Heating, Ventilating, and Air Conditioning D3041 Air Handling Distribution

PART 1 - GENERAL

1.1 OVERVIEW

- A. This section describes criteria for design of facility air handling distribution systems, including air handlers, ductwork, ductwork accessories, terminal units, air devices, and stairwell pressurization systems (if applicable to the project).
- B. Additional requirements for patient treatment, laboratory, and other specialized environments are addressed in other Design Guideline elements.
- C. Air handling unit selection and performance shall comply with the latest state adopted version of ANSI/ASHRAE/IESNA 90.1. The outside air flow rate must be measured, distributed, and controlled via the BAS.
- D. The quality and quantity of outside air must meet the if applicable version (FGI, TJC, CMS) of ASHRAE Standard 62.1 and 170 requirements and must also maintain the building pressurization reasonable positive (such as 5 to 15 percent net positive pressurization (outside air exhaust air)/total supply air]) depending on the building envelope design/construction. Tighter buildings are eligible for less net pressurization.

PART 2 - DESIGN CRITERIA

2.1 GENERAL

- A. Refer to Design Guideline Element Z2005 for Codes and Applicable Regulatory Agencies. Where direction described in applicable codes are in conflict, the A/E shall comply with the more stringent requirement. The A/E shall be familiar with all applicable standards, codes and ordinances and assure compliance thereto. The system design shall be per the strictest standards.
- B. Mechanical rooms must be large enough to allow for air handling unit coil pull space and full space service clearance around the unit for filter replacement and to accommodate both major and minor repairs. A minimum clearance of 3 feet must be planned around the unit with additional space at the heating and cooling coil pull locations. Indicate the designated coil pull and maintenance clearance space on the Drawings.
- C. Each air handling unit fan equipped with a fan motor size 5-horsepower and above shall be provided with a variable frequency drive (VFD). The high efficiency fan motor shall be compatible with VFD applications, which is controlled by the supply duct static design pressure setpoint.
- D. Air handling unit fans shall have an efficiency rating where the ratio of the fan system power to the supply fan airflow rate (main fan) of each HVAC system at design conditions shall not exceed the allowable fan system power indicated in the latest state adopted version of ASHRAE Standard 90.1.

- E. Fan arrays are acceptable to use on air handling units and energy recovery units (ERU's) unless noted otherwise by Owner. Air handling units shall not contain individual motors larger than 10 HP.
- F. Access doors (or panels) on the air handling unit sections shall always open against the positive side of the door and shall not be blocked by internal filter casings or internal equipment components. Micro switches or safety switch interlocks need to be provided at access doors or panels to protect maintenance personnel from possible injuries from rotating or electrical equipment components inside the air handlers.
- G. The use of permanent affixed ladders, stairs, and walkways shall be evaluated on all air handling units to provide safe access to components, filters, and instruments, and damper actuators and switches. This should include the addition of OSHA compliant non-skid steps / stairs from the exit of the accessible compartments to the general walkways, taking into account utility piping directly in the path of maintenance and operations personnel as well as elevation changes between the base floor height of the AHU and the surface directly outside the entry doors of the AHU.
- H. Coordinate location of wall-mounted room temperature sensors with furniture and equipment, so that sensor locations do not conflict with tall items of furniture/equipment.
- I. Schedule the minimum and maximum water, air flow rates, fan horsepower, entering and leaving coil water and air temperatures, MBTUs, water and air pressure drops, and physical parameters of the coils for each air handling unit.
- J. Implement supply fan static pressure setpoint reset per ASHRAE 90.1 (latest state adopted version).
- K. Consult with owner before considering implementation of any liquid desiccant (Kathabar) energy recovery systems.

2.2 COILS

- A. If chilled water is used as the cooling medium, the A/E needs to acquire the supply water temperature at the site where the coil will be used. Similarly, if hot water is used as the heating medium, the A/E needs to acquire system temperature at the site where the coil will be used. Confirm with Owner's Project Manager.
- B. Use a chilled water differential temperature of 16 degrees F for renovation work and 22 degrees F for new buildings. Normal heating coil hot water design differential temperature for new buildings is 30 degrees F for air handling units and 20 degrees F for terminal units. Where other "delta T" conditions may apply to specific projects, advise Owner and obtain review acceptance.
- C. Design two (2) coils in a series arrangement if the cooling coil capacity requirement exceeds the capability of a 6-row coil. Chilled water shall be piped in series through both coils and an access section shall be provided between the two coils.
- D. Maximum differential pressure across the air side of the cooling coil shall not exceed 0.7-inch w.g.

