1. This information provides guidelines for the design and construction of the air distribution, ventilation, and exhaust portions of heating, ventilating, and cooling (HVAC) systems. HVAC steam and water distribution systems, piping, controls, insulation, commissioning, and temporary facilities and controls are covered in other parts of these standards or are available from the Facilities Management (FM) project representative.

2. FM project representative, FM, Public Safety Office, and Environmental Health and Safety Office shall approve selection of materials, means, and methods. Unless otherwise approved, the design intent requires means and methods that provide minimal disruption to adjacent building activities and operations.

3. When working in or adjacent to occupied buildings, require means and methods that protect occupants from exposure to noise, dust, traffic, and other hazards.

4. FM project representative shall inform FM and other campus departments or groups affected by the work.

5. General:
   a. Air distribution systems shall be designed and constructed in accordance with the latest editions of ASHRAE Guides and Data Book and SMACNA Duct Construction Standards.
   b. Air system design shall consider conservation of energy, noise, relief, pressurization, maintenance, and safety of building user.
   c. Ducting systems to be fully ducted (supply, exhaust, return) in lieu of plenumized return.
   d. Outside air louver intake velocities shall not exceed 400 FPM across the free area.

6. Require design of air distribution systems to comply with "DIV 20 Mechanical Basic Methods and WWU Design Guide Acoustical Standards". Web Link.
   a. Comply with recommended maximum Noise Criteria (NC) in specified rooms.
   b. Minimize noise in HVAC systems: utilize sound attenuators, provide duct liner (as indicated below), provide round or oval ducts in lieu of rectangular, provide low RPM fans, and provide larger ducts to reduce air velocities.

7. Central station air handling units:
   a. Require custom units for building central HVAC systems including supply fan, return or exhaust fan, economizer section, filters, dampers, coils, humidifier, etc.
   b. Unsightly individual rooftop/wall HVAC units are prohibited.
   c. Coordinate air intake location early in the design process. Avoid air intakes from ground level or near any vehicle accessible areas. Separate from any exhaust discharge or plume from sanitary sewer vents, generator exhausts, bathroom exhausts, fume exhaust, etc.
   e. Units shall have UL/ETL listed components, ARI 430 Certification, and NFPA 90 fabrication and installation.
   f. Require manufacturer's recommended clearance on all sides for maintenance access.
   g. Require an economizer control cycle capable of providing 100% outside air. Air system design shall consider conservation of energy, noise, relief, pressurization, maintenance, and safety of building user. AHU/economizers shall not relieve into mechanical rooms.
   h. AHU casings shall be configured as follows:
      i. Access doors shall be provided on motor side of casing to allow for ease of motor replacement.
i. AHU doors shall be hinged and air tight, with latch and locking door hardware. Size required for access. Consultant to specify coordinated full maintenance swing clearance on drawings with all disciplines. Unless otherwise indicated, doors shall swing so that fan pressure or suction holds the doors closed.

ii. Require all units to be specified with pre-wired lights and 120V grounded receptacle connected ahead of the main disconnect by means of fusing and/or transformer. Each section shall have a separate 120V LED lamp fixture with guard and light switch in each compartment mounted near the door. Grounded receptacle shall be mounted on the exterior adjacent to door or access panel.

iii. Doors shall have visible ports into each compartment.

j. AHU fans shall be configured as follows:

i. Fan sections shall include fan with motor and drive mounted on a common base within an insulated galvanized steel casing.

ii. Factory test fan performance per AMCA 210, 300, 301.

iii. Fans shall be “V” belt drive.

iv. Fan assemblies statically and dynamically balanced and designed for continuous operation at speeds specified throughout range of rpm and motor torque experienced.

v. Provide with sealed bearings where possible. If non-sealed bearings are used, provide means for remote lubrication.

vi. The number and size of the belts shall be determined by the drive manufacturer and shall be sized for 150% of nominal motor capacity.

vii. Adjustable drive sheaves shall be provided for balancing the fan system. After balancing, fixed sheaves of the required size shall be provided and installed by the mechanical contractor. If Variable Frequency Drives (VFD) is on the fan motor, the set point for the fixed sheave shall be at 60hz.

viii. VFD shall be preapproved by WWU project representative and Technical Maintenance. Preferred products are Danfoss and ABB.

ix. Motors operated by VFD shall be high efficiency and rated for VFD application.

x. Fans shall have OSHA approved, easily de-mountable belt guards. Prime coated, painted yellow. Belt guards for fans shall be mounted outside of cabinets.

xi. Bearings shall be L-50 200,000 hour average life (ABMA 9 or ABMA 11).

