PART 3: MAKE-UP AIR SYSTEMS

A clear understanding of the MUA system-specific design intent is an absolute necessity because MUA design applications vary and work in conjunction with many other HVAC systems.

BY RICH PERROTTA

Author’s note: In this last article in a three-part series exploring make-up air (MUA) systems, the author will focus on other types of MUA systems typical to commercial/industrial structures. In the first two articles, published in the February 2018 and March 2018 issues of RSES Journal, and discussed in the April 18, 2018 RSES Technical Webinar, the author explained the importance of having a properly designed and operating MUA system. He also discussed the implications of these systems not functioning according to their original design intent. The webinar can be found at www.rses.org/myrses/webinars.aspx.

Today’s newer residential structures are designed with some type of make-up air (MUA) system to ensure, among other things, proper indoor air quality (IAQ). This is precisely why it is of utmost importance that HVACR maintenance, service and facility managers recognize the type of system that has been designed and applied for that purpose, and ensure proper operations throughout the lifecycle of the MUA equipment.

That said, it is the HVACR professional’s job to review each facility’s equipment layout and refer to all original design criteria, such as blueprints, submittals, TAB (testing, adjusting and balancing), reports and equipment installation operation manuals (IOM), to develop a clear, precise understanding of how the facility is supposed to operate, especially with respect to MUA requirements. In most situations this will require fully trained, responsible service and maintenance personnel, and specific equipment factory-authorized training programs to be completed.

The following is an overview of different types of equipment layouts that incorporate MUA:

→ Rooftop package units: With this type of setup, the design team equips the structure with standard package heating/cooling units to meet its comfort conditioning requirements. Each unit is affixed with an economizer and either mechanically activated or forced convection type barometric relief dampers.

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In this application the minimum outdoor air requirements for each zone are being served by each respective unit, to be brought in when conditions dictate. The unit will operate in full economizer mode when the barometric relief dampers are activated. With this type of equipment it becomes critical to ensure not only the proper functionality of the economizer, but also that the correct amount of minimum outdoor air (OA) is being brought in at all times, according to its design.

These design criteria can be found in the facility’s IOMs, but can only be verified via the TAB team. Too often the minimum OA is erroneously set by estimated guesses or rules of thumb that may or may not result in over- or under-pressurization of the structure.

Another factor to consider is the Building Control System (BCS) or Building Management System (BMS). As previously mentioned in this series, to achieve the end result of a properly functioning facility in all aspects, but especially MUA, it requires a close effort between many concerned parties.
It is critical that HVACR maintenance, service and facility personnel understand the type of MUA system(s) they have to ensure proper operations throughout its lifecycle. Image courtesy of Addison HVAC.

Unfortunately, it is not unusual for the BCS to not be on the same page with the mechanical equipment. This can be a result of many issues, including improper commissioning, lack of a clear understanding of the original design intent, or simple neglect. When it comes to MUA, it is always best to allow the onboard factory controls in the equipment to control all aspects of the rooftop equipment’s operation, and the BCS to simply send an enable or disable signal to the unit. The only exception would be in cases where a zone’s CO₂ sensor has been employed to activate a purge mode to bring high CO₂ levels down to acceptable requirements.

→Rooftop package units without economizers: When the building layout employs standard rooftop units without economizers, or a combination of units with and without economizers, some other form of MUA has been factored into the design scheme, such as dedicated unitary MUA systems as discussed in previous articles.

When a rooftop unit is affixed with a manually set fixed OA damper to introduce a percentage amount of outdoor air, a remote exhaust fan or fans may be included to work in conjunction with the rooftop unit. In this case the exhausters in the building may run continuously or will be electrically interlocked to run when the rooftop units operate.

Remember, the design team’s goal is to maintain the structure's indoor air pressure slightly positive in relation to the outdoor air pressure to prevent harmful infiltration from the outside of untreated air, while providing the correct amount of MUA as outlined in ASHRAE guidelines.

This goal, along with the proper amount of exhausting of stale air to maintain acceptable VOC (volatile organic compound) and CO₂ (carbon dioxide) levels, can become a significant challenge to service/maintenance personnel if the mechanical and control systems are not functioning as designed.
Split systems: When a building incorporates split system heating/cooling, and remote exhausting equipment, dedicated MUA is usually the choice. In these situations the proper operation of the dedicated MUA system(s) becomes absolutely essential. One of the most important things to understand here is that these MUA systems are not primary heating or cooling units and that neutral air should be delivered from these units at all times.

It is important to be aware of the fact that if neutral air conditions are not maintained from the MUA, the result can be disastrous. Neutral air is defined as air that is typically in the 70°F range and at or around 50% relative humidity. When an MUA system is properly controlled it is absolutely critical that its discharge air delivery is set to maintain delivery at neutral conditions.

As in the case of split systems, a facility in which water source heat pumps, central station air handling equipment, ductless systems, or any combination thereof, neutral air delivery ensures preservation of the mechanical integrity of the equipment and prevents undesirable cold drafts or extremely warm zones from occurring.

In all of the above cases, the supply ducting from the dedicated MUA is routed directly into the return ducting or plenums of the equipment. When this ducting method is used, anything but neutral air can cause undo strain to the equipment. As an example, if a typical water source heat pump is being delivered at, let’s say 55°F air into its return duct from the MUA then it is operating in cooling mode and will have a drastic effect on the heat pump’s operating suction temperatures, resulting in eventual compressor issues or safety trip-outs.

Conversely, if that same piece of equipment in heating mode is delivering 100°F MUA air into its return, the result could be a high-pressure safety trip-out or a host of other mechanical issues.

When MUA supply ducting is also delivered to dedicated corridor diffusers or dedicated zone diffusers, in combination with return ducting methods, anything other than neutral air delivery can result in undesirable zone temperatures and occupant complaints.

VAV (variable air volume) systems: With VAV systems the MUA requirements are combined with the exhausting needs to maintain proper conditions in the facility with respect to pressurization, temperature control and zone reheat requirements. With this type of system, and any specialized application, the need for a clear and definitive understanding of the manufacturer’s equipment literature is of utmost importance.

There are many different application variations required to accomplish the conditions mentioned above. VAV systems encompass several types, including pressure dependent, pressure independent, with onboard reheat, without, etc. The responsible parties need to review each application-specific design to develop a clear understanding of the proper design intent and operational verification.

With VAV systems an exception to the rule exists regarding neutral air. Specifically, these systems are primary sources of heating/cooling in conjunction with reheat, and typically supply main high-pressure supply trunk air in the 55°F range.
The MUA requirements are introduced via a constant level of outside air into the intake hood, and a percentage of power exhaust usually based on a supply duct static pressure setting. This arrangement does present some challenges, with a fine line between maintaining a high enough supply trunk static pressure and not over-pressurizing the facility, which can cause doors to blow open or not close properly, ceiling tiles to warp, etc. Through proper commissioning and TAB practices, the end goal can be achieved.

Commercial kitchen hoods: Every kitchen requires proper MUA to work, in conjunction with the usually large amounts of exhausting requirements, to maintain sufficient slightly positive pressures. The types of unitary MUA/exhaust systems vary from very basic to highly sophisticated.

MUA design applications vary and work in conjunction with many other HVAC systems and facility control systems. It is for that very reason that a clear understanding of the system-specific design intent is an absolute necessity, and sometimes requires a consolidated effort between many trade specialists to reach the end goal of proper facility conditions.

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