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Application Manual for Air Curtains

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

The International Authority on Air System Components

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Application Manual for Air Curtains

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Authority

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Related AMCA Standards and Publications

AMCA 211 *Certified Ratings Program - Product Rating Manual for Fan Air Performance*

ANSI/AMCA 220 *Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Ratings*

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Application Manual for Air Curtains

1. Purpose

The purpose of this application guide is to familiarize the reader with air curtain unit (ACU) technology.

2. Scope

This document covers ACU theory, components, construction, testing and certification of ratings, applications, benefits, selection, purchase, installation, service and maintenance.

3. Definitions - Units of Measure - Symbols

3.1 Definitions

3.1.1 Air curtain (airstream). A directionally-controlled air curtain, moving across the entire height and width of an opening, which reduces the infiltration or transfer of air from one side of the opening to the other and/or inhibits flying insects, dust or debris from passing through. For the purposes of this publication, "air curtain" and "airstream" are synonymous.

3.1.2 Air curtain depth. The air curtain dimension perpendicular to both the direction of airflow and the air curtain width; the short dimension of the air curtain.

3.1.3 Air curtain width. The air curtain dimension perpendicular to both the direction of airflow and the air curtain depth; the long dimension of the air curtain.

3.1.4 Air curtain unit (ACU). An air moving device that produces an air curtain.

3.1.5 Air discharge nozzle. A component or assembly, which may include adjustable vanes in the ACU, that directs and controls the air curtain.

3.1.6 Air discharge nozzle depth (N_d). The inside dimension perpendicular to both the direction of airflow and the air curtain width.

3.1.7 Air discharge nozzle width (N_w). The inside dimension perpendicular to both the direction of airflow and the nozzle depth.

3.1.8 Air discharge angle (θ). The angle between the plane of the protected opening and the direction in which the air curtain leaves the discharge.

3.1.9 Psychrometrics (From ANSI/AMCA 210)

3.1.9.1 Dry-bulb temperature (t_d). The air temperature measured by a dry temperature sensor.

3.1.9.2 Wet-bulb temperature (t_w). The temperature measured by a temperature sensor covered by a water-moistened wick and exposed to air in motion. When properly measured, it is a close approximation of the temperature of adiabatic saturation.

3.1.9.3 Wet-bulb depression. The difference between the dry-bulb and wet-bulb temperatures at the same location.

3.1.9.4 Stagnation (total) temperature. Stagnation (total) temperature is the temperature which exists by virtue of the internal and kinetic energy of the air. If the air is at rest, the total temperature will equal the static temperature.

3.1.9.5 Static temperature. Static temperature is the temperature which exists by virtue of the internal energy of the air only. If a portion of the internal energy is converted into kinetic energy, the static temperature will be decreased accordingly.

3.1.9.6 Air density (ρ). Air density is the mass per unit volume of the air.

3.1.9.7 Standard air. Air with a density of 1.2 kg/m^3 (0.075 lbm/ft^3), a ratio of specific heats of 1.4, a viscosity of 1.8185×10^{-5} Pa•s (1.222×10^{-5} lbm/ft•s). Air at 20 °C (68 °F) temperature, 50% relative humidity, and 101.3207 kPa (29.92 in. Hg) barometric pressure has these properties, approximately.

3.1.10 Pressure and head

3.1.10.1 Pressure. Force per unit area.

3.1.10.2 Absolute pressure. The value of a pressure when the datum pressure is absolute zero. It is always positive.

3.1.10.3 Barometric pressure (p_b). The absolute pressure exerted by the atmosphere.

3.1.10.4 Gauge pressure. The value of a pressure when the datum pressure is the barometric pressure at the point of measurement. It may be positive or negative.

3.1.10.5 Velocity pressure (P_v). The portion of the air pressure which exists by virtue of the rate of motion only. It is always positive.

3.1.10.6 Static pressure (P_s). That portion of the air pressure which exists by virtue of the degree of compression only. If expressed as gauge pressure, it may be positive or negative.

3.1.10.7 Total pressure (P_t). The air pressure which exists by virtue of the degree of compression and the rate of motion. It is the algebraic sum of the velocity pressure and the static pressure at a point. Thus, if the air is at rest, the total pressure will equal the static pressure.

3.1.10.8 Pressure loss. The decrease in total pressure due to friction and turbulence.

3.1.11 Air curtain unit performance variables

3.1.11.1 Unit airflow rate (volume) (Q). The airflow volume which leaves the discharge nozzle, at standard air conditions, as measured in accordance with ANSI/AMCA 210, and reported in m^3/s (cfm).

3.1.11.2 Average outlet air velocity (V_a). The airflow rate produced by the air curtain unit divided by the cross sectional area of the discharge nozzle plane at free-air delivery.

3.1.11.3 Outlet air velocity uniformity (U). An indicator of the consistency of air velocities across the air curtain width, expressed as a percentage.

3.1.11.4 Air curtain core velocity (V_{cx}). The maximum air velocity of the air curtain at point X as measured across both the air curtain depth and width at specified distances from the discharge nozzle.

3.1.11.5 Air curtain average core velocity (V_{ca}). An average of air curtain core velocities measured along the air curtain width, at specified distances.

3.1.11.6 Air curtain velocity projection. A set of average air curtain core velocities measured along the air curtain width at distances specified in ANSI/AMCA 220.

3.1.11.7 Power rating of the air curtain unit (W). The amount of energy, expressed in kW, consumed by the drive motor(s) of the air curtain unit at free-air delivery.

3.1.11.8 Air curtain unit efficiency (η_{ac}). The ratio of the ACU air power to the power rating of the ACU. This value is based upon total fan efficiency given in ANSI/AMCA 210.

3.1.11.9 Air curtain unit target distance. A distance perpendicular to the discharge nozzle depth in meters (feet), determined by the sponsor of the test, for the purpose of setting up the test.

3.1.11.10 Air power. The useful power delivered to the air. This is proportional to the product of the ACU airflow rate and total pressure.

3.1.12 Miscellaneous

3.1.12.1 Point of operation. The relative position on the air curtain performance curve corresponding to a particular airflow rate, pressure, power and efficiency.

3.1.12.2 Free-air delivery. Free-air delivery is that point of operation where the air curtain unit operates against zero static pressure.

3.1.12.3 Determination. A determination is a complete set of measurements for a particular point of operation for the parameter being determined.

3.1.12.4 Test. A series of determinations of various characteristics at a single point of operation of an air curtain unit.

3.2 Units of measure

SI units (The International System of Units - Le Systéme International d'Unités) [1] are the primary units employed in this publication, with I-P units given as the secondary reference. SI units are based on the fundamental values of the International Bureau of Weights and Measures [1], and I-P values are based on the values of the National Institute of Standards and Technology that are, in turn, based upon the values of the International Bureau.

3.2.1 Basic units. The unit of length is the meter (m) or millimeter (mm); I-P units are the foot (ft) or inch (in.). The unit of mass is the kilogram (kg); the I-P unit is the pound-mass (lbm). The unit of time is either the minute (min) or the second (s). The unit of temperature is either the kelvin (K) or the degree celsius (°C); I-P units are the degree rankine (°R) or the degree fahrenheit (°F). The unit of force is the newton (N); the I-P unit is the pound force (lbf).

3.2.2 Airflow rate and velocity. The unit of airflow rate is the cubic meter per second (m^3/s); the I-P unit is the cubic foot per minute (cfm). The unit of velocity is the meter per second (m/s); the I-P unit is the foot per minute.

3.2.3 Pressure. The unit of pressure is either the Pascal (Pa) or the millimeter of mercury (mm Hg); the I-P unit is either the inch water gauge (in. wg), or the inch mercury column (in. Hg). Values in millimeters of mercury or inches of mercury shall be used only for barometric pressure measurements. The inch water gauge shall be based on a 1 inch column of distilled water at 68 °F under standard gravity and a gas column balancing effect based on standard air. The millimeter of mercury shall be based on a 1 inch column of mercury at 0°C under standard gravity in a vacuum. The inch of mercury shall be based on a 1 inch column of mercury at 32 °F under standard gravity in a vacuum.

3.2.4 Power, energy and torque. The unit of power is the watt (W); the I-P unit is the horsepower (hp). The unit of energy is the joule (J); the I-P unit is the foot-pound (ft lb). The unit of torque is the Newton-meter (N•m); the I-P unit is the pound-inch (lb in.).

3.2.5 Efficiency. Efficiency is expressed on a per-unit basis. Percentage values can be obtained by multiplying by 100.

3.2.6 Rotational speed. There is no unit of rotational speed as-such in the SI system of units. The commonly used unit in both systems is the revolution per minute (rpm).

3.2.7 Gas properties. The unit of density is the kilogram per cubic meter (kg/m^3); the I-P unit is the pound-mass per cubic foot (lbm/ft^3). The unit of viscosity is the Pascal second (Pa•s); the I-P unit is the pound-mass per foot-second (lbm/ft•s). The unit of gas constant is the joule per kilogram Kelvin (J/kg•K); the I-P unit is the foot-pound per pound-mass degree Rankine (ft•lb/lbm•°R).

3.2.8 Dimensionless groups. Various dimensionless quantities appear in the text. Any consistent system of units may be employed to evaluate these quantities unless a numerical factor is included, in which case units must be as specified.

3.2.9 Physical constants. The value of standard gravitational acceleration shall be taken as 9.80665 m/s^2 at mean sea level at 45° latitude; the I-P value is 32.1740 ft/s^2 at mean sea level at 45° latitude [1]. The density of distilled water at saturation pressure shall be taken as 998.278 kg/m^3 at 20 °C; the I-P value is 62.3205 lbm/ft^3 68 °F [2]. The density of mercury at saturation pressure shall be taken as 13595.1 kg/m^3 at 0 °C; the I-P value is 848.714 lbm/ft^3 at 32 °F [2]. The specific weights in kg/m^3 (lbm/ft^3) of these fluids in a vacuum under standard gravity are numerically equal to their densities at corresponding temperatures.