xii. Motors shall be on an adjustable base to aid in belt tightening.

xiii. Fan base shall be fully internally spring isolated with a minimum of ¾” to 1” (13 to 25 mm) deflection. Flex connections shall not be required on fans that are internally spring isolated. Fans shall be provided with internal thrust springs if required for specified operating conditions.

xiv. Contractor shall provide one set of replacement “V” belts and two sets of all air filters (including pre-filters).

xv. Main disconnect shall come factory mounted, including units that contain multiple fans. Exception: When supply or exhaust fans are required to be connected to the emergency system.

k. AHU coils shall comply with the following:

i. Preheat coils are mandatory for all AHUs.

ii. Require hot water as the heating medium for heating coils.

iii. Steam coils are acceptable only for preheat or for a remodel when an existing building employs steam coils. Steam coils shall be rated at 125 (861 kPa) psig. Provide a maximum inlet steam pressure of 15 (103 kPa) psig. Steam coils shall be non-freeze type and be self-draining.

iv. Locate coils to allow access for water jet or steam cleaning.

v. Require drain pans under all cooling and heating coils to allow for drainage of
condensation and cleaning water. P-traps from drain pans shall be sized appropriately and be piped to an indirect sanitary drain with air gap.

I. AHU filter requirements:
   i. Filter rack assemblies shall be properly blanked and structurally supported off to the sides, floor, and roof so as to be sealed to prevent air bypass through filter bank. Provide pressure gauges equivalent to Dwyer Series 2000 Magnahelic Pressure Gauge across each filter bank.
   ii. Filter banks for multiple fan units shall be divided and isolated with operable automatic damper systems to allow filter replacement per fan without turning off all fan units.
   iii. Velocities across filter banks shall not exceed the manufacturer's filter FPM rating or 350 FPM, whichever is less.
   iv. Western's standard minimum filtration efficiency for pleated filters is per LEED standards (MERV 8 typical, higher efficiency review with FM). Pleated filters are the standard for typical office and classroom facilities. When higher levels of efficiency are required, coordinate with FM on the appropriate and maintainable percent and filter type.
   v. All air stream filters over 2" (50mm) in depth must have a pre-filter with installation frame.
   vi. Provide a minimum of three feet clear unobstructed space with an access door in front of the filter banks for maintenance access. This space does not include the depth of the filters.
   vii. At a minimum, one set of filters is required to be installed prior to final TAB, and one new set is required to be stored for the owner’s use after substantial completion.
   viii. Do not operate any AHU systems without filtration on return and supply air.
   ix. Provide space in the mechanical room containing the AHU for storage of one full set of filters, pre-filters, and replacement "V" belts.

m. AHU damper requirements:
   i. Require AHU manufacturer to provide low leak dampers.
   ii. Damper frames shall be constructed of 13 gauge or heavier galvanized sheet metal and shall have flanges for duct mounting.
   iii. Damper blades shall not exceed 6" (150mm) in height.
   iv. Damper actuators shall be electric 120 V DDC. Locate all actuators outside of the airstream, readily accessible for maintenance. Require actuators to be mounted indoors and protected from the weather.

8. Terminal units:
   a. Variable air volume (VAV):
      i. Locate at accessible locations for maintenance.
      ii. Seals, gaskets, and moving components shall be specified for a minimum of 20 year service life.
   b. Hot water reheat coils:
      i. Locate at accessible locations for maintenance.
      ii. Provide isolation valves before and after so coils can be replaced without draining whole system.
      iii. Provide accessible high point bleed.

9. Exhaust fans:
   a. Require a main disconnect for each fan.
   b. Require a grounded receptacle adjacent to fan for service work. Coordinate roof top locations and waterproofing details with architect.
   c. Fans shall be "V" belt drive. Require contractor to provide one set of replacement "V" belts.
   d. During design, demonstrate maintenance clearances on the drawings and coordinate
clearances with all disciplines.
e. Keep discharge points as far as practical from any air intakes or operable windows. Be aware of natural air flows such as hot discharge air rising even if minimum code required separations are satisfied. Watch for potential short cycling of air.
f. Verify acoustic isolation for any fans located in close proximity or above ceilings of noise sensitive areas.
g. Cased units: Follow similar requirements as AHU cased units.
h. Rooftop units: Coordinate service access route with architect and roof membrane protection zones for service.
i. Type I kitchen hoods: Provide grease collection and containment to avoid safety hazards and damage to roof membranes.
j. When exhausting hazardous materials or any fumes, provide verification that contamination levels are acceptable for the general public, occupants, operable windows, and other facility air intakes. When required, provide wind tunnel modeling and engineering studies.
k. Preferred manufacturer: Greenheck, Cook.

