Compliance: Outdoor air ventilation shall be introduced into each occupied building space in compliance with *ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality as well as ASHRAE Standard 90.1 – Energy Standard for Buildings.* The goal is to provide adequate quantity and quality of ventilation air in an energy efficient manner.

Central Systems: As stated within the *HVAC Systems* section within these *General Guidelines e*ach building shall be served by a minimal number of high quality central HVAC systems rather than numerous smaller systems. Each central ventilation system shall typically include an air handling unit, a return and/or exhaust fan or fans, air supply, return and/or exhaust ductwork and terminal units and devices.

System Configuration: As stated within the *HVAC Systems* section within these *General Guidelines* HVAC systems shall be configured such that spaces with similar usage are served by a common dedicated unit. Spaces with significantly dissimilar usage types or schedules shall not be served by the same system.

Future Expansion: Within practical limitations each ventilation system shall be sized and configured to accommodate potential future expansion of load and/or infrastructure.

Future Conversion: Ventilation systems may be designed (sized and configured) for future space-type conversion. However, this is not allowed in cases where significant energy penalty would result. For example, a non-lab space shall not be provided with once-through ventilation "just in case" it might be converted into a wet lab in the future.

Air Handling Units: Central air handling units with design airflow greater than 5,000 CFM shall be custom units as specified within *Section 23 73 23 – Custom Air Handling Units* within these *Facilities Standards*. Air handling units with design airflow less than 5,000 CFM may be either modular or custom units. Exception: All units with energy recovery wheels or heat pipe coils shall be custom units. Draw-through shall be the default configuration. However, with the increased application of plenum fans (as opposed to housed centrifugal fans) in conjunction with AHU supply plenums blow-through configuration has become a viable option for improving airflow mixing. It should be kept in mind that a simple blow-though unit typically discharges supply air into the duct system at a higher relative humidity than a comparable draw-through unit. Supply airflow can approach the saturation point unless heat is added or moisture removed downstream of the cooling coil.

DOAS: Installation of dedicated outdoor air and dual path ventilation system configurations are encouraged where applicable and beneficial to overall system performance. The installation of such systems shall not reduce the requirement for <u>100% economizer</u> on systems with return air. (See paragraph below entitled *Economizers.*)

Equipment Location: As addressed within the *HVAC Systems* section within these *General Guidelines* mechanical equipment shall be located within indoor equipment rooms with the exception of roof mounted exhaust fans. However, it is acknowledged that for building renovation projects adequate space may not be available to comply with this requirement. This is particularly the case with new air handling equipment incorporating one or more energy recovery wheels. Thus, it is deemed acceptable to locate sizable air handling unit(s) on the roof of existing buildings if there is no practical alternative. This presents two options: 1) Provide a structural "brick and mortar" penthouse mechanical room to protect these units from the weather and facilitate service or 2) provide outdoor units that are the equivalent of such equipment rooms in terms of quality and functionality. From this perspective an expensive unit becomes inexpensive in relative terms. When locating equipment on roofs sight lines and aesthetics shall be key considerations. Approval of such shall be obtained from the Architect and Owner as design progresses. Provision of architectural screening or cladding may be required to gain such approval.

Access: Access from the building interior to roof mounted air handling equipment shall be adequate to facilitate anticipated maintenance and repair activities. In many cases installation of full size interior or exterior stairs are required to satisfy this requirement. See *Roof Access* section within the *Building Elements* section within these *General Guidelines* for specific requirements. Ladders, platforms and walk ways shall be provided as required to provide safe and convenient transport to roof-mounted equipment access points. Particular attention shall be given to transport of boxed air filters given the difficulty of handling these bulky items.

Energy Recovery: Ventilation system design shall incorporate energy recovery opportunities to the greatest degree practical. See the *Energy Recovery Systems* section within these *General Guidelines* for specific air distribution/exhaust system requirements related to energy recovery. As addressed in the section entitled *Laboratory Ventilation* within these *General Guidelines* general lab exhaust systems shall be separated from fume hood exhaust systems to facilitate optimized heat recovery for each system type.

Economizer: Each air handling system for which a return fan is required (see paragraph entitled *Return Fans*) shall include a 100% air-side economizer unless the design of the air handling system precludes its use. Additionally, requirement for air-side economizer shall comply with the requirements of *ASHRAE Standard 90.1* at a minimum.

Minimum OA: "Minimum outdoor air dampers" shall be provided as applicable to ensure provision of and optimized control of required ventilation and makeup air during periods of reduced total outdoor airflow.