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- E. Maximum cooling coil discharge face velocity shall not exceed 425 fpm in variable air volume (VAV) applications and 375 fpm in constant air volume (CAV) applications. Heating coil discharge face velocity shall not exceed 700 fpm. These values are required to allow for an additional margin of 10 percent capacity for future renovations and to help meet fan power limitations in energy code.
- F. Pipe spool connections at the coils must be bolted flange connections to allow the coils to be pulled and installed without having to remove the control valves.
- G. For new facilities with evaporative cooling towers and/or rainwater harvesting, use cooling coil condensate waste for cooling tower make-up and/or collect condensate in rainwater harvesting cisterns. Provide a dedicated piping system from air handling equipment to point of use or storage. Intent is to reduce potable water use and chemical treatment of evaporative cooling make-up water, while reducing sewage treatment of condensate. Confirm application of condensate reuse with Project requirements.

2.3 OFFICE / ADMINISTRATION AIR HANDLING UNITS

- A. Air handling units and distribution systems serving office / administration areas within Owner's buildings shall be variable air volume type terminal units. Perimeter and high occupancy spaces such as meeting rooms shall use series fan-powered terminal units with the ability to modulate fan speeds.
- B. Office / Administration units will be single duct, draw-through, re-circulating type with outside and return air introduced to the air handler through duct work.
- C. Each air handler shall be a variable volume draw through type and shall include the following components:
 - 1. Air inlet plenum section.
 - 2. Pre-filter section.
 - 3. Hot water preheat coil; There will be no need for preheat if the outside air pretreatment unit is installed. Refer also to the Coils Section of this Design Guideline Element.
 - a. A preheat coil is only required if the quantity of outside air has the potential to lower the mixed air temperature below 36 degrees F.
 - b. If the building does not have a heating hot water system, then electric heating coils are to be used. The electric heating coils shall be powered through the use of an SCR to maintain a controlled leaving air set point. If the electric power requirement of the coil is large where a single SCR application is not viable, then the coil shall be step controlled using a Vernier (combination SCR and contactor) staging sequence.
 - 4. Access section.
 - 5. Chilled water-cooling coil; Refer also to the Coils Section of this Design Guideline Element. If any amount of raw outside air is introduced into the air unit, a freeze stat shall be specified.
 - 6. Properly spaced ultraviolet germicidal irradiation (UVGI) lamps shall be located on the leaving air side of the cooling coil. Access section.

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- 7. Fans; Prefer direct drive centrifugal airfoil blade type, plug fans.
- 8. High and low static pressure shutdown control and reset capability.
- 9. Instrument measurement taps for static pressure, temperature, etc as specified on Drawings.
- 10. Specify optimum start controls for AHU's that are turned off during unoccupied hours per energy code.
- 11. Specify demand control ventilation where required by energy code.

2.4 OUTSIDE AIR PRETREAT UNITS

- A. Depending on the ventilation and air conditioning system design situations, outside air pretreat units may be required to condition and dehumidify all outside air to existing mixed air handling units during a partial building renovation.
- B. Outside air pretreat units shall be dedicated for the conditioning and dehumidification of all outside air to mixed air handling units on new construction projects.
- C. All outside air pretreat units shall be designed as draw-through type.
- D. Each outside air pretreat unit shall include, but not be limited to the following components:
 - 1. Inlet plenum (100 percent outside air).
 - 2. Pre-filter with more than 12" unobstructed behind rack (for future bag filter if desired).
 - 3. Hot water heating coil (preheat position). Refer also to the Coils Section of this Design Guideline Element.
 - a. Provide a heating hot water recirculating pump on the bypass piping of the preheat coil for freeze protection and activate pump when air leaving the preheat coil falls below 38 F.
 - b. If the building does not have a heating hot water system, then electric heating coils are to be used. The electric heating coils shall be powered through the use of an SCR to maintain a controlled leaving air set point. If the electric power requirement of the coil is large where a single SCR application is not viable, then the coil shall be step controlled using a Vernier (combination SCR and contactor) staging sequence.
 - 4. Access section.
 - 5. Chilled water-cooling coil; refer also to the Coils Section of this Design Guideline Element. All cooling coils shall have a freeze stat upstream of the coil.
 - 6. Access section.
 - 7. Fans. Prefer direct drive, centrifugal airfoil type.
 - 8. Instrument measurement taps for static pressure, temperature, etc.

