

CHAPTER 49. UNITARY AIR CONDITIONERS AND HEAT PUMPS

UNITARY air conditioners are factory-made assemblies that nor- mally include an evaporator or cooling coil and a compressor/ condenser combination, and possibly provide heating as well. An **air-source unitary heat pump** normally includes an indoor conditioning coil, compressor(s), and an outdoor coil. It must provide heating and possibly cooling as well. A **water-source heat pump** rejects or extracts heat to and from a water loop instead of from ambient air. A unitary air conditioner or heat pump with more than one factory-made assembly (e.g., indoor and outdoor units) is commonly called a **split system**.

Unitary equipment is divided into three general categories: residential, light commercial, and commercial. Residential equipment is single-phase unitary equipment with a cooling capacity of 65,000 Btu/h or less and is designed specifically for residential application. Light commercial equipment is generally three-phase, with cooling capacity up to 135,000 Btu/h, and is designed for small businesses and commercial properties. Commercial unitary equipment has cooling capacity higher than 135,000 Btu/h and is designed for large commercial buildings.

1. GENERAL DESIGN CONSIDERATIONS

User Requirements

The user primarily needs either space conditioning for occupant comfort or a controlled environment for products or manufacturing processes. Cooling, dehumidification, filtration, and air circulation often meet those needs, although heating, humidification, and ventilation are also required in many applications.

Application Requirements

Unitary equipment is available in many configurations, such as

- **Single-zone, constant-volume**, which consists of one controlled space with one thermostat that controls to maintain a set point. This equipment may be single stage, multistage, or variable capacity.
- **Multizone, constant-volume**, which has several controlled spaces served by one unit that supplies air of different temperatures to different zones as demanded (Figure 1).
- **Single-package, variable-volume**, which consists of several controlled spaces served by one unit. Supply air from the unit is at a constant temperature, with air volume to each space varied to satisfy space demands (Figure 2).
- **Multisplit**, which consists of several controlled spaces, each served by a separate indoor unit. All indoor units are connected to an outdoor condensing unit (Figure 3). When each indoor unit varies its refrigerant flow in response to heating or cooling load demand, the system is called **variable refrigerant flow (VRF)**.

Factors such as size, shape, and use of the building; availability and cost of energy; building aesthetics (equipment located outdoors); and space available for equipment are considered to determine the type of unitary equipment best suited to a given application. In general, roof-mounted single-package unitary equipment is limited to five or six stories because duct space and available blower power become excessive in taller buildings. Split units are limited by the maximum distance allowed between the indoor and outdoor sections because of losses in refrigerant piping, compressor capability, and refrigerant oil management. Indoor, single-zone equipment is generally less expensive to maintain and service than multizone or multisplit units.

