UNITED CoolAir
All-Indoor Solutions

TECHNICAL PAPER SERIES

Dedicated Outside Air Systems (DOAS)

Dedicated Outside Air System (DOAS) Solution to Critical Outside Air Problem

The late sixties, early seventies ushered a new era into many facets of our lives. The rising cost of oil along with the uncertainty of supply made it necessary to evaluate what we had taken for granted for many years.

The October of 1973 Arab oil embargo sent oil prices rocketing while shortening oil supplies, causing building owners/operators to search for more reliable, less expensive ways to heat and cool large commercial spaces. The solution it seemed was to create a sealed building envelope thereby limiting the amount of infiltration and ventilation air to the minimum.

National energy conservation measures called for a reduction of outside air to 5 CFM per building occupant from 10 CFM. Most experts believed this would be sufficient ventilation to ensure adequate health and comfort, but they were quickly proven wrong.

The reduction in expensive OA resulted in a large increase in occupant complaints traced to their time at their workplace. Symptoms included nose or throat irritation, headache, dry cough, itchy skin, sensitivity to odors, nausea, and eye discomfort. Sick Building Syndrome (SBS), as it was later known, caught the public's attention with the sickening of 221 people and death of 34 others at an American Legion convention in Philadelphia through contamination in their air conditioning system.

Many studies have since proven beyond a doubt and established links between indoor air quality and human illness. When you consider the economic impact through lost productivity, law suits and increased insurance costs, building owners, HVAC design engineers and operators all take this issue very seriously.

OA is the Answer

ASHRAE Standard 62.1 – 2013--Ventilation for Acceptable Indoor Air Quality for commercial buildings—quantifies the minimum ventilation rates and indoor air quality that will be acceptable to human occupants. 62.1 intends to minimize the potential for adverse health effects and has increased average ventilation rates from 5 CFM/person up to 20 CFM/person.

As a result, greater amounts of outside air must be introduced to the space, which also affects humidity levels. Humidity control becomes particularly important in the eastern half of the United States where mean dew point temperatures are 60°F e.g., 78°F/54% relative humidity, and higher during the summer.

These issues influence the need for a HVAC unit design capable of controlling ventilation, moisture levels and temperature in the space. To rectify the problem, traditional central station comfort cooling air conditioners must be "oversized" to handle peak latent load. To attempt to meet the new ASHRAE ventilation standards, a traditional air conditioning system generally requires 20%–70% more outside air than it was designed to cool, heat and dehumidify. Also, the traditional central HVAC must be set to provide the proper amount of outside air for the space with the greatest ventilation requirements. This ultimately causes over ventilating the rest of the building in the process and increasing the cost of conditioning that air.

Adapting DOAS To Your HVAC System

There is a proven method that will meet the challenges of complying with the ASHRAE Standards, delivering precise amounts of ventilation to spaces regardless of load size, and do it cost effectively.

Known specifically as a Dedicated Outside Air System, or DOAS, the outdoor air is conditioned separately from the air that controls the building's space temperature (dry bulb). By having one system to provide and dehumidify all the ventilation air and a second system to control the space dry bulb temperature, both humidity control and space temperature control are improved.

By conditioning the outdoor air and recirculated air independently, a DOAS effectively separates the sensible and latent loads. The outdoor-air DOAS unit removes the latent load to control humidity, and the main HVAC unit removes the sensible load to produce a comfortable temperature. This is important because the primary source of building humidity in most climate areas is fresh outdoor ventilation air that has not been properly dehumidified. Additionally, the DOAS unit can assist the main HVAC unit by controlling smaller internally generated amounts of latent load that naturally build from occupants and other sources. It does this by providing air that is slightly drier than the target humidity level. Generally speaking, a DOAS provides "neutral" air of 70°F to 72°F @ 50% RH.

If desired, a DOAS unit can also provide the dehumidified air directly to the space at 55°F where it will offset some of the sensible load of the local HVAC unit. By delivering the air "cold", this operation strategy doesn't waste the sensible cooling byproduct performed by dehumidification but allows the local heating/cooling units to be sized smaller and requires less valuable floor space. A smaller main heating/cooling system means less energy consumption through smaller fans and compressors. A DOAS delivering cold supply air requires less reheat, but some reheat may be needed during periods of low sensible loads so the space is not "over-cooled" by the DOAS unit.

A DOAS doesn't rely on totally new technology, but rather uses HVAC equipment configured to condition outdoor ventilation air separately from return air. The outside air conditioning system design consists of a cooling/dehumidification-reheat coil and supplemental heating system. The deep evaporator coil's consist of 10 fins per inch/6 rows deep design, positioned in the draw-through air flow arrangement that provides the most effective moisture removal efficiency. It is this technique that differentiates it from conventional HVAC systems. This configuration will cool and dehumidify air in the summer and heat or cool it in the winter.

The operation is simple in design with the outdoor air first passing through an optional preheat coil (if used), which is sometime used for winter operation. When a heat exchanger is used, it brings the outdoor air closer to the temperature and humidity of the conditioned exhaust air.