Air Stream Mixing: Inadequate mixing of return air and outdoor air streams at air handling units (AHUs) is the single greatest recurring problem the University has experienced with air handling systems over the years. Effective mixing of air streams is essential in preventing coil freeze-up problems and nuisance trip-outs of freeze protection safeties. For mixed air units. The mixing area upstream of each AHU shall be configured such that air streams mix thoroughly prior to entering the unit. The University has found that, for the most part, standard mixing box design is woefully inadequate. A design that ensures good mixing typically requires increased length of the AHU/duct assembly and, in turn, increased space requirements within the mechanical equipment room. A down-sized equipment room is the worst enemy of good mixing. A configuration that introduces return air beneath outdoor air as the two air streams move into the mixing area is preferred. Dynamic mixing of the two air streams is essential. Optimized control damper selection (parallel vs. opposed blade), sizing and orientation is important in this regard. Air handling units in variable air volume (VAV) systems are especially susceptible to poor mixing. The use of special air blending devices located within air handling units or mixed air plenums is viable. However, the use of these devices shall be treated as a secondary rather than primary means of achieving thorough mixing. In other words, they shall be viewed as "insurance" rather than an essential component. When used, the length of airflow downstream of the device shall be substantially greater than the manufacturer's published minimum.

Fans: Housed centrifugal fans and plenum fans are both approved for use in air handling units and associated return/exhaust fans in ducted ventilation systems. Fan arrays are approved but shall not necessarily be treated as default design as seems to be the current trend in the industry.

Return Fans: Each air distribution system with return airflow rate of 3,000 CFM or more shall incorporate a return fan. The fan and ductwork shall be configured such that the fan is located in the return air path rather than the relief air path. In other words, it shall be a true return fan rather than a relief air fan.

EC Motors: As required by *ASHRAE Standard 90.1* fan motors that are 1/12 HP or greater and less than 1 HP shall be electronically commutated motors or have a minimum motor efficiency of 70% when rated in accordance with *Dept. of Energy 10 CFR Part 431*. The use of EC motors is generally encouraged for single phase motorized equipment.

System Effect: When ductwork is attached to the outlet connection of a housed fan, a length of straight duct shall be provided prior to the first fitting or transition, thus minimizing “system effect”. This maximizes efficiency and minimizes noise. The minimum length of this section of duct shall be calculated using the formulas provided within the chapter entitled *Duct Design* in the current edition of the *ASHRAE Fundamentals Handbook*. Typically, the application of these formulas yield a minimum straight duct length that is equal to 2 to 3 times the diameter of the equivalent round fan outlet opening. Adequate space shall be provided within the mechanical equipment room to accommodate this. System effect on the inlet side of fans shall also be minimized by ensuring a uniform inlet air velocity profile. This applies to fans with either ducted or un-ducted inlets. Again, this requires adequate space within the equipment room.

Vibration Control: All sizable fans shall be supported by properly selected spring type vibration isolators in order to minimize transmission of vibration into associated equipment and building structures. Such isolation is much more critical on upper levels of a building than on lower levels. Thus, the University’s preference is that large rotating equipment be located in equipment rooms at the lowest level. Flexible duct connections shall be installed at all points of connection between fans and associated air distribution ductwork regardless of location in order to minimize transmission of vibration into and throughout duct systems. Exception: Flexible connections may not be required for small in-line fans, roof exhausters and some fume exhaust fan installations.

Sound Control: The use of sound attenuating devices within supply and/or return air duct systems is often necessary. However, the best way to control noise is to not create it in the first place. When the efficiency of air distribution systems is maximized noise becomes much less of an issue. This is accomplished via proper fan selection/sizing, duct design and terminal device selection/sizing (i.e. VAV boxes, diffusers and grilles). As stated elsewhere, the allowable HVAC-related background noise level for a given type of occupancy shall not exceed the guideline criteria provided within the chapter entitled *Sound and Vibration Control* in the current *ASHRAE HVAC Applicatio*ns Handbook. With rooftop HVAC units of any size/type, sound and vibration problems abound. Supply ducts oriented vertically downward consistently create problems. As a result, the University strongly discourages the installation of rooftop units. In such cases when a rooftop unit is permitted, special steps shall be taken to prevent these sound and vibration problems from occurring.