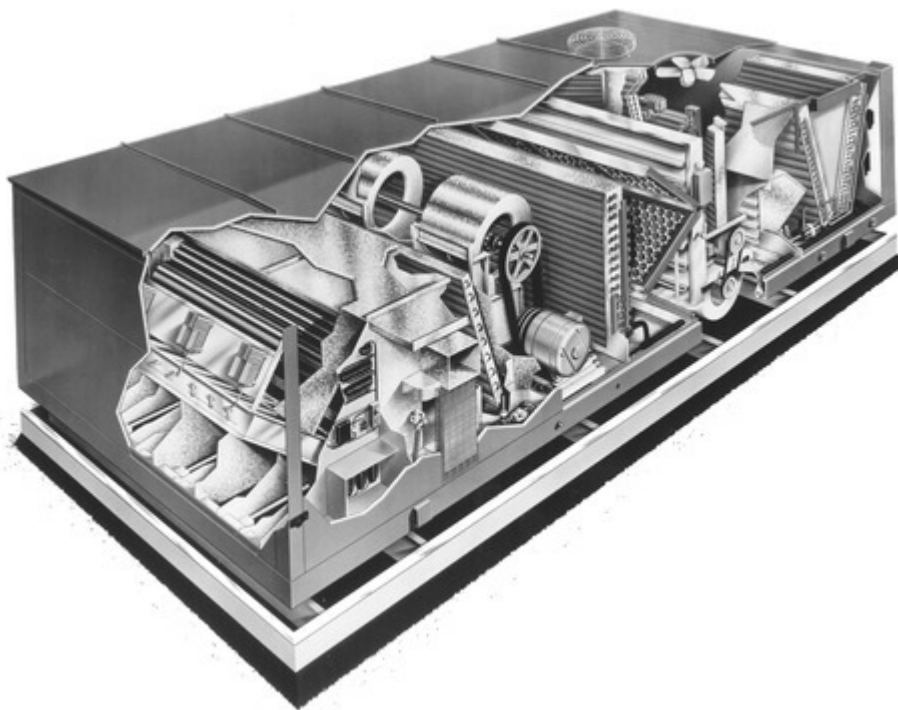


Figure 1. Typical Rooftop Air-Cooled Single-Package Air Conditioner

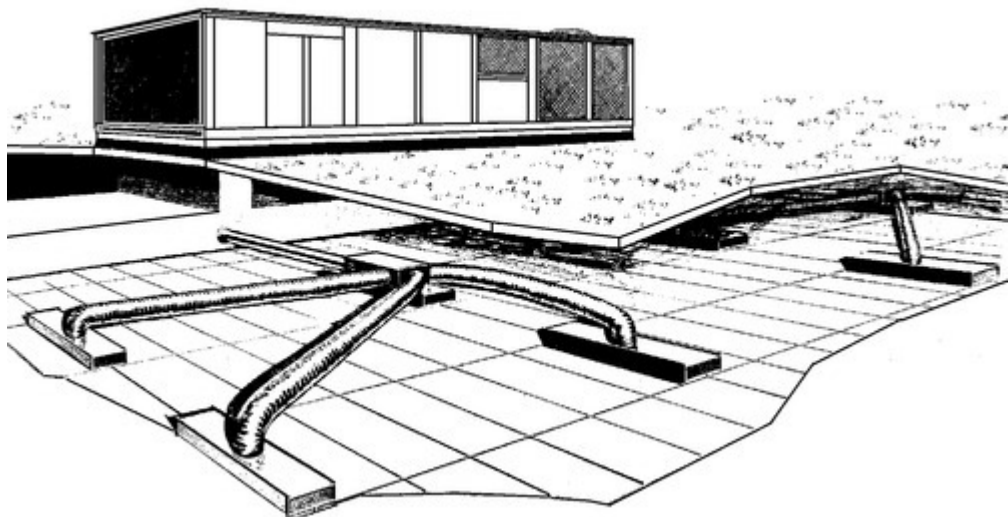


Figure 2. Single-Package Air Equipment with Variable Air Volume

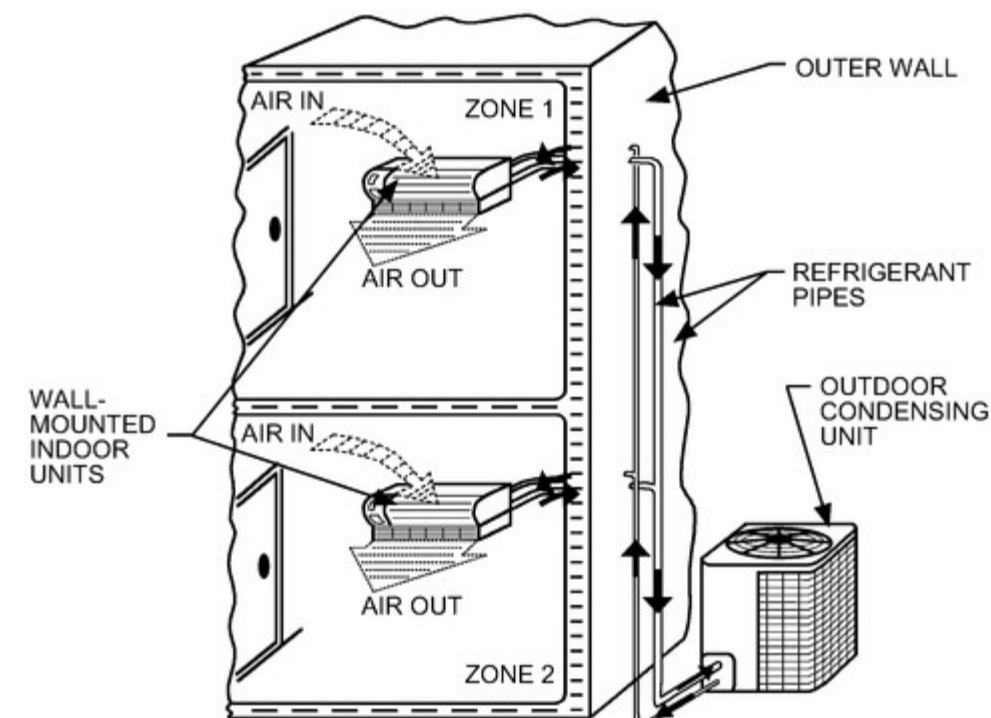


Figure 3. Example of Two-Zone Ductless Multisplit System in Typical Residential Installation

The building load and airflow requirements determine equipment capacity, whereas the availability and cost of fuels determine the energy source. Control system requirements must be established, and any unusual operating conditions must be considered early in the planning stage. In some cases, custom-designed equipment may be necessary. Manufacturers' literature has detailed information about geometry, performance, electrical characteristics, application, and operating limits. The system designer selects suitable equipment with the capacity for the application.

Installation

Unitary equipment is designed to keep installation costs low. Equipment must be installed properly so that it functions in accordance with the manufacturer's specifications. Interconnecting diagrams for the low-voltage control system should be documented for proper future servicing. Adequate planning is important for installing large, roof-mounted equipment because special rigging equipment is frequently required. *ACCA Standard 5* describes minimum criteria for the proper installation of HVAC systems in residential and commercial installations.

The refrigerant circuit must be clean, dry, and leak-free. An advantage of packaged unitary equipment is that proper installation minimizes the risk of field contamination of the circuit. Care must be taken to properly install split-system interconnecting tubing (e.g., proper cleanliness, brazing, and evacuation to remove moisture and other noncondensables). Split systems should be charged according to the manufacturer's instructions. Filter-driers are necessary; if they are not installed at the factory, they should be field installed.

When installing split, multisplit, and VRF systems, lines must be properly routed and sized to ensure proper oil return to the compressor. *Chapters 1 and 2 of the 2014 ASHRAE Handbook—Refrigeration* have more details on appropriate refrigerant piping practices.