A DOAS provides design engineers installation flexibility to meet the requirements of the application. Variables facing the engineer include, but are not limited to, if it's new construction, retrofit or an installation having

an existing system in place. Other considerations include the type of new or existing HVAC system installed such as constant volume, VAV and even the newer variable refrigeration flow (VRF) terminal units.

Delivering the conditioned OA from the DOAS to where it's needed usually includes a separate ducting system running parallel to the HVAC supply air. For many climates, an independent duct system is considered the best choice because the ventilation air volume better meets the volume requirements of the project, and the DOAS ducting can be smaller than the conventional HVAC saving on the installation cost. Smaller ducting is also easier to manage in retrofit and existing HVAC installations.

A popular alternative ducting choice is a single duct system where the conditioned OA is blended with return air from the main HVAC system in a mixing box, or in a terminal unit that serves just one zone. If using a multi-zoned HVAC control system, individual zones are controlled separately and the DOAS will deliver the proper amount of outdoor air directly to each zone. In all cases, the DOAS can vary the fraction of ventilation to supply air, which can reduce the outdoor airflow rate by 40 percent by conditioning only the amount of air necessary for each zone.

DOAS and VRF

The choice of installing a DOAS, especially if the existing HVAC system already includes provisions for OA, is for operating efficiencies and the need to meet ventilation code requirements or occupant comfort. But we are now seeing new cooling technology being specified that has no provisions for OA and requires a dedicated outside air system for this purpose. One of these systems is the variable refrigerant flow (VRF) system.

Japan introduced the variable refrigerant flow technology in the 1980s as a flexible way to condition spaces without the complexity of large HVAC systems that require bulky mechanical rooms and expensive ducting. As the technology improved, the American market embraced VFR systems but to a lesser degree.

Today's VRF units offer the building owner/manager many benefits including low first cost, simple installation, minimal maintenance and the ability to run multiple evaporator units from a single condensing unit. But with all its benefits, VRF systems have limited to no ability to satisfy ASHRAE ventilation requirements or remove excess latent loads typical of certain geographical regions.

With rising energy costs and expanding energy consumption awareness, it's no wonder variable refrigerant flow technology continues to gain ground in the U.S. marketplace. VRF has the potential to achieve significant energy savings compared to older HVAC systems, according to a study by the U.S. General Services Administration.

Reports going as far back as 2012 indicated the U.S. market was estimated to be worth over $7 billion for VRF systems. More recent estimates of the U.S market indicate a compound annual growth rate of 5.2 percent is expected through 2019. You can expect the sales of DOAS systems will grow as much if not better to match the upcoming surge in OA units.

Not All DOAS Systems Are Built Alike

DOAS systems are an ideal choice for new construction, retrofit installations or adding to your existing HVAC system to improve performance. Traditional HVAC roof-top systems require adequate space for the air handler location and ducting large enough to handle the both the ventilation/supply and return air. A DOAS is the ideal unit to handle the latent load requirements for OA requirements and dehumidification while the existing HVAC system manages the sensible load.

A DOAS system is ideally suited for retrofit applications where the new HVAC system (air handler and DOAS) must work within the confines of the existing space. The original HVAC system could have been installed in one of many configurations, requiring the design engineer and contractor to manage challenges as needed. Some manufacturers of DOAS units like United CoolAir Corporation have taken this serious problem into account and designed their units with special features to overcome even the most perplexing installation challenges.

United CoolAir's DOAS, like their entire line of air conditioning equipment, is designed specifically for indoor installation. This feature is extremely important for multi-story buildings that have limited or no access to the roof or ground pad. Units are sized to accommodate floor-by-floor installations, and multiple units are easily

installed if more cooling capacity is needed. Air-cooled condensers are easily mounted indoors near an outside wall for waste heat removal, or a water-cooled condenser option is offered if tower water is available.

Unlike the "one size fits all" approach by some manufacturers, the United CoolAir outside air system is made specifically for each project. Vertical configurations are ideal for small mechanical rooms, including closets while horizontal styles offer in-ceiling mounting, saving valuable floor space.

Having the ability to customize your DOAS unit to fit your installation requirements can save thousands of dollars in contractor charges and shorten installation time. United CoolAir's OmegaAir II allows modification in air paths, component configuration and utility placement before leaving the factory. They also offer a comprehensive list of factory-installed options to meet even the most complex cooling requirements.

Unlike new installations, retrofit applications generally have limited access to the job site. United CoolAir's indoor, customizable DOAS units can be broken down into sections that fit through standard doorways, halls and into elevators. Lifting units by crane and modifying the building structure to accommodate equipment becomes a thing of the past, saving time and thousands of dollars in building modifications.

United CoolAir charges and tests each of their units before leaving the factory. DOAS units include re-sealable refrigerant couplings between separable sections to preserve the factory refrigerant charge. Refrigerant couplings are reattached during jobsite assembly, and ready for immediate operation. Brazing, recharging and testing are eliminated saving additional time and money.

Dedicated outside air systems are as necessary to the safe and efficient cooling and dehumidification operation in commercial buildings as their HVAC cooling counterparts. It is important to investigate the many systems available to find a DOAS that best fits your unique retrofit installation requirements.