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9. High and low static pressure shutdown control and reset capability.

2.5 UNITS WITH ENERGY RECOVERY

The determination of energy recovery is based on the compliance of ASHRAE 90.1 or ASHRAE 62.1 or actual energy recovery needs.

- A. Unless otherwise required to comply with applicable codes or standards, energy recovery components should be evaluated by considering equipment installed cost, equipment life, the time value of money, any utility avoided costs, and a simple payback of 5 years or less.
- B. All the major parameters of an energy recovery system should be connected to the building automation system.
- C. Owner's Master Construction Specifications address several types of energy recovery units (ERU) that must be evaluated during Schematic Design. The type of energy recovery unit is dependent on exhaust contaminants and exhausts odors.
 - 1. Enthalpy (total energy) wheels. Enthalpy wheels application shall be on a project by project basis, but in no case should be applied in a system serving BSL-3 or higher classifications. Where enthalpy wheels are used, the following should be provided.
 - a. Preference for wheels driven by direct drive motors.
 - b. Exhaust and supply fans selected to accommodate wheel purge air from the outdoor air stream into the exhaust air stream;
 - c. MERV 8 or higher filtration of exhaust air stream upstream of wheel;
 - d. Units with economizers and wheels will require exhaust and outside air bypass of wheel;
 - e. Outside air flush of ERU/OAU/AHU exhaust sections during maintenance activities;
 - f. Where Photo-Catalytic Oxidation Air Cleaning systems are used, position in supply air downstream of enthalpy wheel and/or cooling coil;
 - g. Cross contamination test stations with tubing to system sampling points; and
 - h. Commissioned verification of cross-contamination limits.
 - i. Heating coils may be required to raise the temperature of the outside air to an acceptable supply air temperature to provide heat to the ventilated space or unit.
 - Fixed-plate energy recovery. Fixed-plate energy recovery shall be on a project by project basis, but in no case should be applied in a system serving BSL-3 or higher classifications. Where fixed-plate energy recovery is used, the following should be provided.
 - a. MERV 8 or higher filtration of supply and exhaust air stream upstream of fixedplate device;

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- b. Units with economizers and fixed-plate devices will require exhaust and outside air bypass of fixed plate if economizer air is supplied through the same unit;
- c. Outside air flush of ERU/OAU/AHU exhaust sections during maintenance activities;
- d. Where Photo-Catalytic Oxidation Air Cleaning systems are used, position in supply air downstream of fixed-plate device and/or cooling coil;
- e. Heating coils may be required to raise the temperature of the outside air to an acceptable supply air temperature to provide heat to the ventilated space or unit.
- 3. Equipment designs for recovering sensible energy include heat pipes; air to air heat exchangers, wrap around coils, and run around coils.
 - a. Some designs are more efficient than others, but the condition of the exhaust air determines the type energy recovery be selected.
 - b. Indirect evaporative heat exchangers and evaporative assist coils (using condensate spray mist in exhaust air upstream of recovery coils) can provide incremental performance enhancement and may merit consideration.
 - c. Due to added maintenance costs and purge air parasitic, but at no increased energy benefits, sensible energy wheels are generally to be avoided unless a specific project condition mandates otherwise.
 - d. ASHRAE 62.1 provides four (4) classifications for return air transfer air and exhaust air. Protection of patients is a high priority in a healthcare facility and the design of any energy recovery system needs to affirm that cross contamination of contaminated air into the outside air stream can be demonstrated to not pose a known health risk in the system where applied.