Unitary equipment must be located to avoid noise and vibration problems. Single-package equipment of over 20 ton capacity should be mounted on concrete pads if vibration control is a concern. Large-capacity equipment should be roof mounted only after the roof's structural adequacy has been evaluated. If they are located over occupied space, roof-mounted units with return fans that use ceiling space for the return plenum should have a lined return plenum according to the manufacturer's recommendations. Use duct silencers where low sound levels are desired. Weight and sound data are available from many manufacturers. Additional installation guidelines include the following:

- In general, install products containing compressors on solid, level surfaces.
- Avoid mounting products containing compressors (such as remote units) on or touching the foundation of a house or building, or outside bedroom windows. A separate pad that does not touch the foundation is recommended to reduce any noise and vibration transmission through the slab.
- Do not box in outdoor air-cooled units with fences, walls, overhangs, or bushes. Doing so reduces the air-moving capability of the unit, reducing efficiency. Manufacturers include minimum clearances in literature.
- For a split-system remote unit, choose an installation site that is close to the indoor part of the system to minimize pressure drop in the connecting refrigerant tubing. Comply with manufacturers' refrigerant line length limits and required accessories listed in their literature.
- For VRF units, locate the refrigerant pipes' headers so that the length of refrigerant pipes is minimized.
- Contact the manufacturer or consult installation instructions for further information on installation procedures.

Unitary equipment should be listed or certified by nationally recognized testing laboratories to ensure safe operation and compliance with government and utility regulations. Equipment should also be installed to comply with agency standards' rating and application requirements to ensure that it performs according to industry criteria. Larger and more specialized equipment often does not carry agency labeling. However, power and control wiring practices should comply with the *National Electrical Code®* (NFPA Standard 70). Consult local codes before the installation is designed, and consult local inspectors before installation.