3.3 Symbols and subscripted symbols

See Table 1.

4. Overview

4.1 Basic design

An ACU utilizes a fan, or system of fans, mounted inside a cabinet. The fan draws air in, raises it to a higher velocity, and discharges it as an air curtain. An ACU is usually mounted above or along side a door or window opening. When mounted above the opening, the ACU discharges its air vertically across the opening. When mounted along side the opening, the ACU discharges its air horizontally across the opening.

4.2 Benefits

There are many benefits of using an ACU. When properly applied, an ACU can maintain the environmental integrity between two distinct areas, affording clear, unobstructed egress and ingress.

More specifically, when areas of different temperatures are separated or when perimeter openings are protected, an ACU can provide significant energy savings, increased comfort levels for customers and employees, increased safety at busy doorways, a decrease in equipment maintenance, and a more sanitary environment.

Benefits of using an ACU will only be fully realized when the equipment is properly sized, installed, adjusted, and maintained.

4.2.1 Cost/energy savings. ACUs save energy by reducing the infiltration of warm or cold air through an opening. By reducing the infiltration of outdoor air, the primary heating or air conditioning equipment will work less, resulting in reduced utility costs. These cost savings often offset the initial cost of the ACU in a relatively short period of time. The energy savings also reduce the building's overall effect on the environment.

4.2.2 Increased comfort. Without an ACU, there are often localized hot/cold spots near an opening due to infiltrated air working its way through the building to mix with the conditioned air or the building's main conditioning system. When an ACU is used, the infiltration of unconditioned outside air can be prevented, eliminating the hot/cold spots. The increased comfort level for customers and employees can result in increased employee productivity and customer satisfaction.

Table 1 - Symbols and Subscripted Symbols

SYMBOL	DESCRIPTION	SI	I-P
A_n	Nozzle cross-sectional area	m^2	ft^2
H_a	Air power of air curtain unit	W	hp
H_m	Power input to motor	W	hp
η_{ac}	Air curtain unit efficiency	per unit	per unit
n	Number of data points	---	---
N	Air curtain unit speed	rpm	rpm
N_d	Air discharge nozzle depth	mm	inches
N_w	Air discharge nozzle width	mm	inches
p_b	Barometric pressure	Pa	in. Hg
P_s	Static pressure	Pa	in. wg
P_t	Total pressure	Pa	in. wg
P_v	Velocity pressure	Pa	in. wg
Q	Air curtain unit airflow rate	m^3/s	cfm
ρ	Air density	kg/m^3	lbm/ft^3
Σ	Summation sign	---	---
s	Standard deviation	---	---
θ	Air discharge angle	degrees	degrees
t_d	Dry-bulb temperature	°C	°F
t_w	Wet-bulb temperature	°C	°F
U	Outlet air velocity uniformity	%	%
V_a	Velocity, average outlet	m/s	ft/s
V_{cx}	Velocity, air curtain core, at point X	m/s	fpm
V_{ca}	Velocity, average (air curtain core)	m/s	fpm
W	Power rating of the ACU	Watt	Watt

4.2.3 Safety. Increased production and safety are achieved by providing a clear and unobstructed opening for both people and motorized vehicles. In industrial applications, full visibility across a doorway or opening can help prevent collisions between fork trucks, other vehicles, people, or other equipment. In cold climates, ACUs may also prevent snow and sleet from entering doorways, which helps keep the floor dry, minimizing slippery spots.

4.2.4 Less door and heating/cooling equipment maintenance. ACUs allow a door to remain open during peak demand. Since an ACU can be left running when the door is open, the door does not have to cycle as often, resulting in less maintenance/repairs of the door. There may also be an increase in the life of the building's primary heating/cooling equipment due to a reduction in workload as a result of less infiltration of outside air.

4.2.5 Sanitation. ACUs provide a more sanitary environment by reducing the infiltration of flying insects, dust, and airborne contaminants.

4.3 Applications

ACUs may be equipped with multiple or variable speed motors, dampers, or both, to control the airflow rate. ACUs used for environmental separation may utilize volume control to adjust for varying temperature or wind conditions. ACUs designated for flying insect control always require full volume and velocity to repel flying insects.

The general applications of ACUs fall into seven categories:

4.3.1 Environmental separation (exterior). ACUs applied in this category provide protection to an exterior (perimeter) door from the unwanted infiltration of outdoor air and the escape of indoor air due to the effects of natural wind and/or temperature differences. In warm and cold climates, this infiltration can be reduced significantly by an ACU that is properly sized, installed and adjusted. In cold climate applications where infiltrating cold air has been reduced, but still exists as a result of normal operation, a wind/stack effect, or exhaust ventilation, the cold air can be heated to a comfortable temperature level. This will prevent a draughty internal climate. See Figure 1.

Benefits of using an ACU to protect an exterior door from the infiltration of outdoor air include cost and energy savings, increased comfort levels, increased safety, and a decrease in equipment maintenance.

4.3.2 Environmental separation (Interior). ACUs applied in this category of provide protection between interior rooms connected by a common opening. Typically, this application is intended to prevent the unwanted infiltration of unconditioned air or the loss of conditioned air from one room to another. Typically, temperature differential is the reason for the air exchange, and this can be controlled by an ACU that has an air performance requirement much smaller than the air performance requirement for exterior applications.

4.3.3 Flying Insect control. ACUs applied in this category provide protection for an opening or doorway, usually exterior, from the unwanted entry of flying insects. This is a common requirement in facilities that produce or process food products, such as kitchens, cafeterias, etc. This application typically requires an ACU with a higher airstream velocity to repel flying insects.

ACUs used for flying insect control provide multiple benefits for a variety of applications, including restaurants, hospitals, and food processing facilities. By reducing the infiltration of flying insects, which can cause disease and unsanitary conditions, ACUs provide a cleaner and more sanitary environment while preventing the contamination of food products. In restaurants, an ACU can increase customer satisfaction by preventing flying insects, which are a nuisance to patrons, and allowing doors and concession windows to be left open, attracting business. In food service applications, ACUs are often used to satisfy local health codes, many of which call for an ACU that is certified to NSF International standards.

4.3.4 Coolers/chill rooms and freezers/cold stores. ACUs applied in this category provide protection from the loss of refrigerated air through openings and/or doorways in coolers and freezers. Three types of applications exist: cooler to freezer, ambient to cooler, and ambient to freezer. These types of installations are generally (but not limited to) indoor applications; therefore, the ACU is only required to overcome airflow due to temperature differential and not wind pressure. Without an ACU, this airflow would result in energy loss, increased operating costs, safety hazards, and potential food or product loss. ACUs are typically horizontally mounted on the warm side of the doorway so that the airstream split created can balance against the air trying to enter and leave the cold room. Cold storage installations can be difficult to balance and may require a vertical mount application, cold side mount application, dampers, and/or multi-speed motors to effectively protect the opening.

4.3.5 Ovens. ACUs applied in this category provide protection against the loss of heated air through openings and/or doorways in ovens. ACUs are normally mounted horizontally over the oven opening and angled slightly inward toward the oven to prevent the hot air from escaping through the top of the opening. These types of installations are generally (but not limited to) indoor applications; therefore, the ACU is only required to overcome airflow due to temperature differential and not wind pressure. The heating process in ovens are typically designed to maintain a balanced pressure with the surrounding environment. The ACU should be adjusted to only entrain and "turn back" the heated air to avoid creating an unbalanced condition by forcing air into the oven. The mounting location of the ACU should also provide adequate protection from exposure to hot air that would escape the oven in the event the ACU is shut down.

4.3.6 Building under negative pressure conditions. ACUs applied where a negative pressure exists require special consideration. Under this condition, an ACU will not protect an opening from unwanted infiltration of outdoor air and the escape of indoor air due to the effects of natural wind and/or temperature differences. However, when installed as if in normal conditions, infiltrating outdoor (cold) air may be heated to a comfortable temperature level.

Some types of ACUs may be used in applications where a small negative pressure exists; usually no more than 5 Pa (0.02 in. wg). The result is a reduction in the ACU's ability to prevent air exchange in an environmental separation application. The sizing of the ACU for this application requires the airflow rate to be large enough to overcome the artificial deflection created by the negative condition, in addition to the air flow necessary for the standard application. Any greater negative pressure (i.e. stack effect, "loose" construction, exhaust processes, etc.) will prevent the airstream from reaching the floor and establishing a stable air curtain.

If the prevention of air exchange is desired, one of two things must be done. Either the building must be balanced by the addition of makeup air (through ACU or other means) or the opening must be balanced by spacing the ACU away from the doorway with a filtered gap so that unconditioned makeup air can "leak" into the building. For the best results, the balanced opening approach should only be used when sizing and application have been done in conjunction with an ACU manufacturer.

4.3.7 Special/custom. ACUs used for applications that do not require thermal protection can be referred to as special applications. Examples include:

4.3.7.1 Dust. ACUs can be mounted on a clean or contaminated side of an opening to protect against the infiltration of dust. In some cases, exhaust ventilation or room pressurization may be desirable.

4.3.7.2 Removal of water in drying process. ACUs can be installed to remove water droplets from canning jars, trains, rolled steel, and furniture; and in other drying processes.

4.3.7.3 Smelting operation. ACUs can be utilized in smelting operations to contain smoke so exhaust fans can remove smoke before it migrates to the outside.

