*engineering bulletin*

# ASHRAE® Standard 15-2022 A2L EDVC Example

## DX Split 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 DX split 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.*

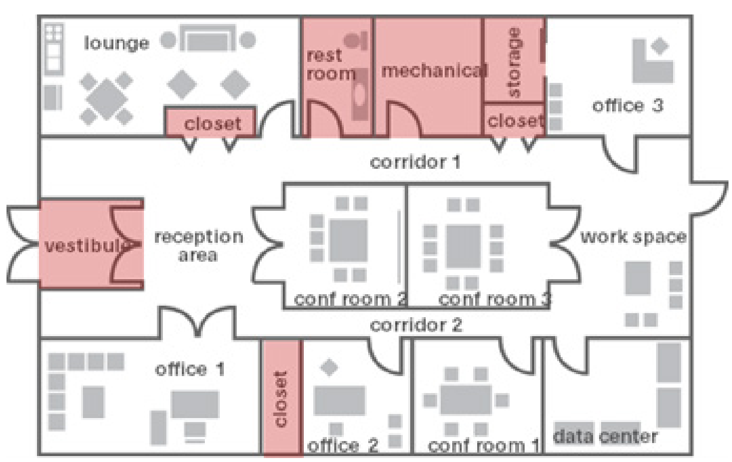
### Example: DX Split Multiple-Zone VAV System Serving a “Commercial” Occupancy with an A2L Refrigerant

**Given:** A 20-ton, direct-expansion (DX) split system with variable-airflow control serves a small office building (Figure 1). The split system consists of a single 20-ton refrigeration circuit. The refrigerant is R-454B (A2L) and the air-handling unit (AHU) has a factory-installed refrigerant detector.

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 ceiling-mounted return-air grilles back to the AHU. The supply and return ductwork is located in the ceiling plenum.

The air-cooled condensing unit is located on the roof. The interconnecting refrigerant piping drops down 2 ft into the interstitial ceiling plenum, runs 35 ft horizontally, and then drops down 10 ft to the AHU in the mechanical space. The liquid line is 5/8 in. and the suction line is 1 5/8 in. The total linear length of each refrigerant line is 47 ft.

**Figure 1. Example office building served by a DX split VAV system**




The refigerant piping has been leak tested in accordance with Section 9.13 of the standard. Therefore, per Section 7.2.3.1.1, areas of the building that contain only continuous sections of refrigerant piping, or that contain only joints and connections that have been leak tested in accordance with the standard, do not need to be considered in the calculations of effective dispersal volume.

Per Standard 15, the occupancy classification is “commercial” (Focc = 1.0) and this system is categorized as a “high probability” 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 whenever 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 mechanical room, storage 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 vestibule and restroom 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.

For this example (Table 1), the effective dispersal volume ($V_{eff}$) of the connected spaces is calculated to be 52,800 ft$^3$.

The DX split system consists of a single 20-ton refrigeration circuit. The manufacturer's installation manual lists the refrigerant charge as 19.5 lb of R-454B, and states that this does not include any of the additional charge needed for refrigerant piping. So we must account for the charge in the entire 47 ft of piping, which will be added in the field. Per the product application guide, this will require an additional top-off charge of 4.5 lb, resulting in a total refrigerant charge equal to 24 lb. Per Section 7.3.4.1, the releasable refrigerant charge ($m_{rel}$) is the entire charge of 24 lb.

Standard 34 lists R-454B as Group A2L refrigerant with an LFL of 18.5 lb/1000 ft$^3$ or 0.0185 lb/ft$^3$.

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 AHU in this example includes a refrigerant detector—which complies with the requirements of Section 7.6.2.4—to initiate air circulation in the event that a leak is detected.

Therefore, per Section 7.6.1.1, the EDVC is calculated to be 488 lb:

$$EDVC = 0.0185 \text{ lb/ft}^3 \times 52{,}800 \text{ ft}^3 \times 0.5 \times 1.0 = 488 \text{ lb}$$

For this example, the releasable refrigerant charge ($m_{rel}$ = 24 lb) is lower than the EDVC, so this system complies with the limit prescribed by Section 7.6.1.

Per Section 7.2.3.1.1, areas of the building that contain only continuous sections of refrigerant piping, or that contain only joints and connections that have been leak tested in accordance with Section 9.13 of the standard, do not need to be considered in the calculations of effective dispersal volume.

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

**Table 1. Example office building served by the DX split VAV system**

| Occupied Space | Volume of Space, ft$^3$ | $V_{eff}$, ft$^3$ |
|---|---|---|
| Office 2 | 2695 | |
| Conf Room 1 | 3144 | |
| Conf Room 2 | 3327 | |
| Data Center | 3593 | |
| Conf Room 3 | 3826 | |
| Office 3 | 3992 | |
| Office 1 | 5389 | 52,800 |
| Lounge | 7319 | |
| Reception | 8383 | |
| Corridor 1 | 2146 | |
| Corridor 2 | 2146 | |
| Work Space | 6387 | |
| Ductwork | 453 | |

### 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, ft$^3$ (m$^3$)

**LFL** = lower flammability limit of the refrigerant, lb/ft$^3$ (kg/m$^3$)*

**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 ft$^3$ and g/m$^3$, 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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