Dampers: All automated dampers shall satisfy the requirements of *Section 23 09 13 – Control Dampers.* Exception: Standard quality dampers are acceptable when factory-mounted on small roof exhausters and similar equipment. Gravity relief dampers are not allowed for any application unless approved by Owner. If approved, gravity relief dampers shall be premium quality counter-balanced type.

Filtration: As a general rule, unless specific requirements dictate otherwise, supply airflow serving standard building environments shall be filtered by 4” pleated MERV 8 (30% efficient) pre-filters followed by 22” bag-type MERV 11 (65% efficient) secondary filters. Supply airflow serving special building environments (e.g. laboratories where cleanliness is more critical) shall be filtered by MERV 8 (30% efficient) prefilters followed by MERV 14 (95% efficient) secondary filters. This more stringent level of filtration may also be required to comply with LEED requirements. Certain devices in return or exhaust systems may also require filtration. Heat wheels and heat pipe coils serve as examples. Such devices shall be protected by 4” MERV 8 filters. Secondary filtration is typically not required. Exceptions: 1) Secondary filters are typically not required for air distribution systems of less than 3,000 CFM total capacity. It is typically acceptable to filter supply airflow through these smaller systems with 4" MERV 8 (30% efficient) filters with no additional secondary filtration. 2) Filters serving small unitary equipment (e.g. fan coils) may be 2" or even 1" if limited space within these units dictates. Regardless, all such filters shall be of the pleated type. (MERV Ratings are per *ASHRAE Standard 52.2.* Filter % efficiencies are dust spot efficiency ratings per *ASHRAE Standard 52.1.)*

Humidification: As stated within the section entitled *HVAC Systems* within these *General Guidelines* space humidification shall not be provided unless required for a specific application. When humidification is required it shall be provided by means of a steam-to-steam reboiler type humidifier with dispersion manifold located within the applicable air handling unit. Humidifier manifolds/dispersion devices shall not be located within air distribution ductwork.

Displacement Ventilation Systems: Use of displacement ventilation (DV) systems is encouraged where appropriate. DV systems shall be treated as default approach ("plan A") for large spaces with high ceilings (e.g. atria) and spaces with high occupant densities (classrooms and auditoriums). DV systems shall also be treated as default for introducing large volumes of air into spaces in which air turbulence is problematic (e.g. kitchen exhaust hood makeup, laboratory fume hood makeup.) Floor level diffuser location is default for occupied spaces. Ceiling level is allowed for kitchen, laboratory, and similar applications where floor level is impractical. DV systems shall be considered for any application where high air quality, minimal drafts and low noise are deemed important. Use of DV systems does not in any way reduce requirement for baseboard heating of exterior spaces as addressed in *Heating Systems* within these *General Guidelines*.

Intake Location: It is generally preferred that outdoor air intake openings be located well above ground level to avoid typical lower level contaminants as well as any intentional harmful contamination. When a ground level installation cannot be avoided, the bottom of each intake opening shall be located a minimum of 3 ft. above the adjacent ground level. When an areaway is used as a means of providing outdoor air to below-grade equipment, compliance with the dimensional requirements set forth in the *Areaways and Window Wells* section within these *General Guidelines* is mandatory. This includes a requirement that each areaway and/or window well be extended a minimum of 1 ft. above adjacent grade level to minimize the entrance of leaves, debris and drifting snow. When selecting locations for outdoor air intake openings, it is essential that prevailing wind direction, building configuration, adjacencies and sources of odors/contaminants be considered. Vehicle exhausts from streets and loading dock areas as well as exhaust from emergency generators are common culprits for causing indoor air quality problems. The same is true of laboratory fume exhausts. In compliance with applicable codes and standards, minimum distances from various sources of contamination (e.g. sanitary vents, toilet exhausts, etc.) shall be maintained. Coordination is needed between designers who locate sources of contamination (i.e. Architect) and those who endeavor to minimize their effect (Engineer).