4.3.7.4 Odor control. ACUs can be installed on the inside and outside of openings to minimize the escape of odors in applications, including dewatering facilities and restrooms. In some cases, exhaust ventilation or room pressurization may be desirable.

4.3.7.5 Paint booths. ACUs can be used to minimize overspray and reduce the exhaust of conditioned air.

4.3.7.6 Defrosting. ACUs have been utilized in cold storage areas as defrosters. An ACU can keep the door from freezing to the floor and prevent ice build-up, allowing the door to close. In high speed door applications, they are utilized to keep ice from building up on the clear plastic, maintaining visibility through the door panels.

5. Theory

5.1 General Theory

The primary purpose of the air curtain is to act as a building's control barrier for environmental separation when its doors/windows are opened. As an environmental separation barrier, the ACU repels the entrance of wind borne dust, dirt, fumes, odors and flying insects from entering a building or a protected area within a building. As a temperature control barrier, the ACU reduces the cross migration of warm, lighter air flowing through the upper part of the opening and cold, heavier air flowing through the lower part of the opening. As a wind resistance barrier, the ACU minimizes the effect of outside wind blowing into a building's openings.

An ACU operates largely on the principles of air entrainment, velocity vector, and pressure. Because the airstream entrains a volume of air as it travels across an opening, an ACU is able to maintain a separation of environments by returning these air volumes back to their respective areas when the airstream splits; therefore, resulting in minimal or no loss.

5.2 Types of ACUs

5.2.1 Non-recirculating. A non-recirculating ACU typically draws air into the unit directly from the surrounding environment in both horizontal and vertical applications (see Figures 1, 2, and 3). An ACU equipped with inlet ductwork, which draws air from outside the surrounding environment, is also considered to be a non-recirculating ACU (see Figure 4). The majority of air curtain units manufactured today are classified as non-recirculating.

5.2.1.1 Non-recirculating, horizontal mount. A horizontally mounted, non-recirculating ACU draws air from the surroundings into the fan(s). The fan(s) pressurize and direct the air into a plenum where the air is shaped and discharged as an air curtain. As the air travels towards the floor, conditioned and non-conditioned air are entrained onto each side of the airstream. When this mass of air strikes the floor, it splits. The entrained conditioned air is returned to the conditioned area and the non-conditioned air is returned to the non-conditioned area.

5.2.1.2 Non-recirculating, vertical mount. A vertically mounted, non-recirculating ACU draws air from the surrounding area into the fan(s). The fan(s) pressurize and direct the air into a plenum where the air is shaped and discharged as an air curtain. As the air travels towards the opposite wall surface or corresponding ACU airstream, conditioned and non-conditioned air are entrained onto each side of the airstream. When this mass of air strikes the opposite surface or airstream, it splits. The entrained conditioned air is returned to the conditioned area and the non-conditioned air is returned to the non-conditioned area.

5.2.2 Recirculating. A recirculating ACU draws air from ductwork that primarily collects and returns ACU discharge air to the ACU inlet. Typical applications will often use a plenum with a floor return that is connected to the inlet of the ACU with ductwork (see Figure 5). An alternate construction includes a horizontal flow which discharges and returns from side to side (see Figure 6).

5.2.2.1 Recirculating, horizontal mount. A horizontally mounted, recirculating ACU draws air through the floor return grate and into the fan. The fan moves air through ductwork and into the discharge plenum where it is pressurized, shaped, and evenly distributed to the discharge nozzle, where it is then discharged as an air curtain. The air then travels toward the return grate, completing the cycle. As the air travels toward the floor, conditioned and non-conditioned air are entrained onto each side of the airstream. When this mass of air strikes the floor, it splits. The air discharged from the discharge plenum is returned to the grate. The entrained, conditioned air is returned to the conditioned area and the non-conditioned air is returned to the non-conditioned area.

5.2.2.2 Recirculating, vertical mount. A vertically mounted, recirculating ACU draws air through the wall return grill into the fan. The fan moves air through ductwork and into the discharge plenum, where it is pressurized, shaped, and evenly distributed to the discharge nozzle, where it is discharged as an air curtain. The air then travels towards the return grate, completing the cycle. As the air travels towards the opposite wall, conditioned and non-conditioned air are entrained onto each side of the airstream. When this mass of air strikes the return grill, it splits. The air discharged from the discharge plenum is returned to the grate. The entrained, conditioned air is returned to the conditioned area and the non-conditioned air is returned to the non-conditioned area.

6. Components and Construction

6.1 Cabinet

ACU cabinets are constructed from a variety of materials. Plastics, ferrous metals, and non-ferrous metals are the most popular. Plastics, a petroleum based product, cover a vast range of synthetic or semi-synthetic materials, such as polyethylene, polypropylene, and polycarbonate. However, metals such as steel, stainless steel, and aluminum are still the most commonly used materials.

The cabinet may be assembled either by welding, riveting, mechanical joining, or a combination of these processes. They may be finished with a liquid or powder paint, which may be an air dried or baked type. Aluminum units may have an anodized finish, and stainless steel units, which do not require paint, may have a brushed finish.

Choices of cabinet materials and finishes are usually made based on the type of application (customer entry doors, loading dock & receiving doors, pass-through, corrosive environments, windows, etc.) and where the ACU is to be installed (inside or outside of the building).

6.2 Fan

ACU fans may be direct or belt driven. The most frequently used types are centrifugal, axial, and cross-flow. The vast majority of ACUs employ centrifugal fans with a forward curved impeller.