2.6 OFFICE AIR TERMINAL UNITS

- A. Select terminal units at maximum 1500 CFM capacity for noise and space considerations.
- B. Locate terminal units for full maintenance access above the ceiling. Ensure that there is a minimum of 24 inches around all terminal unit controllers and operators for access. Electrical access panels on terminal units and electrical heater panels require (per NEC) a minimum 42-inch clearance for voltages above 120 and 36 inches for voltages of 120 or less.
- C. Consider future renovation when laying out terminal unit zoning. The maximum number of exterior or interior office rooms per terminal unit is limited to no more than four rooms. Each corner room shall have its own terminal unit.
- D. Specify constant volume, ultra-quiet series fan-powered series terminal units with heating coil for office applications where space heating is required at building perimeter zones, level one entrances and corridors, and zones with high occupancy, such as meeting rooms. If the existing building does not have or use hot water heating systems, then electrical power for electric heating coils must be controlled with the use of an SCR. In either case each VAV terminal and heating coil shall be controlled by the building automation system with a supply air temperature setback mode.

- E. Specify variable volume single duct terminal boxes with zone heating for interior spaces.
- F. Single-zone, constant volume exhaust terminal units are to be used for rooms where oncethrough ventilation is required such as toilet rooms and janitor's closets. Variable air volume single duct terminal boxes with heating coils shall be used for supply with airflow varying based on space temperature. Ensure adequate paths for makeup air are provided.
- G. Single zone, variable volume terminal units cooling only are to be used for areas that are typically unoccupied, including electrical equipment rooms, rooms with mechanical equipment, etc. Confirm with Owner.
- H. Refer to Owner's Master Construction Specifications for acceptable liners for terminal units.
- I. Terminal units shall have night setback and override capability through featured thermostat from the building automation system.
- J. For high occupancy areas (25 or more occupants per 1,000 square foot of space) such as conference rooms, utilize single-zone, variable volume terminal units with supplemental heat and CO₂ override controls. The intent is to increase room supply air volume if CO₂ levels in the space are not achieved when supply airflow is not at maximum flow.

2.7 AIR DEVICES

- A. For office applications, building perimeter supply ceiling devices shall be off-white slot diffusers with round or oval necks, or four-way directional square panel face diffusers with round neck. Review diffuser selection with Owner prior to preparing Project Specifications.
- B. Interior and general supply ceiling devices shall be four-way directional square panel face diffusers with round neck. Diffuser size is to be based on flow rate for proper flow within noise criteria limits set forth by Design Guideline Element D3002 Sound Criteria.
- C. Perforated return air grilles or directional square face panel diffusers shall be provided in open areas and individual offices for return to air handling unit. Diffuser is to be based on flow rate for proper flow within noise criteria limits set forth by Design Guideline Element D3002 Sound Criteria.
- D. Coordinate location of air devices and device frame style with architectural drawings. Offset location of supply and return diffusers and grilles to avoid short circuit of air flow inside the conditioned or ventilated space.

2.8 FAN COIL UNITS

- A. Draw through fan coil units with pre-filter, hot water pre-heat coil (only on rooms requiring heat), cooling coil and direct drive fan. Fan coil units shall be mainly used for environmental control of mechanical equipment, electrical, and telecommunication rooms.
- B. Draw through direct expansion (DX) fan coil units (with pre-filter, a direct expansion refrigerant cooling coil and direct drive fan, section shall be only used for environmental control of elevator machine rooms, telecommunications (IDF/MDF) rooms or as the redundancy purpose. If a fan coil unit is outside of the electrical, telecommunication, or elevator machine room space that it serves, then chilled water coils can be used in lieu of the electric heat and

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DX coil.

C. Telecommunications rooms shall be served from floor air handlers during normal operating hours and fan coil units after normal building operating hours to support the unoccupied set back or shut down of main air handling units. Refer to Design Guideline Element D501001 Electrical System for Telecommunications Rooms for specific fan coil unit power requirements during emergency conditions.

2.9 UNIT HEATERS

- A. Hot water or electric unit heaters shall be used for supplemental heating of diesel generator rooms and loading dock areas if the loading dock area is enclosed.
- B. Electric unit heaters must be explosion proof if they are located in a space where explosive vapors may exist.