Intake Louvers: Outdoor air intake louvers shall be sized generously to prevent the carryover of rain and snow into associated ventilation systems. Light powdery snow is especially difficult to remove from the air stream regardless of louver type. Thus, air velocity across the net free area of any intake louver shall not exceed 500 FPM. If, due to unalterable existing conditions, (such as historic preservation requirements) it is not possible to comply with this limitation, a louver rated for wind driven rain shall be used. If a horizontal wind driven rain louver is used in such cases (only) the air velocity across the net free area shall not exceed 700 FPM. If a vertical wind driven rain louver is used air velocity across the net free area shall not exceed 900 FPM. In such cases special provision shall be made to capture rain and snow within the building and direct it to drain. Any design that incorporates louver air velocity in excess of 500 FPM requires approval of *F&S Engineering*. Proper configuration and flashing of the outdoor wall sleeve and associated louver is critical, particularly when mullions or other vertical members are involved. Wall sleeves and louvers are almost never flashed properly. See *Drawing*

23 37 00-1, Louver Installation Detail. Bird screen shall be installed at each outdoor air intake opening. It shall be installed on the exterior of louvers as required by *ASHRAE Standard 62.1* in order to prevent the roosting and nesting of birds which is a serious ongoing problem at numerous locations on campus. (See the *Bird and Pest Control* section within these *General Guidelines*.)

Outdoor Air Plenum: A plenum shall be provided inside each outdoor air intake louver to serve as a "stilling chamber" to remove entrained rain and snow from the air stream. Plenums associated with wall louvers shall be of adequate depth (in direction of airflow) to ensure that air velocity profile is consistent across the full face of the louver. Inadequate louver depth results in localized areas of high velocity flow. Outdoor air ductwork connected to the plenum shall also be sized and configured to facilitate even air distribution at the louver. It has been the University's experience, plenum depth is often inadequate. This results in localized areas of high air velocity through the louver in the immediate area(s) of duct connection(s). Each plenum shall include a basin at the bottom designed for collection and re-evaporation of snow and water. Where substantial entrance of snow or water is anticipated a piped drain that directs water to an interior floor drain shall be provided. In cases where a wall louver is dedicated to a single outdoor air duct, it is preferred that a full size transition fitting be used in lieu of a "box plenum". In such cases the bottom of the transition fitting shall be pitched toward the louver such that water drains back outdoors. As addressed in the paragraph above entitled *Intake Lou*vers proper configuration of the duct/louver connection is critical. An access door shall be provided at each plenum/duct to facilitate cleaning of the louver / bird screen and shall be as large as practical. Plenums shall have adequate structural strength to support the weight of service personnel who enter to perform maintenance/cleaning. See *Drawing 23 37 00-2, Plenum Construction Detail*.

Roof Intake: When an outdoor air intake hood or louvered penthouse is located at the roof level of a building it shall be installed in a manner that minimizes the potential for snow penetration. Toward this end, the lowest point at which air may enter the device shall not be less than 24" above the adjacent roof surface. In locations which are vulnerable to snow drifting this dimension shall be increased as appropriate. When an intake hood is used the air velocity across the total effective intake opening shall not exceed 300 FPM and the associated throat velocity shall not exceed 600 FPM. It shall be noted that louvered penthouses are particularly vulnerable to rain and snow penetration due to increased velocity of wind at the roof level in conjunction with a design that allows air to blow through the device horizontally. (i.e. air enters the windward side and exits the leeward side). For this reason, the use of louvered penthouses is generally discouraged. When these devices are used they shall incorporate wind driven rain louvers. The air velocity across the total effective intake opening shall not exceed 300 FPM and the associated throat velocity shall not exceed 600 FPM. Each vertical outdoor air duct or plenum shall include a basin at the bottom designed for collection and re-evaporation of snow and water. Where substantial entrance of snow or water is anticipated, a piped drain shall be provided that directs water to an interior floor drain. One or more hinged access doors shall be provided as required to gain full access to the motorized outdoor air damper and collection basin. See *Drawing 23 37 00-03, Roof Intake Detail*.

Relief Location: Each relief air opening shall be located, at an absolute minimum, 10 ft. from the nearest outdoor intake opening. Consideration shall be given to the prevailing wind direction, building configuration, intake and relief opening orientation, etc. when locating outdoor air and relief air openings to minimize the potential for recirculation of relief air back into the intake air stream. Such consideration will almost always dictate a separation distance that exceeds that which is required as a minimum. Relief air shall be ducted directly to the outdoors rather than being discharged into a mechanical equipment room or other interior space. It is acknowledged that there may be advantage in some cases to discharging relief air into an equipment room. In such cases approval of *F&S Engineering* is required.

Relief/Exhaust Louvers: Requirements for intake louvers as listed above in the paragraph entitled *Intake Louvers* shall be applied to relief air and exhaust air louvers with the exception of the stated velocity limitations.

ASHRAE Handbook: *HVAC Applications - Building Air Intake and Exhaust Design* shall serve as a noteworthy reference for the paragraphs above addressing air intake and exhaust design.

