Rooftop Units
Level 1: Constant Volume
Technical Development Programs (TDP) are modules of technical training on HVAC theory, system design, equipment selection and application topics. They are targeted at engineers and designers who wish to develop their knowledge in this field to effectively design, specify, sell or apply HVAC equipment in commercial applications.

Although TDP topics have been developed as stand-alone modules, there are logical groupings of topics. The modules within each group begin at an introductory level and progress to advanced levels. The breadth of this offering allows for customization into a complete HVAC curriculum – from a complete HVAC design course at an introductory-level or to an advanced-level design course. Advanced-level modules assume prerequisite knowledge and do not review basic concepts.

Constant volume packages rooftop units are one of the most common HVAC systems for commercial buildings. The reason for this is that these units provide cost effective, complete, pre-engineered air-conditioning systems with a large offering of options and accessories to adapt them to many commercial applications. In addition, the largest number of commercial buildings fall within the range covered by these units. Most HVAC designers will at sometime in their career find a rooftop unit is a good solution for a project. Even though the manufacturer fixes the selection of the internal components, the designer must have an understanding of their features, ratings, limits, options, application, and selection to properly select and apply them. This TDP module presents the basic information a designer needs to properly select and apply constant volume rooftops.

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Introduction

Packaged constant volume rooftop units are one of the largest and most important segments of the air-conditioning industry, primarily due to their all-inclusive design, low cost, application flexibility, ease of installation, and widespread use.

This TDP module will give you an understanding of the types of constant volume rooftops, their application, available options and accessories, and guidelines for their use and installation.

The function of commercial packaged rooftop equipment is to provide complete air conditioning, including control of temperature, humidity, air circulation, exhaust, energy recovery, and filtration. Although standard rooftop units do not directly control relative humidity in most cases, they dehumidify the air, which usually results in acceptable humidity levels. While all rooftop units provide mechanical cooling, some are equipped with a gas-heating system while others use electric heaters, steam or hot water coils to provide year-round control of temperature.

Packaged rooftop units are generally available in sizes from 1½ tons to over 100 tons of cooling capacity. Two types of airflow control are available within this tonnage range: constant volume, in which the volume of air is constant and the air temperature is modulated to match cooling load requirements, an variable volume, in which the temperature is constant and the volume of air is modulated. While much of the construction of these two unit types is the same, there are several special construction features necessary in variable volume units. Generally, units under 20 tons tend to be constant volume type and units over 30 tons tend to be variable volume. However, much smaller units are available as variable volume and units to over 100 tons are used in constant volume applications. This TDP module covers primarily 2 to 25 ton constant volume (CV) commercial rooftop air conditioners. Units five ton and smaller are sometimes used for residential applications due to the special requirements of residential units, this application is not covered in this TDP. Much of the material in this module can be applied to larger tonnage constant volume units as well.

![Figure 1](image)

**Figure 1**

2-25 Ton Constant Volume Rooftop Units
What is a Rooftop Unit?

The term “packaged” is defined as products that fall within the unitary air conditioner category as defined by the Air Conditioning and Refrigeration Institute (ARI). ARI states that a unitary air conditioner consists of one or more factory-made assemblies that normally include: an evaporator or cooling coil, evaporator fan, compressor, and condenser combination. (It may include a heating function as well.)

When these components are integrated into one cabinet, they are single packaged units. When provided in separate assemblies and designed to be used together, they are split systems.

Since these units are most often placed on the roof, single package units are commonly called “rooftop” units. However, they also can be slab-mounted on the ground. They are usually available with either vertical or horizontal supply and return air connections.

On a typical rooftop unit, the compressor(s) are located at one end and the condenser coils are wrapped around or in close proximity to them. Filters are positioned on the entering air-side of the evaporator coil. These are typically one or two-inch throw-away filters. Figure 2 shows a gas-fired rooftop unit so the flue gas exhaust fan and its discharge are shown. The unit controls are located in an electrical compartment. The gas heat exchanger is located in a separate section on the downstream side of the evaporator fan. A perimeter base rail assembly is used to support the unit when placed on its curb (not shown) and to handle and rig the unit. The evaporator coil is two, three, or four rows deep and is a draw-thru design in front of the indoor fan which discharges air into the heater then down the supply duct. Direct-drive propeller fans draw outside air across the condenser coils and discharge the warmed air upwards.

Rooftop units are designed, tested and certified with national safety certification agencies such as Underwriter’s Laboratories (UL), Electrical Testing Laboratories (ETL), and Canadian Safety Agency (CSA.).

Definitions and Descriptions

ARI categorizes packaged rooftop units by the ability to provide heating. These categories are single packaged air conditioner (SP-A), single packaged year-round air conditioner (SPY-A), and single packaged heat pump (HSP-A). In this text we will use three commonly accepted acronyms for these units. SP-A will be referred to as PAC, SPY-A as YAC (with gas heat), and HSP-A as HP.
Packaged Air Conditioner (PAC)

A PAC is a packaged air conditioner (rooftop unit) that provides cooling only, or cooling with other than gas heat. The primary function of the PAC is cooling. Electric heaters are typically available factory installed as an accessory for field installation. Sometimes, PACs are called “all electric” or “electric-electric” because the source of heat is usually an electric resistance coil.

Year-Round Air Conditioner (YAC)

A YAC is a packaged unit with a gas heating section. It is called year-round because heating and cooling are integral factory-installed unit functions. Gas heating sections are normally designed for natural gas, but propane models or propane conversion kits are typically available.

Note: A YAC is also known as a gas-electric unit.
Heat Pump (HP)

A heat pump rooftop unit looks just like a PAC from the outside but the mechanical refrigeration cycle inside is different. The refrigeration cycle provides both cooling and reverse cycle heating. In the heating mode, the refrigerant flow is reversed using a four-way valve so that heat is extracted from the outdoor air and transferred to the indoor air. The heat pump is not just a PAC with a four-way valve, however. The evaporator and condenser are larger and the metering device arrangement is different to allow for the dual role. Because the heat pump does not heat efficiently at very low outdoor temperatures and to provide heating during defrost, the unit often contains optional electric heaters that supplement the reverse cycle heat.

Discharge Air Configurations

Shown is a vertical, or down supply air discharge as well as a vertical return configuration. Next to it is a horizontal discharge and return configuration. If the unit features both vertical supply and return and horizontal supply and return it is referred to as a “convertible” design.

For vertical discharge

the ductwork that delivers the conditioned airflow from the rooftop unit to the space and returns the air back to the rooftop should be attached to the curb and NOT the rooftop. The unit is simply placed on top of the curb using a crane or helicopter. The curb is a sheet metal platform that supports the unit.

Many rooftop designs offer horizontal supply and return duct connections in addition to vertical. Many of these designs are installed on grade (ground level) on a concrete slab.