engineering bulletin

ASHRAE® Standard 15-2022 A2L EDVC Example

Self-Contained (DX) Multiple-Zone VAV System

The following abridged material is from Trane application manual APP-APM001*-EN, *Refrigeration Systems and Machinery Rooms: Application Considerations for Compliance with ASHRAE® Standard 15-2022.* It is strongly recommended that any user of this document also reviews the source material for additional clarifications, givens, and commentary.

A self-contained system is classified by Standard 15 as a "high-probability" system, since leaked refrigerant has a high probability of entering the occupied space. When designing a high-probability system, the occupied space must be of sufficient "volume" to safely disperse and dilute any leaked refrigerant. Dilution is the solution! The maximum allowable refrigerant charge, known as the Effective Dispersal Volume Charge (EDVC), is calculated using the volume available to disperse the leaked refrigerant, and depends on the refrigerant's safety group classification.

Standard 15 may provide more than one approach for complying with the EDVC. The designer may use one or a combination of several of these approaches. For the purposes of brevity, it is not possible to discuss all possible approaches, so this document only focuses on the simplest approach. Refer to Trane application manual APP-APM001*-EN for additional approaches.

Because ASHRAE Standard 15 is under continuous maintenance, the requirements can change frequently. This document is based on the 2022 published version. Refer to the ASHRAE web site for the most current version of the standard, including any published addenda and errata.

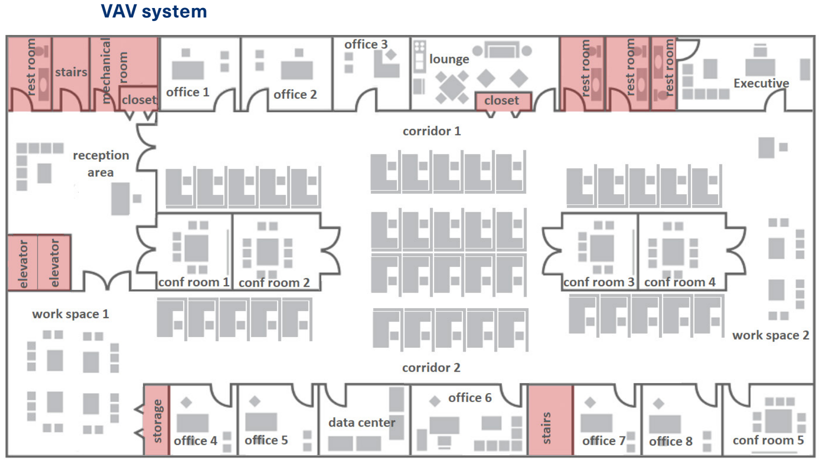
Example: Self-Contained (DX) Multiple-Zone VAV System Serving a "Commercial" Occupancy with an A2L Refrigerant

Given: A 70-ton self-contained unit with variable-airflow control serves a floor of a high-rise office building (Figure 1). The direct-expansion (DX) self-contained unit consists of two independent refrigeration circuits: one 40-ton circuit and one 30-ton circuit. The refrigerant is R-454B (A2L) and the unit is equipped with two, factory-installed refrigerant detectors: one in the evaporator section and one in the compressor section.

Each occupied space is served by a VAV terminal unit, with minimum airflow setpoints higher than 10 percent of design supply airflow. Supply air is ducted to diffusers located throughout the occupied spaces. Return air is ducted from return-air grilles back to the self-contained unit. The supply and return ductwork is located in this ceiling plenum.

Per Standard 15, the occupancy classification is "commercial" (F_{occ} = 1.0) and this system is categorized as a "high probability" system.

Figure 1. Example floor of a high-rise office building served by a self-contained VAV system



Solution (A2L refrigerant): This is an example of "connected spaces" via a ducted air distribution system (per Section 7.2.3.3). When calculating the effective dispersal volume (V_{eff}) of the connected spaces in this example, include the following:

- The volumes of all spaces served by the common supply and return ductwork, since the VAV dampers in this example do not close below 10 percent of design supply airflow when the supply fan is operating. (The standard states that we can ignore fire or smoke dampers that only close in an emergency.)
- The volume of the supply and return ductwork. (Note that this volume would be ignored if the ductwork is routed through a ceiling plenum that was used as part of the return-air path.)