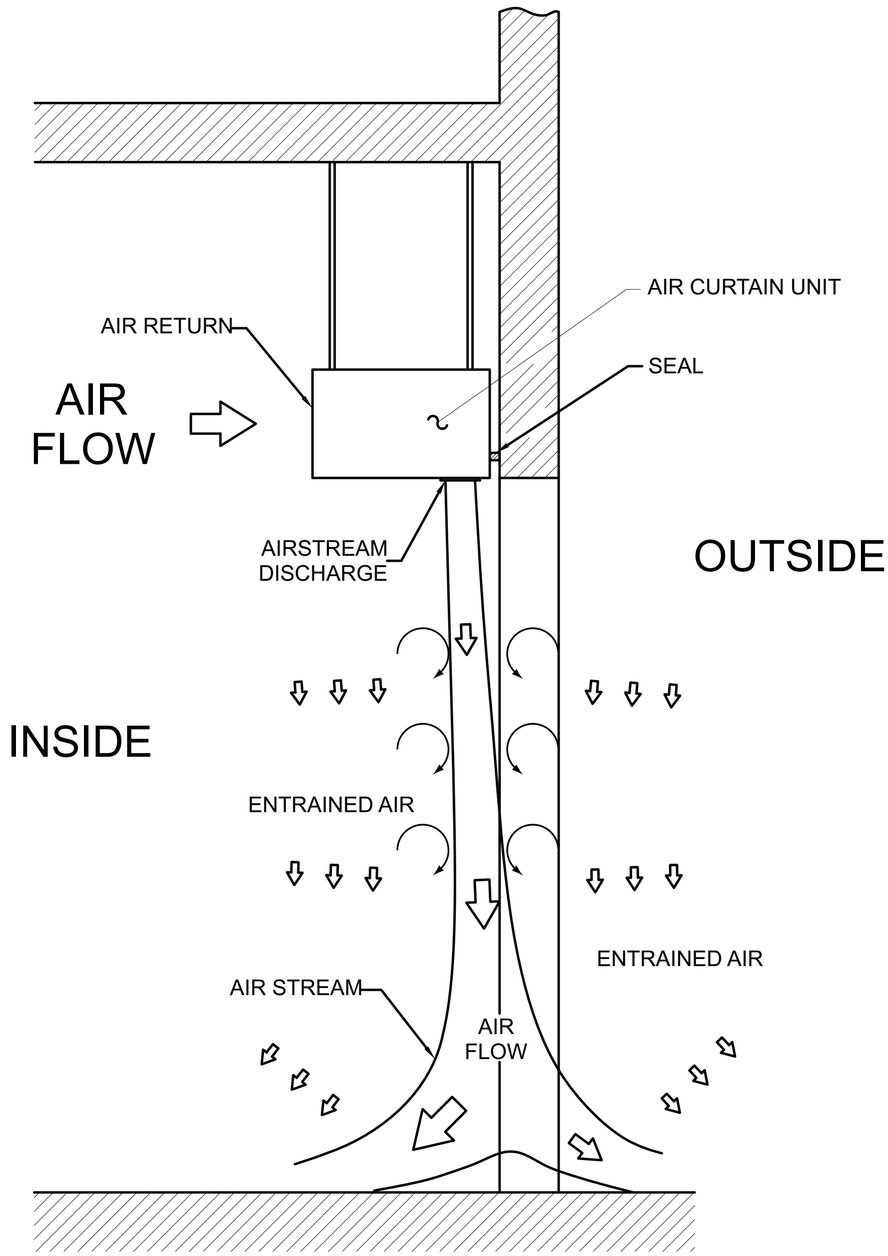


Figure 1 - Non-Recirculating, Horizontal Mount High Velocity ACU

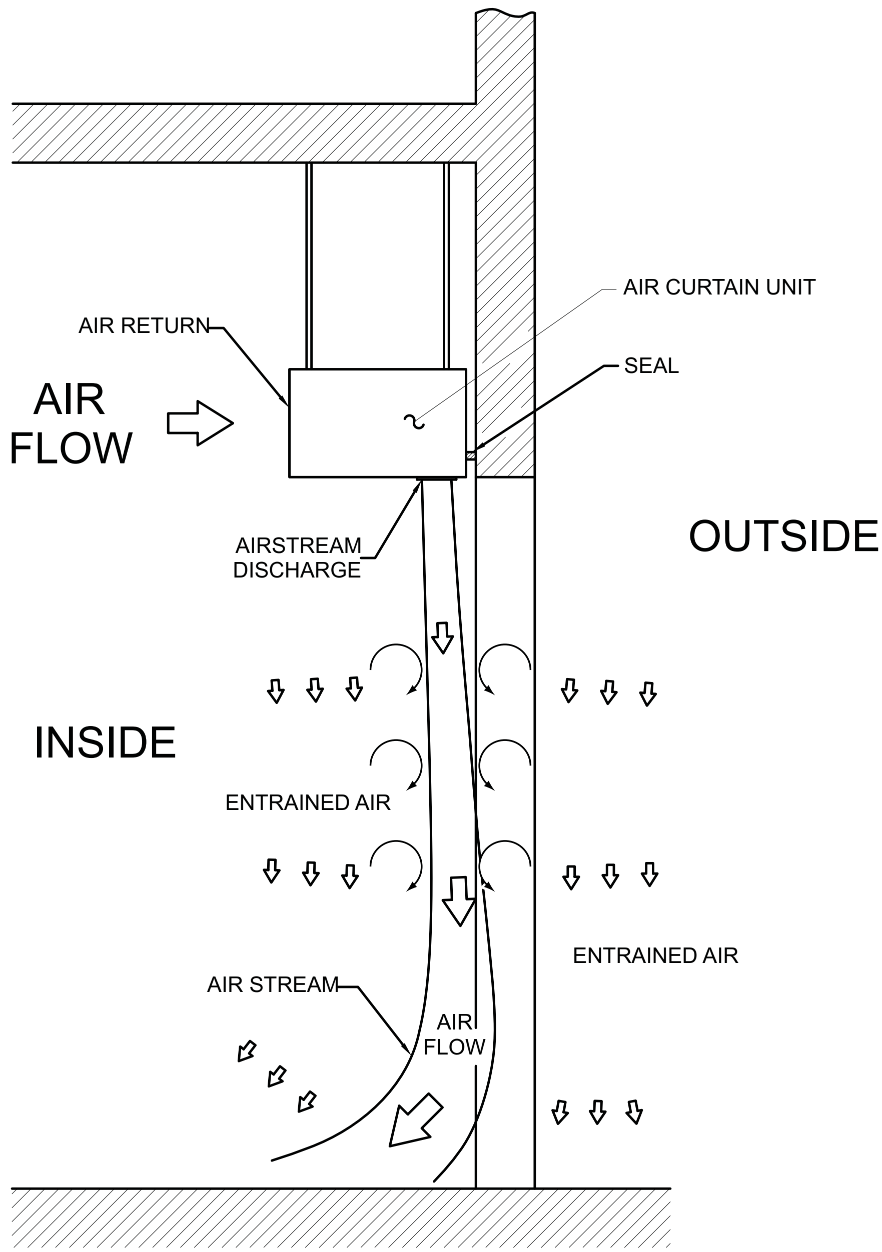


Figure 2 - Non-Recirculating, Horizontal Mount Low Velocity ACU

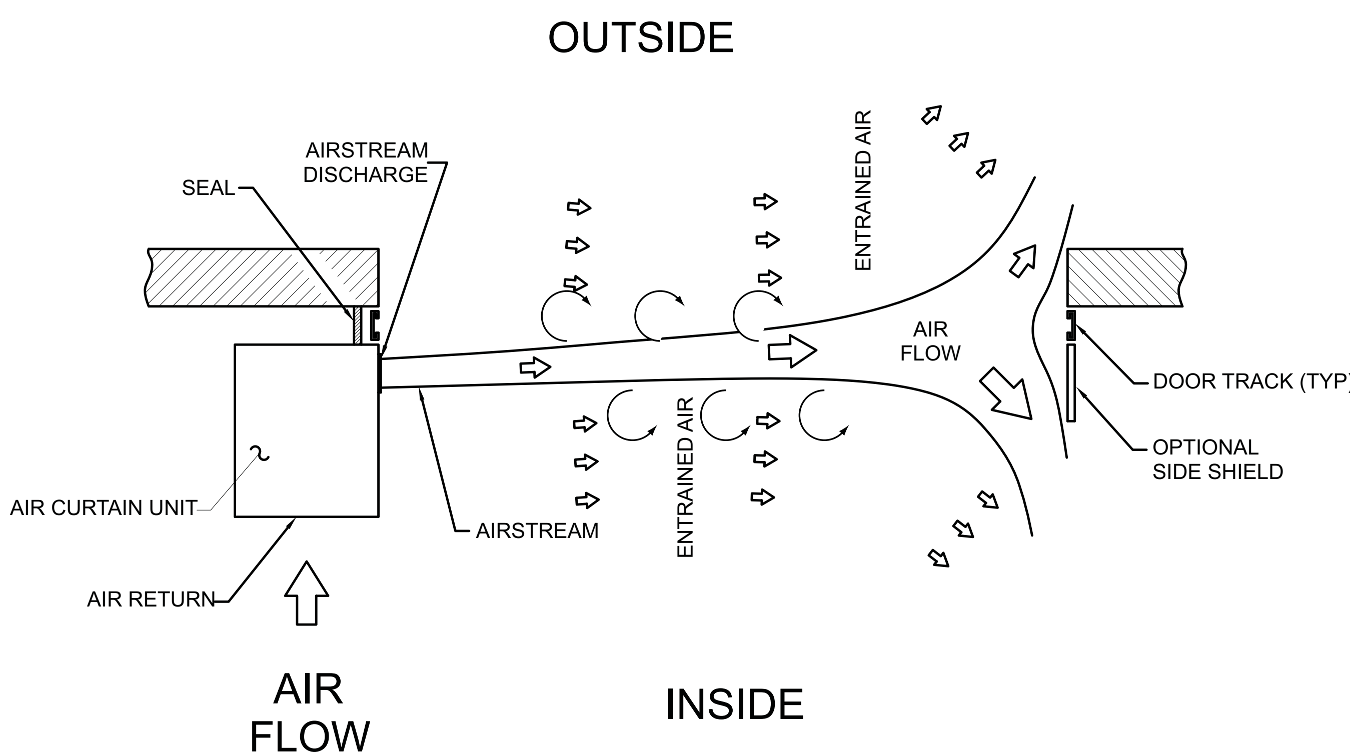


Figure 3 - Non-Recirculating, Vertical Mount ACU

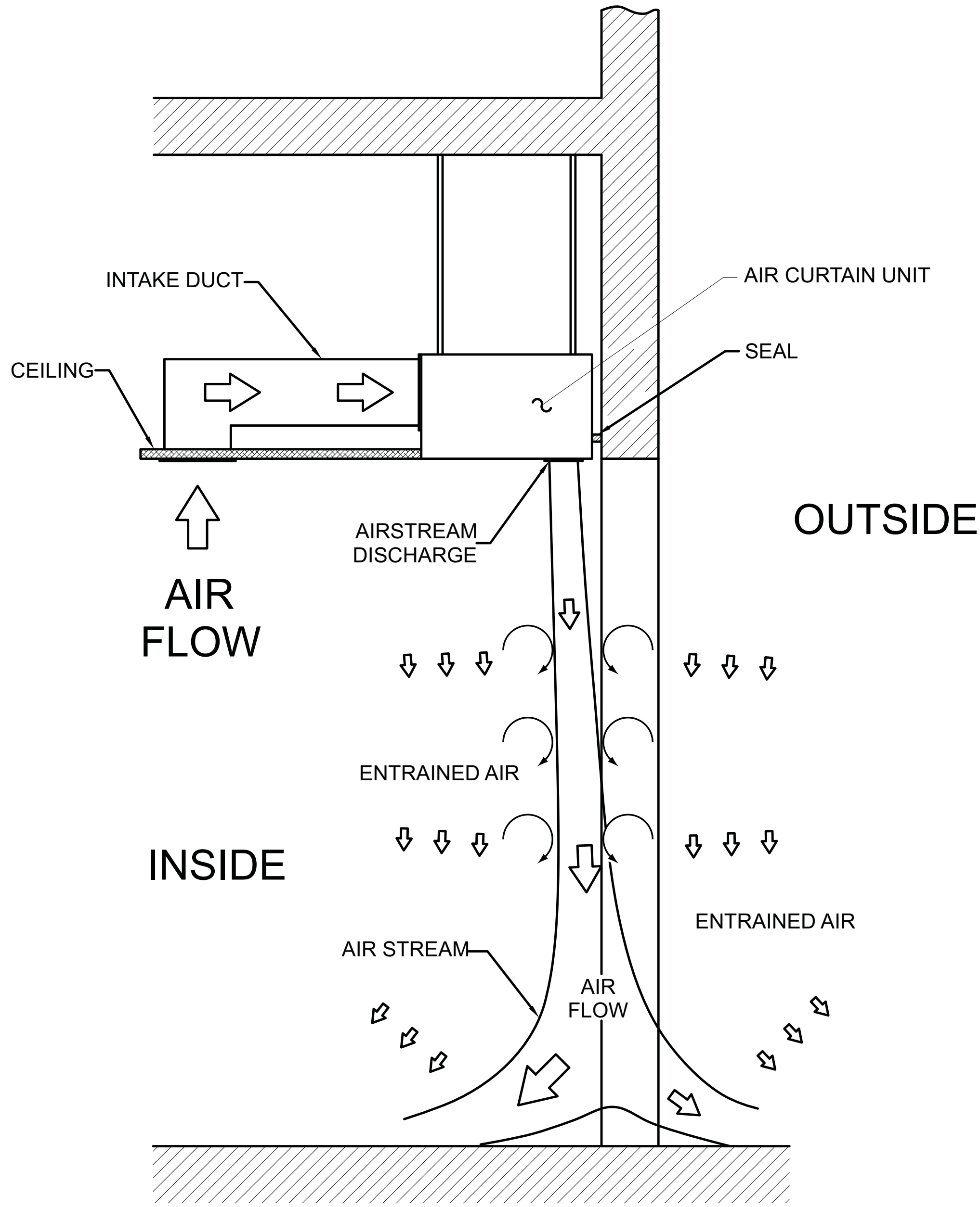


Figure 4 - Non-Recirculating, Horizontal Mount ACU with ducted inlet

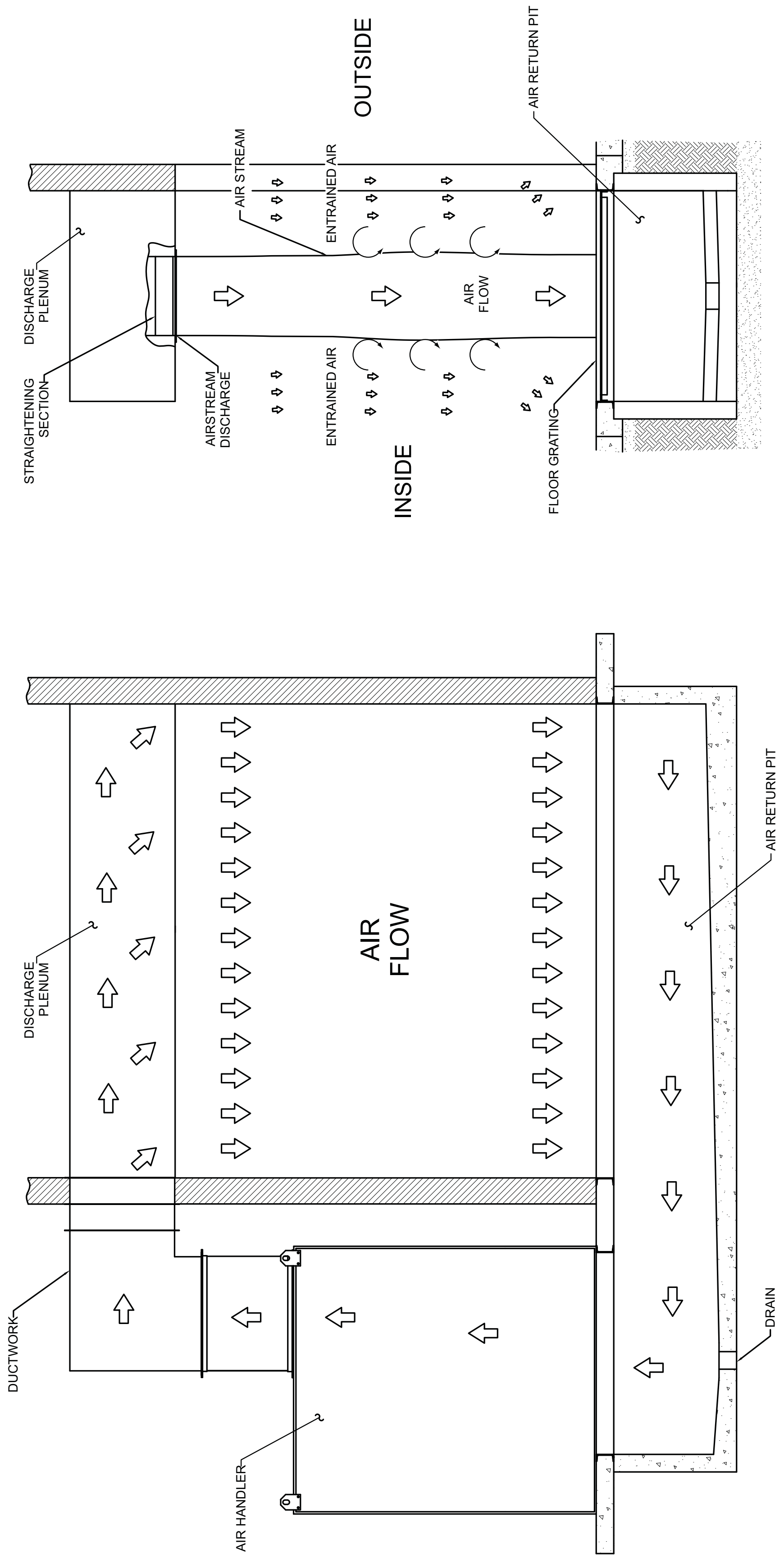
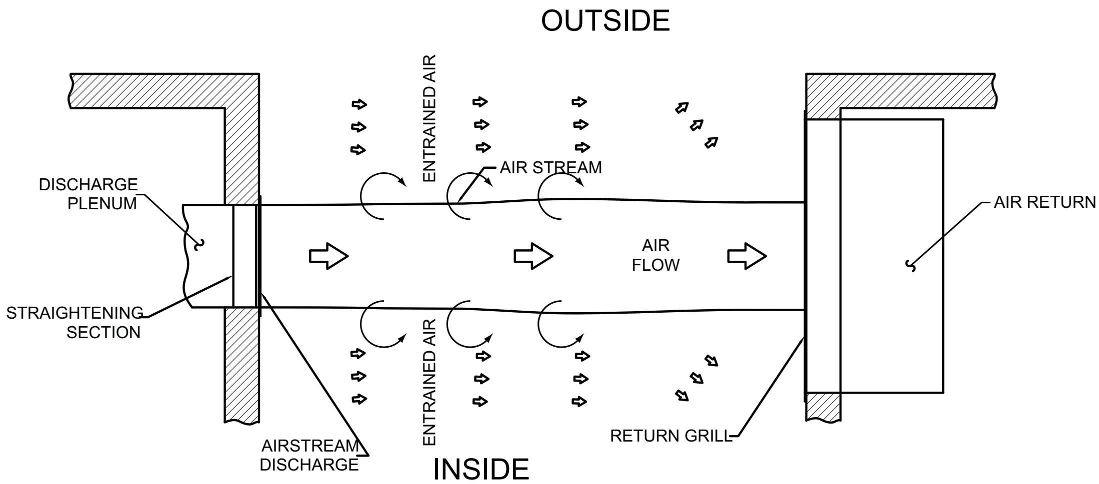


Figure 5 - Recirculating, Horizontal Mount ACU



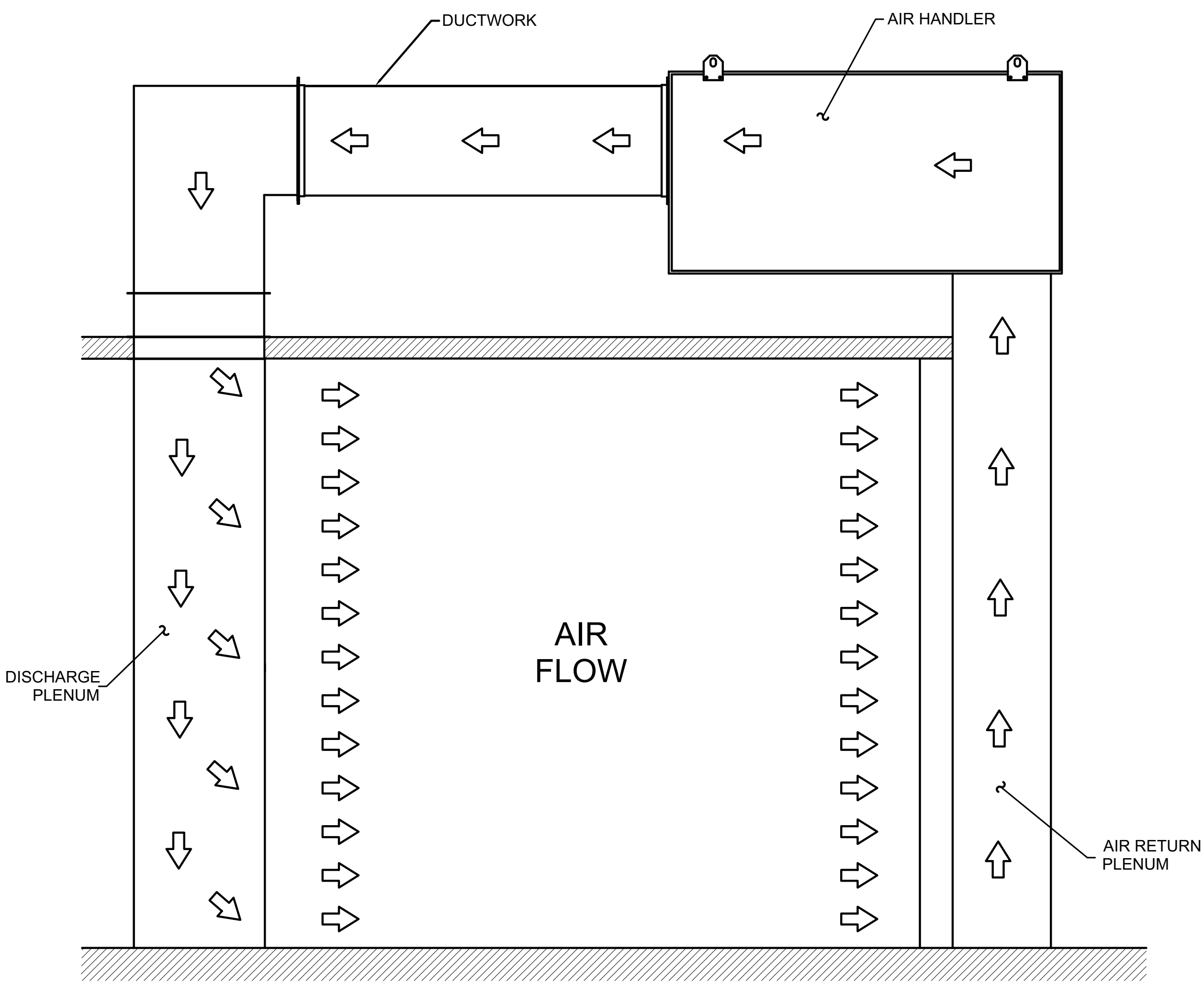


Figure 6 - Recirculating, Vertical Mount ACU

6.3 Motor

ACUs may employ one or more motors in or on the cabinet. Motors are available in a single or multi-speed construction in any of the voltages used around the world (commonly single or three phase). Motors are usually built to a standard such as NEMA (National Electrical Manufacturers Association) or IEC (International Electrotechnical Commission). Motor types include, but are not limited to, the following:

- TEFC (Totally Enclosed, Fan Cooled) - this enclosure is designed to be dust tight with a moderate water seal; the motor relies on a small fan on the motor shaft for cooling.