Ductwork: The importance of optimized duct design is cannot be overstated yet is often overlooked. Ductwork is more than just getting air from point A to point B in an acceptable manner. The impact of duct air pressure loss and resultant fan energy consumption can be huge. Engineers often work hard to minimize pressure drop within air handling equipment and then all but ignore the impact of duct pressure drop. Reducing distributed duct pressure drop and associated noise generation by upsizing ducts is helpful but installation of proper fittings is typically even more critical. Sudden expansions and contractions at duct-to-plenum connections are common violations of good design. Expanded area or oversized bell mount connections shall be consistently utilized. All applicable *SMACNA* standards shall be applied. In order to ensure proper installation, ductwork shall be clearly laid out and drawn to scale on project drawings. Adequate coordination with other systems shall be provided and focused oversight shall be provided during construction to ensure compliance. Exterior supply and return ductwork shall generally be kept to a minimum and shall be limited to that directly connected to roof top air handling equipment. All exterior ductwork shall be round with the exception of plenums and transitions. Exterior duct insulation shall comply with *Section 23 07 13 – Duct Insulation.* Lagging in particular shall be skillfully installed to prevent eventual ingress of water into the insulation system. This is of particular concern based upon negative past experience with saturated fibrous exterior insulation systems. Uninsulated exterior ductwork (e.g. exhaust ductwork) shall be stainless steel construction.

Duct Leakage: Duct leakage tests shall be performed on 100% of medium pressure ductwork rather than 25% as required by *ASHRAE Standard 90.1*. For low pressure ductwork testing a representative 25% is acceptable. All metal ductwork shall be SMACNA Seal Class A with all joints, seams and wall penetrations sealed. All rectangular ductwork shall be SMACNA Leakage Class 6 and all round metal ductwork shall be Leakage Class 3. All rectangular ductwork shall have Pittsburg type longitudinal seams to maintain seam integrity. Snaplock seams are not allowed.

Supply Air Velocity: For the purposes of this writing, a low pressure air distribution system is defined as a system with duct static pressure less than or equal to 2” wc. A medium pressure air distribution system is defined as a system with duct static pressure of greater than 2” and less than or equal to 6” wc. Air velocities within low pressure supply ducts including those located downstream of VAV and constant volume boxes shall not exceed 1,200 FPM. Branch run-outs to individual grilles and diffusers shall not exceed 600 FPM. Air velocity within medium pressure supply ducts shall not exceed 2,400 FPM.

Fibrous Lining: Fibrous lining shall not be installed within an air handling or air distribution system with the following exceptions:

- Within room-to-room and room-to-plenum return air transfer “boots”.
- Within other ductwork and system components (e.g. air handling units, attenuators, VAV terminal units, etc.) where the fibrous material is completely sealed within a Tedlar or Mylar membrane and is separated from the air stream by a perforated metal barrier.

Additional conditional exception:

- With written permission from *F&S Engineering*, fibrous lining may be provided within limited lengths of readily accessible sections of supply air ductwork downstream of terminal VAV or CAV units given that the lining incorporates a protective coating (e.g. neoprene) and is carefully sealed at joints to prevent any erosion of fibers.

This exception will only be considered for systems serving non-standard spaces with very low allowable sound levels where adequate sound attenuation cannot be achieved by application of standard noise control measures. Such applications are rare.

Flex Duct: The use of flexible duct shall be limited to low pressure duct systems. Within these systems it shall be limited to final connections to diffusers and grilles. Flex duct shall not be used in medium pressure duct systems (e.g. inlet connections to VAV boxes). Each segment of flex duct shall be limited to 6' maximum length. Flex duct shall be supported by pre-manufactured devices designed specifically for this purpose. The use of wire, tie wraps, duct tape or fabric is not allowed. Where a change in orientation from horizontal to vertical is required (e.g. at a final connection to a diffuser or grille) a metal elbow shall be used. In lieu of a metal elbow flex duct may be used to "turn the corner" if a support saddle is provided to prevent kinking. The support saddle shall be pre-manufactured. Flex duct shall be high quality (e.g. MK

VAV Boxes: All VAV boxes shall be fitted with reheat coils. VAV boxes shall not be lined with fibrous material. They shall either be double wall construction or shall be single wall construction with fiber-free liner. Airflow measuring sensors shall be metallic construction to prevent potential of over-heat failure as has been experienced by the University multiple times in previous years. Sensors shall be configured in a grid pattern and shall not be linear probes.

