

## **Compare Air To Water Heat Pump To VRF (VRV)**

3-Page Fast Read

This document offers a brief comparison of monoblock air to water (ATW) heat pumps and VRF (Variable Refrigerant Flow) heat pumps, also known as VRV (Variable Refrigerant Volume). Regardless of the name, VRF/VRV heat pumps are commonly known as “multi-head mini-split” heat pump systems, they follow the format of a normal mini-split but use a design which provides several indoor “head” units all interconnected and connected back to a single outdoor unit, using manifolds, valves, and high-pressure refrigerant lines. Monoblock ATW systems on the other hand have all their refrigerant self-contained in the outdoor unit and connect to indoor units via insulated (PEX) flexible water lines. The ATW indoor “head” units use water (or water-glycol mix) and as such are like fan coil units commonly used in higher-end commercial chilled water or boiler systems.

VRF systems have seen accelerated growth in recent years due to a strong attempt by the USA HVAC industry to leverage the advantages of a ductless system while satisfying consumer demand for serving multiple rooms without an outdoor unit dedicated to each room. And a push by local installers for the higher margins and lower levels of competition that exist with VRF technology helps things along. As such, VRF has had a lot of marketing success in spite of various performance and safety problems.

While VRF has seen increasing popularity in recent years, Monoblock (self-contained) air to water (ATW) heat pumps are now the fastest growing sector of the HVAC industry due to superior efficiency, safety, and flexibility, among other reasons. As mentioned, monoblock ATW heat pumps are self-contained, meaning that 100% of the refrigerant is located outdoors. Using simple water lines, ATW heat pumps can connect to a virtually unlimited number of indoor units with no real limits on the length of the lines. Indoor units may be ductless (room) units, or ducted air handlers, or may consist of radiant floor heating systems. Any or all ducted, ductless, or radiant approaches can be used within the same ATW application.

Further, simultaneously while performing heating and/or cooling, ATW systems can include an integrated high-efficiency source of domestic water heating, with official UEF ratings up to 50% higher than Energy Star Qualified standard heat pump water heaters, and 490% higher efficiency than electric element water heaters. VRF systems cannot make hot water and require a separate system.

A real advantage of monoblock ATW heat pumps is the fact that they are self-contained appliances. This means that the installation technician does not need a refrigeration/HVAC license or special HVAC skills to install the system. ATW systems can be installed by HVAC technicians, and also, by plumbers, handymen, general construction crews, remodelers, indeed, many have been installed as DIY by the homeowner. As you may imagine, with a factory sealed self-contained system, nearly all risk of refrigerant leak or improper charging has been eliminated, giving ATW systems far higher reliability than conventional split systems, with reliability levels similar to that of a “packaged” unit heat pump, which while not very efficient, do ship with a “factory perfect” level of charge and rarely if ever have leaks since no refrigerant connections need to be made on-site by the installer.

As to VRF safety issues, like all new systems, they use either R32 or R454B, both are classified as A2L refrigerants. These refrigerants are used in new VRF (Variable Refrigerant Flow) systems to meet low GWP requirements under the EPA's AIM Act. A2L refrigerants can ignite if they reach a high concentration (above the Lower Flammability Limit or LFL) and encounter an ignition source (e.g., electrical arc). Restrictions are beginning to exist to prevent leaks from creating flammable mixtures in occupied spaces, especially in VRF systems with extensive piping and large total charges.

The **US government** has decided that VRF Systems will not be permitted in Air Force facilities. The Army will allow VRF Systems; however, they will be strongly discouraged. The Navy is not restricting VRF systems as long as they comply with ASHRAE 15 Safety Standard for Refrigeration Systems (effectively eliminating VRF). Codified in December 2020, UFC 3-410-01 you can see the original US ARMY Corps of Engineers document here: [https://www.chiltrix.com/documents/vrf\\_army\\_corp\\_engineers\\_directive.pdf](https://www.chiltrix.com/documents/vrf_army_corp_engineers_directive.pdf)

Further, many local codes have the following VRF requirements for A2L usage:

<b>Refrigerant Charge Limits</b>	Releasable charge limited by <b>Effective Dispersal Volume Charge (EDVC)</b> or room-volume-based calculations (per ASHRAE 15 and UL 60335-2-40). Often ~4–6+ lbs. per indoor unit or space, depending on room size and LFL. Larger total charges require mitigation.	Keeps leaked refrigerant concentration well below 25% of LFL (with safety factor of ~4).
<b>Leak Detection &amp; Mitigation</b>	Required on systems exceeding charge thresholds. Detector must activate within ~30 seconds at 25% LFL: shut down compressor, energize fans, open dampers, isolate sections (via valves), disable ignition sources (e.g., duct heaters). Must run for at least 5 minutes.	Prevents buildup to flammable levels. Systems must be listed to UL 60335-2-40.
<b>Ignition Source Controls</b>	No open flames or certain electrical ignition sources in ducts/areas with refrigerant. Arc-resistant components required.	A2L precautions eliminate common triggers.
<b>Piping &amp; Shaft Requirements</b>	Piping often cannot run through certain spaces without protection. Requires shield plates (16-gauge steel, extending 2 inches beyond the pipe). No Unprotected vertical risers through multiple floors without a rated shaft. Use in certain plenums or connected spaces prohibited if they could allow refrigerant to spread without mitigation.	Limits spread of leaked refrigerant across floors. Recent code updates (2024/2025 IMC/ASHRAE 15) relaxed some shaft rules for tested continuous systems.
<b>Ventilation &amp; Air Circulation</b>	Enhanced ventilation in some cases; air handlers must circulate air upon detection.	Dilutes any leak quickly.

Some of the reasons for Local Code Restrictions and US Government elimination or restriction of VRF systems include the fact that VRF/VRV systems contain far more than a “normal” amount of refrigerant and make extensive use of high-pressure refrigerant lines *\*inside\** buildings. A typically sized VRF system contains enough refrigerant to silently, and without odor, asphyxiate a building’s occupants in the event of a refrigerant leak. Further, the new refrigerants required by the EPA after December 2024 are NOT non-flammable.

**The future.** R410a refrigerant is no longer allowed (as of Dec 31, 2024) and all new units are using the new R454B or R32 refrigerant. Unlike R410a, the new refrigerants are NOT non-flammable, therefore having a large amount of new gases (called A2L Gas) can be hazardous. In many jurisdictions, local code now requires some VRF systems to have the entire lineset enclosed in a pressure-tight vented “conduit”. But the next refrigerant on the horizon is R290. This is superior to R454b and R32 with much higher efficiency, better cold weather performance, and GWP of 3. Yes 3! Not a misprint. But R290 is a highly flammable, explosive gas and must not be indoors under high pressure in any amount needed for a typical heat pump.

Monobloc air to water design will be the future requirement for customers who wish to take advantage of R290. So, for remodels or new-builds, moving to monobloc air to water now makes more sense than ever. R717 is being considered as part of the longer term refrigerant roadmap, due to its incredibly high performance, but it is a deadly poison. ATW systems do not have any dangerous refrigerant or refrigerant lines within the building envelope, so in the future, any type of refrigerant can be used regardless of its hazards.

**Reliability.** Long refrigerant runs are common with VRF systems and generally the lines are branched out with many connections and many points of failure. A refrigerant leak is far more likely to occur at some point, and leaks are very difficult to locate, often requiring drywall demolition to locate a leak and once found, very difficult to repair.

**Energy Storage.** This is something that will become increasingly important as more utilities implement time-of-use rate tiers. Many utilities have peak rate periods where the rate may be 3x or higher per kWh than it is during an off-peak period. Thus, producing heating (or cooling) during an off-peak time and using it during a peak period (with the heat pump off during peak times) is a very effective cost saver. This is called “load shifting”. And storing energy in an air to water (hydronic) system is quite simple, it uses a large tank which can be far more practical, safer, and less costly than storing energy in batteries for the same purpose. For a DX (VRF) system to store energy one must use electrical battery storage systems that present cost, safety, and lifetime (charge-cycle) issues.

**Efficiency.** About efficiency, all VRF systems perform below their official published “general” rating as additional indoor heads are added. As an example, a high-efficiency VRF system with average seasonal efficiency rating (SEER) of 18 may only have an actual SEER 13 or 14 after 5 or 6 indoor heads have been added, compared to an ATW system that may have an average seasonal efficiency as high as 23, and not suffer degradation of efficiency regardless of the number of indoor units.

**Backup Heat & Flexibility.** Further, it should be noted that only an ATW system can have backup heat fully integrated (it’s in the water). In a VRF system, once the outdoor temperature drops below a certain point, the compressor stops and heating is fully handled by lower efficiency resistance elements. However, with a properly designed ATW system, the compressor can continue to contribute high efficiency heat, mixed with lower efficiency backup heat, to meet a total heat load. And only ATW systems can provide domestic hot water and/or radiant heating, in addition to normal space heating and cooling, and exclusively allow DHC (Dynamic Humidity Control) technology, which is also not possible with VRF systems.

In summary, monoblock ATW systems are inherently safer, more reliable, easier to install, have higher efficiency, present energy storage options, have more flexible use options, and are future-proof.