- TEAO (Totally Enclosed, Air Over) - this enclosure is designed to be dust tight; the motor relies on the airstream of the fan it is driving for cooling.

- TENV (Totally Enclosed, Non Ventilated) - this enclosure is designed to be dust-tight and moderately sealed, which rejects a degree of water and radiates excess heat for cooling.

- ODP (Open Drip-Proof) - this enclosure is designed with a vented frame. These vents are designed in such a way to prevent dripping water from entering the motor; the motor relies on the open frame for cooling.

The above motor types can be modified to operate in environments such as explosive, hazardous, high temperature, washdown, corrosive atmosphere, etc.

6.4 Discharge control

The discharge of the ACU may be capable of adjusting the direction of the air curtain for proper protection. This adjustment may include (but is not limited to) the following:

- Pivot Mount – the ACU cabinet is capable of pivoting on its mounting so that it may direct the air curtain at the proper angle to protect the opening.

- Adjustable Nozzle – the ACU discharge nozzle is capable of pivoting within the ACU so that it may direct the air curtain at the proper angle to protect the opening.

- Adjustable Nozzle Vane(s) – the ACU discharge nozzle employs a vane, or vanes, that are capable of pivoting within the nozzle so that it may direct the air curtain at the proper angle to protect the opening.

- Both Adjustable Nozzle and Vanes – the ACU employs a combination of the Adjustable Nozzle and Adjustable Nozzle Vanes.

- Diverter Nozzle – the ACU employs an apparatus within the nozzle that is capable of diverting the air curtain at the proper angle to protect the opening.

- Rectifier - the ACU discharge may also employ a rectifier, which is a particular discharge grill that converts the turbulent airflow from the fans into a more laminar airstream, making it so that relatively little air is needed to reach the floor.

6.5 Optional components and construction

6.5.1 Filter. The inlet section of an ACU may employ an air filter that protects the interior (heat exchanger, fans, electronics) from dust and particles.

6.5.2 Heating and cooling options. ACUs may be offered with various heating and cooling options depending on the intended application and cabinet construction. Note that a heating or cooling option may not improve the effectiveness of the air curtain. It generally serves as an enhancement to the application, independent of the protection provided by the airstream. A heat source may be added for use as supplemental heat to reduce the wind chill effect of the air curtain. The most common heating types are:

- Electric heating coils - open (helical) or fin tube element
- Hydronic coil - hot water or steam
- Indirect gas - a furnace that utilizes a heat exchanger to separate the combustion air from the heated air curtain
- Direct gas fired - the burner fires directly into the airstream being heated
- DX Evaporator Coil - Direct expansion vapor-compression refrigeration cycle system

Cooling options are used for the same general reasons as the heating options; usually for customer comfort, supplemental cooling, or dehumidifying. Special care must be exercised in cooling applications that account for the removal of the condensate generated in the cooling apparatus. The most common types are:

- Hydronic Coil - chilled water
- DX Evaporator Coil - Direct expansion vapor-compression refrigeration cycle system

6.5.3 Construction options. ACUs are often used in mild indoor environments. Outdoor use and other special applications may require optional construction considerations.

6.6 Operational and safety controls

Like any heating, ventilating, and air conditioning product (HVAC), ACUs require operational and safety controls. Operational controls ensure that the ACU functions effectively to protect the opening while being flexible enough to meet the application's sequence of operation. Operational controls determine when and how the ACU and optional heating/cooling section are energized.

Controls range from a basic limit switch mounted to the door to interfacing with a Building Management System (BMS) to activate the ACU. The type of control needed is also dependent upon the motors incorporated and the special requirements necessary for heating/cooling options.

Basic switches are typically electro-mechanical in nature and can be mounted on the unit or remotely. Some examples are thermostats; motor control panels; and limit, rocker, and cam switches.

Intermediate controls involve stand alone electronic controls or a combination of electronic controls and basic switches. Some examples include programmable controllers or programmable thermostats.

Complex controls involve interfacing with computer controlled systems such as Building Automated Service (BAS), Building Management System (BMS) or Direct Digital Control (DDC).

Safety controls ensure that the ACU functions in a safe and healthy manner. Safety controls are regulated by standards that are both legally required and optional. Examples of required standards are OSHA, CE, national, and local codes. Optional standards include UL, CSA, ETL, ISO, AGA, CGA, and NSF. Note that some local codes require conformance to one or more of these optional standards.

Safety standards are applicable to all functions of the ACUs, including the heating/cooling options and operational controls.

7. Performance Testing, Rating and Safety Standards

7.1 Aerodynamic performance testing

While manufacturers are free to test units and publish their findings, AMCA remains the only internationally recognized agency engaged in ACU aerodynamic performance testing, and ANSI/AMCA 220 is the only published aerodynamic performance testing procedure. ANSI/AMCA 220 and AMCA Publication 211 clearly define the performance criteria for testing and the performance ratings that ACU manufacturers publish.

7.2 Sound performance testing

Currently, there is no Certified Ratings Program that defines the performance testing procedure and measurement for the sound performance of an ACU. Presently, most ACU manufacturers publish their unit's sound output ratings as an A-weighted sound pressure level (dBA). An A-weighted scale accounts for the human ear sensitivity variations between low and high frequency sounds at the same decibel level.

Most ACU manufacturers commonly measure their unit's dBA in a free field environment. This free field environment is an open space where sound freely radiates away from the ACU, with no obstructions that would cause sound to reflect back to the ACU. It is important to specify the distance away from the ACU that the measurement is being made. The above method is meant to serve as a comparative guideline, as opposed to a quantitative one.

7.3 Safety standards

An ACU can be tested for potential hazards such as life safety, electrical safety, and fire. Organizations such as Underwriters' Laboratories (UL), Intertek's ETL SEMKO (ETL), CSA International (CSA), CE Mark, etc., all test ACUs for these and other product compliant issues. There are various versions of these standards and approvals worldwide, many of which are country specific.

ACUs for foodservice applications may be required to be tested in accordance with ANSI/NSF Standard 37. This standard addresses the concerns for public health in food service environments and has established a testing procedure for such.

Most of the testing agencies referenced can perform any of the tests mentioned above. If there are concerns as to which of these third-party accreditations or approvals are required, the authority having jurisdiction in the area should be contacted.

8. Selection

8.1 Intended use and application

ACUs should first be selected by application and opening size. Manufacturer's recommendations on mounting height and wind resistance should be used as a guide. Units should be sized to totally cover the opening, and perhaps, provide a slight overlap. Two vertically mounted, less powerful units can be an alternate solution to a single horizontally mounted, more powerful unit.

8.2 Opening size, obstructions, and restrictions

ACU selection is dependent on the width and height of the opening. In order to maximize efficiency, the ACU must cover the entire opening. Typically, the ACU is mounted directly above the opening, or beside the opening for vertically mounted models. The ACU discharge must have a free and clear path to the entire opening for optimum performance.

All ACUs must be fastened with properly sized materials and hardware to ensure stability and rigidity. Some mounting hardware may be provided by the manufacturer as standard equipment or as optional accessories. Contact the manufacturer for details. All walls and beams must be able to withstand the loads applied by both the ACU and all the miscellaneous items attached to the unit. Walls may require additional backing to provide the necessary support.

8.3 Construction types

ACU cabinets are constructed with a variety of materials, as described in Section 6.1. Environmental and aesthetic concerns may require special consideration.

8.4 Power source/voltage

ACUs are available in all voltages used around the world, ranging from 115V to 600V at 50 or 60 Hertz. Electrically heated models are usually 3Ø and not 1Ø power due to the excessively high amperage requirements.

8.5 Controls

ACU controls are essential to provide the correct velocity, temperature, and depth of the air curtain. They are also used to prevent unnecessary energy usage and overheating within the building entrance. Although supplemental heating can be provided by an ACU, it should not be seen as the primary heat source for warming internal areas.

For convenience, user operated controls are normally remotely mounted and configured to satisfy the needs of the building occupants. Depending on the application, controls are available in most IP/NEMA enclosure configurations. At the simplest level of control, only manual operation of the fan(s), the fan speed, and the heat output may be required; however, more advanced control options may be included, such as:

- Room thermostat
- Door contact switch
- Timer
- Step or modulating control of electric or water heating
- BMS control interface
- Optimization controls for on/off and temperature adjustment

Besides the inputs, where the above mentioned control options are connected, the control unit may also have outputs for signaling failures. For instance, The control unit can also provide for the correct communication between the ACU(s) and the central heating system, sliding door system, VRV-system (i.e. heat pump), etc.