2.10 STAIRWELL PRESSURIZATION FANS (IF APPLICABLE)

- A. The IBC lists physical building height criteria, for determining an application of when stairwell pressurization fan system is required.
- B. The stairwell pressurization system shall meet or exceed NFPA and local code requirements.
- C. Two fans shall be provided for pressurization of each building exit stairwell. One fan shall be located at the top of the stairwell and the other fan shall be located near the bottom of stairwell.
- D. The fan shall be variable volume using a VFD and shall maintain positive static pressure in each stairwell. The differential pressure across the stairwell access door shall not exceed the maximum opening force of 30 pounds as specified in the latest edition of NFPA 92A.
- E. Specify properly sized motorized dampers for relief. Do not specify gravity dampers.

2.11 DUCTWORK

- A. Refer to the ductwork construction specifications for ductwork definitions, applications, and materials.
- B. The preference is to use smooth radius elbows with a radius not less than 1 1/2 times the width of the duct on centerline but where space is limited, single radius smooth elbows or elbows with turning vanes may be used.
- C. Ductwork transitions shall be no more than 20 degrees for divergence and 30 degrees for convergence.
- D. Ductwork Sizing: The following criteria will be utilized for sizing ductwork for the various systems:
 - 1. Medium pressure supply ductwork upstream of air terminal units will be sized for a maximum pressure drop of 0.15 inches of water per 100 feet of ductwork for ducts carrying up to 12,000 CFM. For ductwork over 12,000 CFM, sizing will be based on maintaining a maximum velocity of less than 2,000 feet per minute (fpm).

- 2. Medium pressure ductwork from outside air handling units to floor air handling units shall be sized at a maximum friction loss of 0.15 inches of water per 100 feet of duct but shall not exceed 2,000 fpm.
- 3. Low pressure supply ductwork downstream of air terminal will be sized for a maximum pressure drop of 0.08 inches of water per 100 feet of ductwork for ducts carrying up to 8,000 CFM. For ductwork over 8,000 CFM, sizing will be based on maintaining a maximum velocity of less than 1,500 feet per minute.
- 4. Transfer openings and return air sound boots shall be sized for 500 fpm at the air handler mechanical room wall and 300 fpm at all other locations.
- E. Low-pressure ductwork will be utilized downstream of the terminal units to transport supply air to the space.
- F. Office/Administration areas may have a ceiling plenum return air system.
- G. . For systems that use the ceiling plenum for return air, ensure that return air openings in mechanical room partitions are sufficiently sized for the design return airflow (CFM).
- H. Flexible runs of ductwork to air devices are not to exceed six (6) feet in length. Flexible duct to terminal units shallnot exceed two (2) feet. Flexible ductwork shall not be used at fan powered terminal units.
- I. Non-metal rigid ductwork shall not be used.
- J. Indicate manual air volume balancing devices in supply, return, and exhaust mains, branch mains, and terminal branches.
- K. Depending on mixed air conditions, hot water heating coils may be eliminated at mixed air units served with pretreated outside air.

2.12 EXHAUST AND INTAKE LOUVERS

- A. Coordinate louver selection with architectural drawings. To allow for future expansion of the HVAC system ventilation requirements, the maximum design face velocity at the louver face must not exceed 450 fpm.
- B. All air intake louvers must include bird screen, and in some cases depending on the location and height of the air intake, the louvers may need to include removable insect screens located on the leaving air side of the louver. This requirement also applies to spaces such as boiler rooms and diesel generator rooms, etc, where combustion air may be required.
- C. Air intake locations shall be coordinated with the building general exhaust system, kitchen exhaust, plumbing vents, generator exhaust, grease traps, trash dumpsters, vehicle exhaust, etc., to avoid introduction of undesirable odors into the building, under all conditions.
- D. The bottom of all outside ventilation air intakes for occupants shall be located as high as practical but not less than twelve (12) feet above ground. Select outside air intake louvers for a maximum face velocity of 450 fpm using a free area of 50 percent.
- E. Due to potential entrainment of contaminated air or odors into outside air intake louvers, A/E

to evaluate the need for a building wind tunnel study, to aid in finalizing the best locations for the ventilation air intake louvers. Ventilation air intakes for occupants shall not be located near potential locations where vehicles idle such as porte-cocheres, garage entrance and exits, loading docks, trash compactors or near LN_2 and CO_2 bulk storage tanks.