Air Terminal Devices: The use of sidewall supply grilles shall be avoided where possible. They are notorious for causing uncomfortable drafts. Properly sized and located ceiling diffusers are preferred. Supply air diffusers shall be carefully selected to prevent "dumping" of cold air at minimum flow conditions. The use of high performance diffusers shall be standard practice. Supply diffusers and grilles shall be selected and installed so as to direct a greater percentage of the supply airflow toward the source of the heating/cooling load (e.g. toward exterior walls). In exterior spaces where no perimeter heating unit(s) have been provided, slot diffusers (or equivalent) shall be provided near the exterior wall(s) to deliver supply air downward at high velocity to "reach the floor" with warm supply air in the heating mode. Diffusers associated with displacement ventilation systems shall be perforated type specifically designed for application. For special requirements for terminal devices in laboratory applications see *Laboratory Ventilation* section within these *General Guidelines.*

Supply Plenums: Ceiling supply plenums are not allowed other than in clean rooms and similar research applications. In such cases they shall be carefully cleaned, sealed and leak tested. Floor supply plenums are approved when used in conjunction with a displacement ventilation system. Similarly, they shall be thoroughly cleaned, sealed and leak tested.

Ducted vs. Plenum Return: In general, it is preferred that air from ventilated spaces be returned to associated air handling equipment via ductwork rather than through ceiling plenum(s). The use of return air ductwork has the advantage of maintaining better return air cleanliness, being easier to balance and allowing the use of standard products above ceilings rather than plenum rated products. The use of ductwork also ensures that return air passageways do not become obstructed as a result of installation of other systems (e.g. supply ductwork, sprinkler piping, electrical conduit, cable tray, etc.) However, it is acknowledged that project budget may not support this approach. Thus, the use of ceiling return air plenum(s) for offices, classrooms and similar finished spaces is approved given that plenum rated cable and devices are installed and an unobstructed return air path is provided. Achieving an unobstructed path may require a combination of ducted and plenum systems.

Airflow Through Passageways: The use of an exit passageway, stair, ramp or other exit as a part of a supply, return, or exhaust air system serving other areas of a building is prohibited except as permitted by the *International Building Code* and the *International Mechanical Code*. Such prohibition applies to major renovations of existing buildings as well as to new structures. Existing air distribution systems that utilize any of the exit elements of a building may not be altered in any way that reduces the level of life safety. Any alteration of an existing non-compliant system shall be approved by Owner. Approval will not be given to any proposed alteration unless it is clearly demonstrated that such alteration will not result in a reduction in occupant safety. Note: For the purposes of this writing, a building will be considered to undergo a major renovation if either the existing air distribution system or the interior space arrangements and/or structure are modified to an extent that the renovation costs exceed 25 percent of the replacement cost of the distribution system or structure.

Makeup Air: Conditioned makeup air shall be delivered in a deliberate manner into each space from which air is exhausted. The makeup airflow rate shall be approximately equal to the exhaust airflow rate. For lab applications airflow rates shall be accurately monitored and controlled.

Toilet Exhaust: Multiple toilet rooms shall be served by a common exhaust system. Janitor rooms are typically served by the same system. When zoning such systems, consideration shall be given to coordinating exhaust zones with air supply zones. This approach allows supply and exhaust systems serving a common area to be cycled on and off together. Exhaust air from toilets shall be discharged in an appropriate manner at roof level to minimize potential for recirculation back into air intake opening(s).

Airflow Monitoring Stations: The successful installation of accurate and reliable duct-mounted airflow monitoring stations has proven to be especially challenging if not impossible. They are rarely installed properly resulting in compromised accuracy. In order to ensure proper installation, airflow monitoring stations and associated ductwork shall be clearly laid out and drawn to scale on project drawings. Adequate coordination shall be provided and focused oversight shall be provided during construction to ensure compliance. During operation, airflow monitoring stations become dirty quickly resulting in further compromised accuracy as time passes. They must be cleaned and recalibrated on a regular basis in order to maintain accuracy and repeatability. Thus, airflow monitoring stations shall be used only as required to satisfy applicable codes and standards. It is acknowledged that they may also be required to accomplish optimized control strategies when no other viable option exists. Typically, pressure feedback control shall be used in lieu of airflow monitoring stations to provide control of building pressurization. When possible, demand control of ventilation using CO2 feedback shall be used in lieu of quantitative airflow monitoring to ensure minimum ventilation air requirements are satisfied. Monitoring stations shall be protected from fouling by location in filtered airstreams if possible.