ACUs can be equipped with controls as simple as a mechanical multi-speed switch, or as sophisticated as an integrated interface (printed circuit board) with a touchpad or LCD panel. The LCD panel can display values, such as discharge speed and temperature, room temperature, failures, filter contamination level, etc. Some manufacturers offer a fully automatic control, which uses switches and sensors to provide real-time information on the entrance condition (indoor/outdoor conditions and infiltration/ventilation rate). This information is processed by a control box, which generates the optimal settings for the air curtain (airstream momentum and heat output). Optimal performance is continuously safeguarded and air curtain settings are corrected if necessary.

8.6 Certifications

Of the many certification bodies in existence, there are a few that have standards specifically created for ACUs, and many that have standards applicable to ACUs. All of these standards can be grouped into two categories: performance and safety.

8.6.1 Performance standards. The first category is comprised of two standards that were written specifically to define the performance ratings of ACUs (see Section 7). Currently there are no standards specifically written to rate ACUs for sound performance, although many sound standards are applicable, and can be used to rate ACUs for sound, such as ANSI/AMCA 300, ANSI/AMCA 301 and ANSI/AMCA 320, to name a few.

8.6.1.1 ANSI/AMCA 220 - *Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating*. This AMCA standard defines the test methods that can be used to generate data for the typical types of air curtain performance. This data can then be used to compare different models for aerodynamic performance. Note that the data generated from the tests described in the standard does not define an ACU's relative effectiveness.

If the data is measured and generated from an AMCA accredited laboratory, the product can be licensed to bear the AMCA Seal (if applied for) under AMCA 211, *Certified Ratings Program - Product Rating Manual for Fan Air Performance*. The AMCA Seal represents the fact that the ACU has been independently tested by a third party, adding credibility to manufacturer ratings.

The performance data generated, as defined by ANSI/AMCA 220 and simplified here, are:

- Average Outlet Velocity - the mathematical derivation of a velocity flow rate by dividing the air volume flow rate by the air curtain discharge area. This value should be used with outlet velocity uniformity to compare different ACUs.

- Velocity Projection - the average of the peak velocities measured along the ACU discharge nozzle at predetermined widths at specified distances away from the ACU. These values can also be used to determine a Velocity Uniformity at said specified distance.

- Outlet Velocity Uniformity - this is a measure of the consistency of the discharge velocities across the ACU width expressed in a percentage determined by a standard of deviation method.

- Airflow Rate - physically measured by a recognized air volume test chamber using ANSI/AMCA 210, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*.

- Power Rating - this is the electrical power actually consumed by the entire unit (in kW) during the Air Volume Flow Rate; not to be confused with the mechanical energy equivalent to the unit horse power.

8.6.1.2 ANSI/NSF 37 - *Air Curtains for Entranceways in Food and Food Service Establishments*. The NSF standard establishes criteria for ACU air performance, construction, design, and material type. An ACU construction that complies with this standard is considered by the food service industry to provide effective flying insect protection to an entryway by deterring flying insects from entering through the opening or nesting in the ACU.

These criteria can be summarized into basic principles that are intended to create a clean and healthy environment. The air performance defined in this standard is geared toward protection from flying insects. The opening types are defined by three categories: Customer Entryway, Service Entryway and Drive Through Window. Each type has its own minimum performance requirement.

The Service Entryway test requires a maximum mounting height declaration and a minimum air velocity of 8.15 m/s (1600 fpm). Velocities are measured within a 75 mm (3 in.) deep by ACU nozzle width wide area broken into 75 mm x 150 mm (3 in. x 6 in.) grids, 0.9 m (3 ft) from the floor.

The Customer Entryway test requires a maximum mounting height declaration and a minimum air velocity of 3.05 m/s (600 fpm). Velocities are measured within a 200 mm (8 in.) deep by ACU nozzle width wide area broken into 50 mm x 150 mm (2 in. x 6 in.) grids, 0.9 m (3 ft) from the floor.

The Drive Thru Window test requires only a minimum air velocity of 3.05 m/s (600 fpm), 1/3 the distance of the vertical opening above the service window counter top. Velocities are measured within a 200 mm (8 in.) deep by ACU nozzle width wide area broken into 50 mm x 150 mm (2 in. x 6 in.) grids.

The design and construction requirements are intended to prevent the nesting of vermin, the accumulation of dirt, debris, and moisture; and to provide accessibility for servicing, cleaning and inspection.

The material requirements are intended to ensure that the equipment is resistant to penetration from vermin and wear in the respect for food safety (i.e., the effect of food, heat, refrigerants, cleaning and sanitizing compounds).

Lastly, ACU units can be tested, certified, and listed to Standard ANSI/NSF 37 by nationally recognized testing laboratories and certifying bodies that have a food service program. Some of these agencies include NSF and the corresponding NSF Mark, UL and the corresponding EPH Mark, and ETL and the corresponding ETL Sanitation Mark.

8.6.2 Safety standards. The second category is comprised of safety standards that include life safety, electrical safety, and fire safety (see Section 7.3). There are no safety standards written specifically for ACUs, but there are standards that are written generically for a category of products that encompass, and can be applied to, ACUs. Some of these include, but are not limited to:

- NFPA 70 - *National Electrical Code*
- NFPA 54 - *National Fuel Gas Code*
- UL507 - *Electric Fans*
- UL508A - *Industrial Control Panels*
- UL2021 - *Fixed and Location Dedicated Electric Heaters*
- C22.2 No. 0 - *Canadian Electrical Code Part II*
- C22.2 No. 0.4 - *Bonding and Grounding of Electrical Equipment*
- C22.2 No. 14 - *Industrial Control Equipment*
- C22.2 No. 46 - *Electric Air Heaters*
- C22.2 No. 113 - *Fans and Ventilators*
- UL 1995 - *Heating and Cooling Equipment*
- ANSI Z83.8-2002:CSA2.6-2002 - *Gas Unit Heaters and Gas-Fired Duct Furnaces*
- IEC 60335-1 - *Household and Similar Electrical Appliances: Safety - Part 2: General Requirements*
- IEC 60335-2-30 - *Household and Similar Electrical Appliances: Safety - Part 2-30: Particular Requirements for Room Heaters*
- IEC 60335-2-40 - *Household and Similar Electrical Appliances: Safety - Part 2-40: Particular Requirements for Electrical Heat Pumps, Air Conditioners and Dehumidifiers*
- UL795 - *Commercial-Industrial Gas Heating Equipment*
- ANSI Z83.4/CSA 3.7 - *Non-Recirculating Direct Gas-Fired Industrial Air Heaters*

Recognized testing agencies can usually perform any of the necessary tests listed above. For example, Intertek's ETL SEMKO will test to UL and/or CSA standards and issue a Mark that certifies that products comply with the standards requirements.

Reciprocity is also an important factor to consider when purchasing or specifying a product. In some instances, agencies have negotiated acceptance of each others' Marks as equals in an effort to extend their market coverage. For example, even if a specification only calls for a CSA approval, the inspector should accept a product with a CUL Mark. If there are concerns as to which of these reciprocities, third-party accreditations, or approvals are required or accepted, the authority having jurisdiction in the area should be contacted.

8.7 Options

As described in Sections 5 and 6, all ACUs have a similar basic design that includes certain essential components. These basic components consist of fans, motors, and usually, controls.

An ACU can include a variety of optional features. Heating, cooling, filters and special controls are a few of these (see Section 6). Where ACUs are mounted outdoors or used in harsh environmental applications, special casing material or casing coatings may be required. When selecting an ACU, it is essential to understand all aspects of the application to ensure the proper optional features are included. In addition, there are also things that must be considered when specifying or purchasing each unique option.

8.7.1 Heating options. ACUs may be offered with various heating options. The addition of a heating option and the type of heat to select require careful study. A heating option should be considered if the area where the ACU(s) will be installed would benefit from supplemental heat. Some heat gained would be realized when the heater equipped ACU is operated with the door open, and substantial supplemental heat would be available by operating the ACU with the door closed.

A heated ACU can mitigate the wind chill effect created by the ACUs output airflow by raising its output air temperature. Even in climates where the inlet and discharge air would not fall below 10 or 15.5 °C (50 or 60 °F), raising the velocity of the air will create a chill factor. This creates discomfort for pedestrian traffic walking through the ACU and/or employees working within close proximity to the ACU discharge. Note that a heating option does not improve the ACU's effectiveness. It only serves as an enhancement to the application site independent of the protection provided by the air stream.

In addition, the availability of steam, hot water, gas and electricity may affect the selection of heating options. With electrically heated models, if 3Φ power is not available, 1Φ may be used, but it is costly to operate and install. While gas-fired options have the highest initial cost, they may be the best choice in areas of high electric cost and on jobs where steam or hot water is not readily available to the area where the door is located.

When considering the various heating options, the operating cycle of the door should be studied. ACUs with certain heating options may be applied as make-up air heaters or door heaters. Heating options may degrade air performance to the extent where the wind-stopping capability associated with an unheated model cannot be realized. In these instances, an ACU operation on 100% indoor air may be classified as a door heater and one operating at 100% outdoor air may be classified as a make-up air heater.

8.7.1.1 Electrical. Electric is a commonly used heating option. It offers instantaneous supplemental heat in an area and may be offered in many wattage ranges and voltages. It is compact, and in most cases, utilizes the same or similar cabinet size as the unheated models. Most areas have at least single or three phase power near the door location, but if not, it may be easily installed by an electrician. However, electrically heated models are very costly to operate. If higher wattages or lower voltages (208 or 240V, 1 Phase) are required, installation and operating costs may be very high. Electrically heated models are typically for indoor use only, but special heaters for outdoor use or other applications are available.

8.7.1.2 Steam. Steam provides a clean and effective heat source and generally produces higher temperature rises than standard hot water. Although an affordable source of heat, steam is not readily available in many areas. Standard steam coils are typically rated for up to 200-350 kPa (30-50 psi), but steam distributing and cupper-nickel coils are available for high pressures and longer coils. Proper sizing of the coil and the condensate traps will maximize coil performance.

