

BY NATE HAYWARD

## Heating and Cooling Office Space With a VRF-HR Heat Pump



In the second-floor entry, which is open to a third-floor mezzanine, wall-mounted units heat and cool the reception area (1), while a ceiling “cassette” conditions air in a second-floor conference room, seen in the background (2). A Daikin VRV Aurora HR outdoor unit (3) (see inset photo) supplies heat and cooling simultaneously to 17 indoor units located in offices and work areas on the 3,200-square-foot second floor and 1,000-square-foot third floor. Two smaller multi-split units supply heating and cooling to the first-floor tenants, one of which is a catering business.

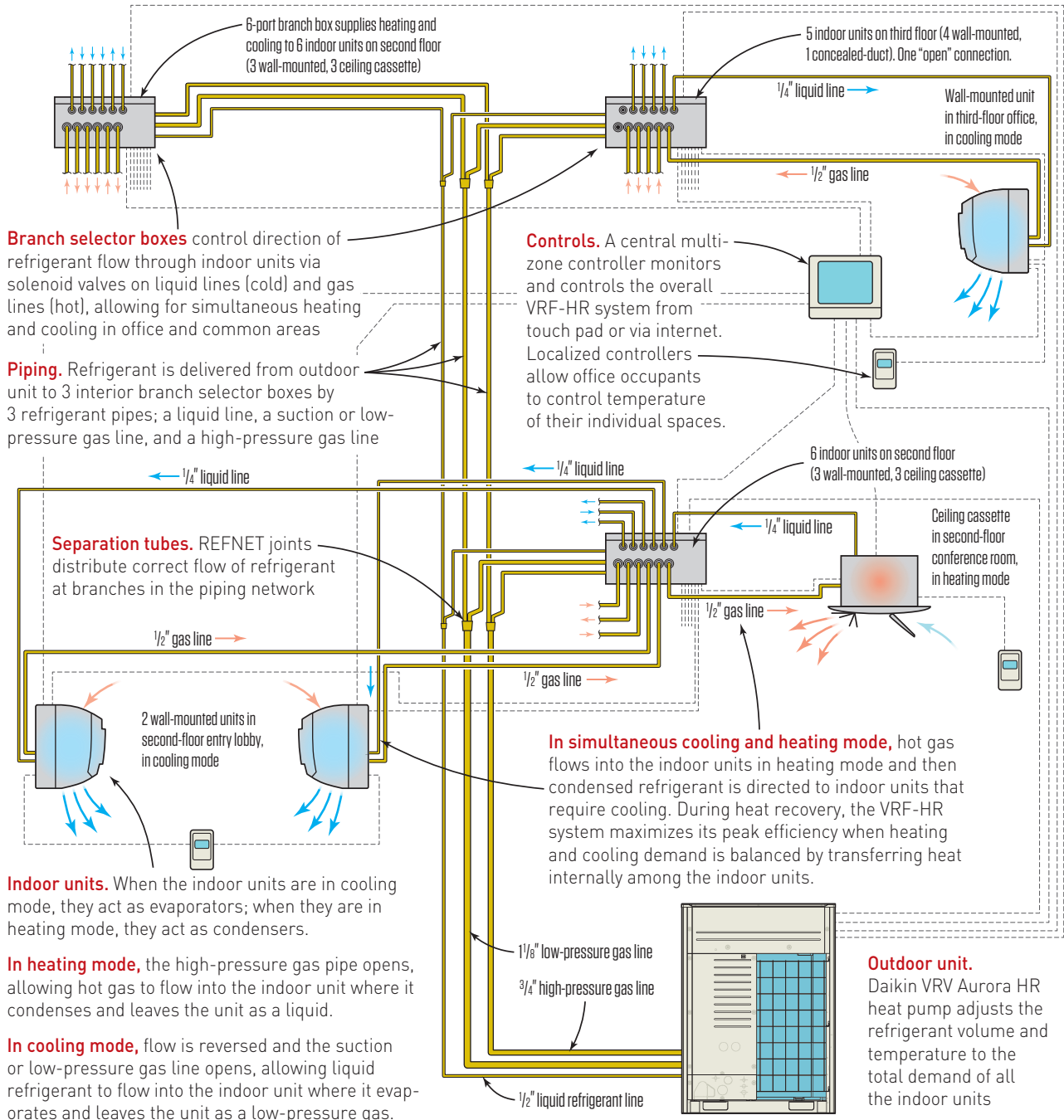
**In a previous article** (“Building a High-Performance Window Wall,” Mar/21), I reviewed some of the high-performance features of a new 7,300-square-foot office building my company, Hayward Design Build, built in northern Vermont. While the story mainly focused on the installation of large, triple-glazed window units, it briefly touched upon the building’s mechanical systems that enabled us to install mostly fixed windows throughout the building.