PART 3 - SPECIAL CONTRACT DOCUMENT REQUIREMENTS

3.1 GENERAL

- A. The A/E shall include the following on the Contract Documents as applicable to the Project:
 - 1. A schematic of the stairwell pressurization system.
 - 2. A schematic of the outside air distribution system and main air handling unit(s).
 - 3. Enlarged ¼-inch scale of outside air handling unit and floor air handling unit mechanical room plans.
 - 4. Separate mechanical floor plan drawing for each floor.
 - 5. Schedule of air handling unit and each terminal unit indicating inlet size and design airflow rate settings (design and minimum airflow).
 - 6. Schedule minimum and maximum CFM for terminal units.
 - 7. Each item of equipment, including individual terminal units, must have a unique equipment identification number that may be referenced for TAB and BAS Commissioning.
 - 8. Provide a schedule of each fire/smoke damper indicating size, pressure drop, and compliance with maximum velocity limit for use in testing dampers.
- B. All ductwork, without exception, shall be indicated on Drawings in double line format. Minimum rectangular duct size shall be 8-inch x 6 inch.
- C. Do not route condensate drains to discharge through exterior walls, unless approved by Owner. Show all condensate drain piping on Drawings. Include a detail indicating drain trap dimension requirements for each cooling coil condensate drain. The equipment pad height dimension plus the air handling unit frame rail height must exceed the total trap height for floor mounted units. Clearance requirements must also be shown on drawings for ceiling mounted fan coil units. Sizing of coil drain traps shall be in accordance with the detail figures:

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Figure 1. Drain for Draw Through Coil.

Figure 2. Drain for Blow Through Coil.

Piping plugs are to be hand tight to seal openings at top of the pipe tees.

D. Evaluate the effectiveness of pretreating outside air to air handling units, using general exhaust and building relief air with an enthalpy wheel, fixed-plate energy recovery, or heat recovery pipe. Consider energy recovery options such as wraparound coils for energy recovery on once-through air conditioning and ventilation systems.

PART 4 - PRODUCTS

4.1 GENERAL

- A. Refer to Owner's Master Construction Specifications. These are available on the Owner's Design Guidelines website: <u>http://www2.mdanderson.org/depts/cpm/standards/specs.html</u>
- B. Use variable frequency drives for static pressure control.
- C. Do not specify forward curved fans. Owner's preference is direct drive plug type fans.
- D. Main and Intermediate drain pans must be insulated on the bottom of the pan.
- E. Outside air to each air handling unit shall be controlled by modulating motor actuated dampers on the outside air intake or combination dampers on both return air and outside air intake. Depending on the design of the HVAC system, either airflow controllers or CO₂ controllers control the dampers.
- F. A/E to investigate the feasibility of adding bi-polar ionization tubes or similar product in the air handling units under the following applications to enhance indoor air quality and potentially reduce outside air requirements per ASHRAE 62.1 addenda: 1) in 100 percent outdoor air handling units that serve patient care areas and 2) for air handling units that utilize mostly recirculated air that serve office/administrative areas.
- G. Supply and return air duct shall be insulated in accordance with the appropriate Climate Zone where the Project is located and also per the Minimum Duct Insulation R-Value tables in

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ASHRAE Standard 90.1.

- H. Field applied duct lining material is not permitted in the supply air ducts.
- I. Refer to Owner's Master Construction Specifications for acceptable sound attenuators, etc. Refer also to Design Guideline Element D3002 Sound Criteria. Where duct velocity generated air noise is a concern, attenuation options may include oversized duct to permit operation of lower velocities, lower static pressures, and lower fan horsepower.

PART 5 - DOCUMENT REVISION HISTORY

Date	Revision Description	Reviser
20190301	Initial Adoption of Element	
20220215	Clerical edits	BTO
20241202	ASHRAE 170 applicability	TFS
	Date 20190301 20220215 20241202	Date Revision Description 20190301 Initial Adoption of Element 20220215 Clerical edits 20241202 ASHRAE 170 applicability

END OF ELEMENT D3041