8.7.1.3 Hot water. Standard hot water, commonly ranging between 60-90 °C (140-200 °F), may not produce temperature rises above that of steam. However, it is another clean and affordable heat option, and in some cases, more practical than steam. Most commercial hot water heaters can produce sufficient hot water to have an effective temperature rise. Coils suited for super heated water are also available. As with steam coils, proper sizing and bleeding of the coil to remove air pockets will maximize coil performance.

8.7.1.4 Indirect gas fired. Indirect gas fired models utilize an air-to-air heat exchanger. This option is often selected when supplemental heat is desired in industrial and heavy commercial applications. This type of heater is capable of providing a moderate temperature rise, typically in the range of 10-20 °C (20-50 °F). Indirect gas fired heaters have a typical efficiency of 80 - 85%. Special venting will be required for exhaust gases, and flues must be sized in accordance to state and local codes. Short cycle applications may not be suitable for this heating option.

8.7.1.5 Direct gas fired. Direct gas fired models utilize a burner(s) that fires directly into the airstream, thereby requiring a complex set of safeties and controls. This type of heater is capable of providing a large temperature rise, generally in the range of 20-50 °C (50-100 °F). Typically, a modulating temperature control maintains a constant discharge temperature. Direct gas fired heaters have a combustion efficiency of 100%. Direct fired ACUs will generally permit operation only when a door is open, unless the ACU is supplied with 100% outside air. Not all areas and/or applications allow direct fired gas heating. Specifically, short cycle applications may not be suitable for this heating option. When considering this heating option, refer to state and local codes.

8.7.1.6 DX Heating. DX heating uses a refrigerant in a direct expansion system (for example R-410A in a VRV system or heat pump). Temperature rises are generally lower than that of other heating options; however, it is envinronmetally friendly (when natural refrigerants are used) and can be less expensive to operate. A disadvantage of the system is that there is no heat output during defrost cycles of the outside unit. Proper sizing of the coil is very important due to significantly lower heating capacities as compared to other heating options.

8.7.2 Cooling options. There are few cooling options available on ACUs (see Section 6.5.2). The two most common are chilled water coil and direct expansion (DX) coil from a vapor compression refrigerant system. However, because these options may require additional support systems to provide cooling to the coil, ACUs with a cooling option are not very common.

Applications that use a cooling option are usually of a special or custom nature. Some examples include climate-controlled rooms with sensitive product such as pharmaceuticals, stage production studios with high temperature lighting, or buildings in hot climates.

Chilled water is the more common and flexible system of the two. This is usually because the design of the coil may be adjusted to meet the desired cooling performance, and because many facilities already have chillers on site. Consult the manufacturer when sizing this type of coil for proper construction (i.e. fin, tube and header size; material; fin spacing; tube circuiting; etc.) and specifications.

The DX coil system is limited only by flexibility of the range of its performance in custom applications, but is well suited for typical ACU applications. It is a closed loop system, lending itself as a very cost effective alternative to the requirements of a chilled water system.

When sizing either of these cooling options, special care must be made to ensure proper ACU construction and insulation to address condensation and piping requirements.

While not all applications are custom, some manufacturers offer catalog cooling systems for common or normal openings, if desired.

8.7.3 Filters

Applications in dusty or dirty areas may benefit from ACUs equipped with inlet air filters. There are many types of filters available, and selecting the correct one depends on the application.

In general, filters are available in thicknesses up to 100 mm (4 in.) and have a Minimum Efficiency Reporting Value (MERV) ranging from 1 to 16; 16 being the most effective filter. The MERV accounts for particle size and velocity. A filter's effectiveness decreases as the face velocity increases or the particle size decreases. If two filters are of the same type, the thicker one will usually have a higher MERV rating. Another consideration in filter selection is motor power or performance reduction. As the filter thickness and/or effectiveness increases, the motor power will also need to increase or there will be a reduction in performance due to the filter's resistance to air movement. Most filters used in ACU applications will have a MERV rating between 2 and 8, unless exceptionally high filtration is required. Filters are typically classified as throw-away or permanent. Permanent filters can be cleaned and reused. However, these have a relatively low efficiency rating in the 1-4 range.

Although the MERV rating system makes it easier to evaluate and compare filters when compared to previous methods, it is based on a relatively new standard (ASHRAE 52.2). Many filter manufacturers have not yet adopted the system and do not post the MERV values in their catalogs. For this reason, many ACU manufacturers do not rate their filters in this manner and instead express filter efficiency as a percentage for a given particle size. The percentage states the ratio of how many airborne contaminates are removed versus the total amount of contaminants in the air (usually measured in microns). The percentage alone does not provide much useful information since it doesn't provide any data on the size of the particles that can be removed. Typically, the same filter will have a higher percentage for a larger particle size than it would for a smaller particle size. This can make comparing two different filters difficult if they are not based on the same particle size.

When the ACU's inlet is closely connected to the outdoors, moisture may occasionally be drawn into the ACU. In these cases, a moisture resistant filter should be the filter of choice. Other filter types, such as those with cardboard frames, may collapse when they absorb water.

It is recommended that filters be used whenever the ACU is equipped with a heating or cooling coil. The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) recommends at least a MERV 6 rating. A clean filter will reduce the dirt buildup on the coil and keep it operating efficiently.

The aerodynamic performance of an ACU will be reduced if the filters are not properly sized, cleaned or changed.

In Europe, filters are classified according to EN 779:2002. Classification is based on the average efficiency for 0.4 μm particles for fine (F) filters, and on the average arrestance of synthetic dust for coarse (G) filters. G2 is the most commonly used filter in ACUs.

8.7.4 Construction for outdoor use. ACUs that are going to be installed outdoors should be rated for outdoor use. ACUs rated for outdoor use may be constructed of stainless steel or other corrosion-resistant materials. Depending on the degree of exposure to the elements, special consideration will be given to the ACU's interior components. Protection for components could include: rain shields; water resistant motors; and water tight conduit, electrical fittings, and junction boxes. The ACU manufacturer should guide the customer through the selection process.

The fan blowers and housings, motor bases, fan shafts, motor junction boxes, or any other component of the ACU may also require special materials for operation in an outdoor installation. Drain holes may need to be put in the bottom of the cabinet to keep rain from accumulating, and sealants can be used to stop water from penetrating the ACU's outer casing.

8.7.5 Adverse indoor use special applications. Adverse indoor applications may include areas of constant moisture, exposure to corrosive chemicals, heat, cold, or other extreme environments. The construction of ACUs intended for use in adverse interior environments may require special components. ACU cabinets may require stainless steel construction, protection with corrosion resistant materials, or coatings intended to withstand the specific environment. Depending on the specific conditions, some, or all, ACU components may require protection from the adverse environment. For example, motors, fan impellers and housings, motor bases, fan shafts, motor junction boxes, or any other component of the ACU may require special materials suitable for use in the adverse environment. ACU manufacturers may offer units designed for use in adverse conditions. Consult the ACU manufacturer for details about units or options that allow ACU use in adverse indoor conditions.

9. Installation

Installation considerations begin during the ACU selection process, and an effective installation considers many factors. Understanding installation implications during the selection process will contribute to a successful installation and a satisfied customer.

When considering an ACU, it is important to decide whether the unit will be mounted horizontally or vertically, and inside or outside the opening. Obstructions surrounding the opening may require special installation considerations. Typical obstructions may include beams, piping, ductwork, eletrical conduit, door hardware, etc. Accessibility for maintenance should also be considered. Each manufacturer provides specific instructions for their models. Carefully follow the specific instructions regarding safety, installer qualifications and recommended work practices.

ACUs are generally installed indoors and are more often installed directly over the doorway so that the air curtain is discharged vertically down the opening. There are cases, due to limitations of space, primarily headroom, in which units are installed vertically and discharge horizontally across the opening. There are cases where units are installed outdoors. It is recommended that outdoor installations be protected from the elements either by an overhang or weather hood; by employing special duty motors, electrical fittings, fans, or impellers; and/or exterior finishes.

Whether units are mounted vertically or horizontally, the discharge width should equal or slightly exceed the opening that is being protected. If units are to be installed using threaded rods or angle brackets, consider the location of existing door hardware (overhead tracks, etc.) when sizing units, so that suspension rods or brackets do not interfere with the door hardware. An additional 15 or 30 cm (6 or 12 in.) of unit may facilitate an easier installation, and the added overlap may enhance performance.

When ACUs are installed to protect perimeter doors, the airstream can be adjusted so that it is directed at a 15-20° angle toward the outdoors. This allows a more powerful vector to oppose the prevailing wind, in the case that wind is directed towards the door opening. Side or top baffles may be employed to effectively extend the door jamb area so that the air curtain can effectively seal the opening.

ACUs are sold with a wide variety control options, motor voltages and heating options. It is best to consider power requirements for the total air curtain installation during the selection process. Assure electrical connections are in accordance with local building code regulations and completed by a qualified technician.

After the ACU is mechanically secured and power properly applied, the installer should validate the manufacturer's intended airflow. This is generally accomplished by holding a light weight fabric such as a handkerchief approximately 30 cm (12 in.) from the target surface. Depending on the air curtain design and manufacturer's recommendations, the airstream should be adjusted to properly cover the opening.

Consult with the manufacturer if you have any questions regarding installation of the ACU. Remember to consider the presence of hidden utilities or electrical wiring. Some manufacturers provide units heated by gas. Sufficient air is necessary for proper combustion and exhaust. Follow the heater manufacturer recommendations for fuel, air supply, and exhaust.

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