Chilled & Hot Water Design: Supply- Return Delta T

Secondary CHW: 16 ⁰F

Air Handling Unit CHW: 18 ⁰F

Secondary HW: 40 ⁰F