...but exclude the following:

- The volumes of the storage room, mechanical room, and closets, since these spaces are not served by the supply or return ductwork, and can be closed (isolated) from the source of the refrigerant leak by a door.
- The volumes of the staircases and restrooms, since they are conditioned by transfer air only.
- The volume of the interstitial ceiling plenum is not included in this example, since it is not part of the return-air path.

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For this example (Table 1), the effective dispersal volume (V_{eff}) of the connected spaces is calculated to be 183,288 ft³.

The 70-ton, DX self-contained unit consists of two independent refrigeration circuits: the 40-ton circuit contains 57 lb of R-454B and the 30-ton circuit contains 43 lb of R-454B. Per Section 7.3.4.2, the releasable refrigerant charge (m_{rel}) is the charge in each independent circuit. We will analyze the larger circuit. If it's refrigerant charge complies with the EDVC, then we know that the smaller circuit will also comply.

Standard 34 lists R-454B as a Group A2L refrigerant with an LFL of 18.5 lb/1000 ft³ or 0.0185 lb/ft³.

Since this is a high-probability system used for human comfort, the use of a Group A2L refrigerant means that the requirements of Section 7.6 apply.

This refrigeration system is ducted, and m_{rel} is greater than 4 lb, so Section 7.6.2.3 requires that it be equipped with a leak detection system that is listed with the equipment. The self-contained unit in this example includes two refrigerant detectors—both of which comply with the requirements of Section 7.6.2.4—to initiate air circulation in the event that a leak is detected. One of the detectors is located in the evaporator section and the other in the compressor section. If a leak is detected in either location, the evaporator fan is activated to disperse any leaked refrigerant. This example self-contained unit contains a method to allow a leak in the compressor section to be circulated by the supply fan and dispersed throughout the same volume.

Since this system uses air circulation to disperse any leaked refrigerant, then per Section 7.6.1.1, the EDVC is calculated to be 1695 lb:

$$EDVC = 0.0185\ lb/ft^3 \times 183{,}288\ ft^3 \times 0.5 \times 1.0 = 1695\ lb$$

For this example, the releasable refrigerant charge in the larger circuit (m_{rel} = 57 lb) is lower than the EDVC, so the charge in the smaller circuit will also be lower than this threshold, and this system complies with the limit prescribed by Section 7.6.1.

Refer to the Trane application manual APP-APM001*-EN for more details.

Table 1. Example floor of a high-rise office building served by a self-contained VAV system

Occupied Space	Volume of Space, ft³	V_{eff}, ft³
Office 1	2700	183,288
Office 2	4000	
Office 3	2700	
Office 4	2700	
Office 5	2990	
Office 6	5390	
Office 7	2700	
Office 8	2990	
Conf Room 1	3330	
Conf Room 2	3830	
Conf Room 3	3140	
Conf Room 4	3330	
Conf Room 5	3140	
Work Space 1	10350	
Work Space 2	14860	
Data Center	3140	
Executive	7320	
Lounge	8320	
Reception	8980	
Corridor 1	43750	
Corridor 2	43460	
Ductwork	168	

Systems with air circulation

If the system has either continuous air circulation (except during short periods for maintenance or service) or air circulation that is initiated by a refrigerant detector that complies with Section 7.6.2.4, the EDVC is calculated as follows (per Section 7.6.1.1):

$$EDVC = LFL \times V_{eff} \times CF \times F_{occ}$$

where,

EDVC = effective dispersal volume charge, lb (kg)

V_{eff} = effective dispersal volume per Sections 7.2.1 through 7.2.3, ft³ (m³)

LFL = lower flammability limit of the refrigerant, lb/ft³ (kg/m³)*

CF = concentration factor = 0.5

F_{occ} = occupancy adjustment factor (0.5 for institutional; 1.0 for all others)

*Note that the values tabulated in ASHRAE Standard 34 are in units of lb/1000 ft³ and g/m³, so be sure to convert to the correct units when using this formula.

When air circulation is used to disperse leaked refrigerant, the UL product safety standard (UL 60335-2-40) prescribes the minimum circulation air flow rate.

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