

**Air-Source (VRF) Heat Pumps.** Air-source VRF Heat Pump systems have been widely discussed in the trade press, including the April 2007 ASHRAE Journal and the August 2008 Environmental Building News.

VRF (Variable Refrigerant Flow) Heat Pumps are a relatively new technology in this country, but have been in use in the rest of the world for twenty years. (In Japan, 50% of medium size buildings currently use VRF systems.) VRF Heat Pumps provide heating and cooling by exchanging energy with the ambient air, extracting energy from the air in the heating mode and rejecting energy to the air in the cooling mode. Unlike conventional heat pumps, which switch to electric resistance heat at around 32 F, VRF heat pumps continue to operate down to below zero degrees F.

Daikin and Mitsubishi both make very efficient air-to-air heat pump systems that work at very low ambient air temperatures. One outdoor unit can serve multiple indoor units connected by refrigerant piping. The systems use R-410A refrigerant, which is applicable for LEED. The combination of the more efficient refrigerant, variable refrigerant volume, inverter driven compressor, and DC fan and compressor motors provide high coefficients of performance (COP), even at low temperatures. Different indoor units are available; including floor mounted, recessed floor mounted, wall hung, ceiling, and ducted air-handling units.

Link to Daikin: <http://www.daikinac.com/commercial/documents/VRF/VRF-S%20Leaflet%20-%20LVSUSE08-08C%20-%20Daikin.pdf>

Link to Mitsubishi: [http://www.mehvac.com/UploadedFiles/Resource/S-Series\\_Flyer.pdf](http://www.mehvac.com/UploadedFiles/Resource/S-Series_Flyer.pdf)

What you would see with this system are the floor, wall or ceiling mounted indoor units, and the outdoor heat pump units. The outdoor units can be located well away from the building (with the added costs associated with longer (buried) refrigeration piping).

The indoor units are very quiet, and the outdoor units are also very quiet (with a sound power rating similar to normal conversation).

This is a very efficient system in both the heating and the cooling modes. The EER ratings in the Cooling Mode are around 13 to 16 which are more efficient than those of conventional systems. A recently completed building in Portsmouth, NH received utility incentives for its efficiency.

The annual COP in the heating mode is around 2.3 to 3.2 which means that about three kW of heat are provided for one kW of electricity. In the heating mode it would be less expensive to operate than any other system except wood chips at current fuel prices, and costs about 1/2-1/3 the cost of oil. Of course, fuel prices and electrical prices all change and it is impossible to predict the future.

VRF systems provide performance very similar to that of ground source heat pump systems when the parasitic losses of those systems (pumping) are taken into account, and are much less expensive to install, as no wells are required.

VRF systems have very few components, which means reduced maintenance costs. There are no boilers to tune, chimneys to clean, pumps to rebuild, or pipes to leak. The equipment is exceptionally quiet and each room can have individual controls. Total system costs should be about the same as a hydronic system with air conditioning.

We have designed this system for the Appledore office building in Portsmouth, NH, which is currently in operation. Systems currently under construction include the (net-zero) Putney Field House in Putney, Vermont, and the Mosaic Commons co-housing project in Berlin, Massachusetts. We have also just installed this system in our own offices in Keene, NH.