10. Ductwork construction and installation:
   a. General: Require galvanized steel sheet ductwork complying with ASTM A 653, lockforming quality, with G 90 zinc coating in accordance with ASTM A 525.
   b. Corrosive or harsh environment: Fume hoods, exterior installation.
      i. Galvanized steel sheet with vinyl coating permitted for corrosive exhaust system.
      ii. Stainless steel: ASTM A 167, type 302, 304, or 316 as required by applications. Provide number 4 finish where exposed to view and number 1 finish elsewhere.
   c. High humidity environment: Shower rooms, pools, etc.
      ii. Stainless steel: ASTM A 167, type 302, 304, or 316 as required by applications. Provide number 4 finish where exposed to view and number 1 finish elsewhere.
   d. Flexible duct:
      i. Provide only at final connections to terminals above suspended ceiling.
      ii. Spiral wound spring steel with flameproof vinyl sheathing complying with UL 181.
      iii. Provide 1" (25mm) thick continuous flexible fiberglass sheath with vinyl vapor barrier jacket.
      iv. The maximum straight length for any duct run using flexible ductwork shall be 6'-0". Provide rigid metal elbows. No turning vanes. Stretch flexible duct to minimize kinks and sags.
   e. Prohibit fiber board duct material.
   f. All ductwork shall come sealed to jobsite and maintained in clean condition.
   g. Follow SMACNA duct sealing class requirements, UL listed sealant types, and methods of sealing. Duct tape not allowed. Masonry or CMU walls shall not be used in lieu of sheet metal in plenums.
   h. Require protection of all ductwork from potential damage.
   i. Provide high/low limit static pressure sensors that will shut down fans in controlled manner and require manual reset.
   j. Avoid square right angle turns in main duct runs, provide radiused turns instead. Provide turning vanes and pressure drop calculations during design for unavoidable tight configurations.

11. Duct accessories:
   a. Diffusers and grilles for new facilities shall be from one manufacturer.
   b. Turning vanes:
      i. Install perpendicular to the entering air and leaving air to minimize air flow turbulence.
ii. Prohibit in exhaust air duct systems.
iii. Prohibit in duct systems downstream of fiberglass duct liner.
c. Dampers – general:
   i. Damper frames shall be constructed of 13 gauge or heavier galvanized sheet metal and shall have flanges for duct mounting.
   ii. Damper blades shall not exceed 6” (150mm) in height.
   iii. All dampers shall be readily accessible.
d. Manual balancing/volume dampers:
   i. Provide readily accessible damper in each duct to a single terminal outlet or inlet, located at the connection to the main branch. Locking quadrants shall be provided for each balance damper. Require testing and balancing contractor to clearly mark setting for final acceptable testing and balancing.
   ii. Opposed blade or parallel dampers at face and neck of terminal diffusers or registers shall not be utilized as a balancing device in order to minimize potential unacceptable room noise levels.
   iii. Indicate location of all balancing dampers on contract drawings.
   iv. Require contractor to clearly mark locations of all installed balancing dampers for testing and balancing field work.
   v. Remote dampers above hard lids shall be hard shaft controlled. Prohibit use of cable shaft remote dampers.
e. Duct access doors: Require rated and listed access doors at coils, UL fire dampers, and turning vanes to permit required adjustment, resetting, and cleaning.
f. Motorized Fire/Smoke Dampers: install within 3’ a single pole 120V disconnect switch at each location for local control.
   i. Require contractor to visibly mark with a 1” red circular sticker at T-Bar locations of all installed Motorized and non-motorized Fire/Smoke Dampers.
   ii. Provide Belimo actuators for all fire/smoke dampers.
   iii. Provide accessibility for inspection, maintenance and replacement without disassembly of other components or assemblies.

12. Sound attenuators:
   a. Sound attenuator materials shall be compatible with the specific application and adjacent ductwork materials.

13. Duct liner:
   a. Application of fiberglass duct liner within air distribution systems shall be subject to FM project representative’s approval.
   b. Duct liner shall be only used near air handlers and mechanical rooms where access is readily available and listed hatches are installed.
   c. Duct liner coatings shall be fiber free in airstream with EPA approved biocide.
   d. Acceptable manufacturer: Knauf Ductliner “M” or approved alternate.
   e. Prohibit duct liner up stream of coils or turning vanes.
   f. Prohibit duct liner in exhaust ducts and outside air intake ducts where moisture can deteriorate the liner.
   g. Require fan plenums to be lined with fiberglass protected with metal perforated plates.
   h. Insulated equipment casings shall be specified with a hard, cleanable surface exposed to air stream.

End