In this follow-up piece, I’ll explain in more detail the variable refrigerant flow system with heat recovery (VRF-HR) capability we installed to supply heating and cooling simultaneously to offices and common areas in order to meet individual comfort levels of building occupants. Teamed with two large-capacity ERV units to provide a balanced air supply throughout the building, the VRF-HR multi-split system has localized programmable thermostats that allow occupants to control the temperature of their individual spaces.

**Outdoor heat pump.** At the center of the system is the heat pump-heat recovery unit. VRF air conditioning, where only the minimum amount of refrigerant needed is circulated at any one time, enabling individual climate control of air-conditioning zones, has been around since the early 1980s in commercial buildings. We installed a Daikin VRV Aurora HR heat pump with heat-recovery capability. (Daikin refers to variable refrigerant flow (VRF) as “variable refrigerant volume (VRV)” —which is a copyrighted term by Daikin—but “VRF” and “VRV” are the same.)

As variable-speed compressor technology has advanced in heat pumps, their ability to pull heat from colder and colder air has improved to the point where they are now able to heat a fairly large space in climate zone 6 without worries. The 10-ton Daikin VRV Aurora HR unit we installed can deliver heating down to -22°F at

## VRF-HR System With Multiple Indoor Units



VRF systems with heat-recovery capability (HR) can operate simultaneously in heating and cooling mode, enabling heat pulled out from the surrounding air by the indoor "evaporator" units during cooling mode to be used rather than being expelled to the outdoors (as it would be in traditional heat pump systems). VRFs work best when there is a need for some spaces to be cooled and some heated during the same period (as often occurs in north and south sides of a building).



Ten wall-mounted units (4), six ceiling cassette units (5), and one concealed-duct unit supply conditioned air to the offices. An “intelligent Touch Manager” (6) controls the overall VRF multi-split system, while thermostats (7) in each office allow for localized control.



A 12-foot-diameter ceiling fan (bigassfans.com) eliminates any temperature stratification in the large volume entry lobby (8).

100% (with a diminishing performance curve at lower temperatures) and is capable of servicing up to 64 indoor units. Each individual indoor unit determines the capacity it needs based on the current indoor temperature and requested temperature from the localized thermostat. The outdoor VRF-HR unit adjusts the refrigerant volume and temperature according to the total demand of all the indoor units. For auxiliary heat in extreme cold or when there is a power outage, the building has a separate gas-fired unit in the lobby.

**Branch selector boxes.** In this case, the VRF-HR unit needed to supply heat and cooling to only 17 indoor units. Refrigerant is delivered from the outdoor unit to three interior branch selector boxes (which in turn deliver refrigerant to the 17 indoor units) via three refrigerant pipes: a liquid line, a suction or low-pressure gas line, and a high-pressure gas line. The branch selection box controls the direction of the refrigerant flow through the indoor units via solenoid valves on two refrigerant pipes—a liquid line and a gas line. (For information on system components, piping, and simultaneous cooling and heating operational modes, see the illustration “VRF-HR System With Multiple Indoor Units” on the facing page.)

**Indoor units.** We employed three types of indoor units to meet our heating and cooling needs: ten wall-mounted units, six ceiling cassette units, and one concealed-duct unit. The ceiling cassettes were placed in offices that had a floor system above them, while wall-mounted units were installed in hard-to-access areas, such as below insulated roof trusses. When the indoor units are in cooling mode, they act as evaporators; when they are in heating mode, they act as condensers.

**Controls.** The overall Daikin VRV (VRF-HR) system is controlled by an advanced multi-zone controller, the “intelligent Touch Manager (iTM)” located in a third-floor office. From the controller’s touch pad (or via the internet), the “iTM” can monitor and control individual cooling and heating set points, range limitations, setbacks, and auto changeovers. Localized Daikin Simplified Remote Controllers (thermostats) allow office occupants to control the temperature of their individual spaces.

**Ventilation.** Critical to the high-performance office building with fixed glazing was supplying fresh air to the occupants. Two Zehnder ComfoAir Q600 ERV units were installed to supply air to the two-story office areas. Supply heads were run to each office, while each unit had a central return (door undercuts in offices work as the return paths). Traditional bath fans with occupant-censors were used to vent the bathroom areas.

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