



Art Hallstrom

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Evolving Technology

Understanding Three Generations of DOAU

BY ARTHUR D. HALLSTROM, P.E., BEMP, FELLOW ASHRAE

Dedicated outdoor air systems (DOAS) continue to evolve as building designs, systems and equipment types change. The heart of DOAS is the dedicated outdoor air unit or DOAU. Designers and operators need to understand DOAU functions to successfully use them in the DOAS. DOAU functions can be roughly split into three generations.

DOAS is defined as a ventilation air system that runs in parallel with the building's heating and cooling systems. Think of it as HVAC split into "V" and "HAC." The DOAS is often called the primary system, and the HAC or H/C is the secondary system.

The DOAS system is supplied by a unit that can be labeled a DOAU. There are three major DOAU groupings or generations. The DOAU selection determines how the DOAS will operate.

The term DOAS first appeared in ASHRAE literature in the mid-1990s. DOAS has since matured into a popular system.

Designers have asked, "Is a traditional makeup air unit a DOAU? According to ASHRAE Technical Committee (TC) 1.6, Terminology, any unit that supplies only outdoor air directly to a space is a DOAS unit, so a space dedicated makeup air unit is a DOAU. But there are significant differences in DOAU design, performance and cost. Processing outdoor air is generally a very significant part of the total HVAC operating cost, so the DOAU design and total unit/system control with performance readout is important.

To help engineers and operators using DOAS, TC 1.6 defined three basic types or generations of dedicated outdoor air units.

The first-generation DOAU rooftop or air handlers predates 1990 and is a makeup air unit with optional series heat transfer component(s) such as a cooling coil and heating coil/burners/etc. These units often had large capacity heating and cooling options.

Second-generation DOAU have an air-to-air recovery component with a system exhaust fan. This unit uses exhaust air energy to pretreat the outdoor air going into the space. This unit can have additional cooling and heating components. Exhaust recovery helps the second-generation DOAU reduce system energy use, sometimes very significantly. The shift to second-generation DOAU occurred when Standard 90.1 started requiring exhaust air energy recovery. (A version of this recovery unit, often called an energy recovery ventilator, can be ducted to the outdoor air (OA) intake of a conventional air handler or rooftop unit, but this unit configuration

Arthur D. Hallstrom, P.E., is president of AD Hall in Crestview, Fla.

makes it a series air-handling system, not a parallel system, and thus not a DOAS or a DOAU.)

Second-generation DOAU/DOAS helped meet the requirements found in the 2007 to 2013 range of ANSI/ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quality*, and ANSI/ASHRAE/IES Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*.

Third-generation DOAU is a single unit with the components needed to meet the latest ventilation requirements in the ventilation Standard 62.1 and the energy Standard 90.1.

Third-generation DOAS/DOAU controls ventilation, humidity and building pressurization and is often today's DOAS system of choice. This DOAU typically has a supply and exhaust fan, filtration, dampers, cooling and heating components, parallel air-to-air recovery device and a packaged unit control all in one unit.

Additional components can be added to this third-generation DOAU to further reduce energy and/or handle specific outdoor air requirements. These components may include—but are not limited to—compressors, condensers, series or additional parallel desiccant components around the cooling coil, VAV fan operation, air cleaning beyond filtration and pumps.

Third-generation DOAU has three basic functions:

- Provide clean ventilation air to building spaces;
- Control the building dew point to the 60°F (16°C) maximum as required in the latest version of Standard 62.1; and
- Control building pressurization for envelope infiltration control and proper operation of the air-to-air exchanger and remote exhaust.

The shift to third-generation units occurred when ASHRAE Standard 62.1-2019 required mechanically cooled spaces to limit the indoor humidity to a maximum dew point of 60°F (16°C) during both occupied and unoccupied hours whenever the outdoor air dew point is above 60°F (16°C). The dew point maximum is intended to help maintain good indoor air quality and minimize, if not eliminate, mold damage.

In summary, to control space dew point, a third-generation DOAU needs to clean and dehumidify the outdoor air and, ideally, offset indoor internally generated humidity loads and control space pressurization. Sensible heating/cooling (H/C) units installed in the

Three Generations of DOAU

First Generation (Pre-1990)

- Makeup air unit with optional series heat transfer component around the cooling coil to provide enhanced dehumidification.

Second Generation (Popular from 1990 – 2015)

- Outdoor air unit with an exhaust air recovery component and a system exhaust fan.
- Can significantly reduce system energy use and meet requirements from earlier editions of Standard 62.1 and Standard 90.1.

Third Generation (2013 – Present)

- Has a supply and an exhaust fan, filtration, dampers, parallel energy recovery (air-to-air) recovery device, optional cooling and heating components and unit control in one unit.
- Controls building ventilation, humidity and building pressurization. Has the components needed to meet the latest ventilation requirements in Standard 62.1 ventilation and energy standards in Standard 90.1.

space cool or heat the space to the right temperature level.

Some DOAUs can be certified under ANSI/AHRI Standard 920, *2015 Standard for Performance Rating of DX-Dedicated Outdoor Air System Units*. If the unit is not AHRI certified, the components inside the DOAU can be and should be individually AHRI certified. Properly configured, commissioned and operating DOAS/DOAU can be a key part of a high-performance building.

More Resources

Resources are available to learn more about DOAS and DOAU in their previous and current iterations.

These resources include ASHRAE's *Advanced Energy Design Guide—Achieving Zero Energy* series; *2020 ASHRAE Handbook—HVAC Systems and Equipment*, Chapter 51, “Dedicated Outdoor Air Systems”; ASHRAE Learning Institute course, “Latest in High Performance Dedicated Outdoor Air Systems (DOAS)”; and ASHRAE eLearning course, “Essentials of Dedicated Outdoor Air Systems (DOASs).” ■