Service

A clear and accurate wiring diagram and well-written service manual are essential to the installer and service personnel. Easy and safe service access must be provided in the equipment for cleaning, lubrication, and periodic maintenance of filters and belts. In addition, access for replacement of major components must be provided and preserved.

Availability of replacement parts aids proper service. Most manufacturers offer warranties covering 1 year of operation after installation. Extended compressor warranties may be standard or optional.

Service personnel must be qualified to repair or replace mechanical and electrical components and to recover and properly recycle or dispose of any refrigerant removed from a system. They must also understand the importance of controlling moisture and other contaminants in the refrigerant circuit; they should know how to clean a hermetic system if it has been opened for service (see *Chapter 7 of the 2014 ASHRAE Handbook—Refrigeration*). Proper service procedures help ensure that the equipment will continue operating efficiently for its expected life.

Sustainability

Unitary equipment should be properly sized; avoid gross oversizing. Equipment performance should be carefully evaluated at all expected load conditions, and equipment should be selected to achieve the most efficient operation at all expected occupancy conditions. See application-specific chapters in the 2015 *ASHRAE Handbook—HVAC Applications* for further information on equipment sizing.

2. TYPES OF UNITARY EQUIPMENT

Tables 1 and 2 show available types of unitary air conditioners and unitary heat pumps, respectively. The following variations apply to some types and sizes of unitary equipment.

Table 1. AHRI Standard 210/240 Classification of Unitary Air Conditioners

System Designation	AHRI Type ²	Heat Rejection	Arrangement	
			Fan	Comp
Single package	SP-A	Air		
	SP-E	Evap Cond	Evap	Cond
	SP-W	Water		
Refrigeration chassis	RCH-A	Air		Comp
	RCH-E	Evap Cond	Evap	Cond
	RCH-W	Water		
Year-round single package	SPY-A	Air	Fan	
	SPY-E	Evap Cond	Heat	Comp
	SPY-W	Water	Evap	Cond
Remote condenser	RC-A	Air	Fan	
	RC-E	Evap Cond	Evap	Cond
	RC-W	Water	Comp	
Year-round remote condenser	RCY-A	Air	Fan	
	RCY-E	Evap Cond	Evap	Cond
	RCY-W	Water	Heat	
Condensing unit, coil alone	RCU-A-C	Air	Evap	Cond
	RCU-E-C	Evap Cond		Comp
	RCU-W-C	Water		
Condensing unit, coil and blower	RCU-A-CB	Air	Fan	Cond
	RCU-E-CB	Evap Cond	Evap	Comp
	RCU-W-CB	Air		
Year-round condensing unit, coil and blower	RCUY-A-CB	Air	Fan	
	RCUY-E-CB	Evap Cond	Evap	Cond
	RCUY-W-CB	Water	Heat	Comp

² Adding a suffix of ~"O" to any of these classifications indicates equipment not intended for use with field-installed duct systems.

Table 2. AHRI Standard 210/240 Classification of Air-Source Unitary Heat Pumps

Designation	AHRI Type ²		Arrangement			
	Heating and Cooling	Heating Only				
Single package	HSP-A	HOSP-A	Fan Indoor Coil		Comp Outdoor Coil	
Remote outdoor coil	HRC-A-CB	HORC-A-CB	Fan Indoor Coil Comp		Outdoor Coil	
Remote outdoor coil with no indoor fan	HRC-A-C	HORC-A-C	Indoor Coil Comp		Outdoor Coil	
Split system	HRCU-A-CB	HORCU-A-CB	Fan Indoor Coil		Comp Outdoor Coil	
Split system, no indoor fan	HRCU-A-C	HORCU-A-C			Comp Outdoor Coil	
Through-the-wall heat pump	TTW-HSP-A	TTW-HOSP-A	Fan Indoor Coil	Comp Outdoor Coil	or	Fan Indoor Coil Comp Outdoor Coil

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