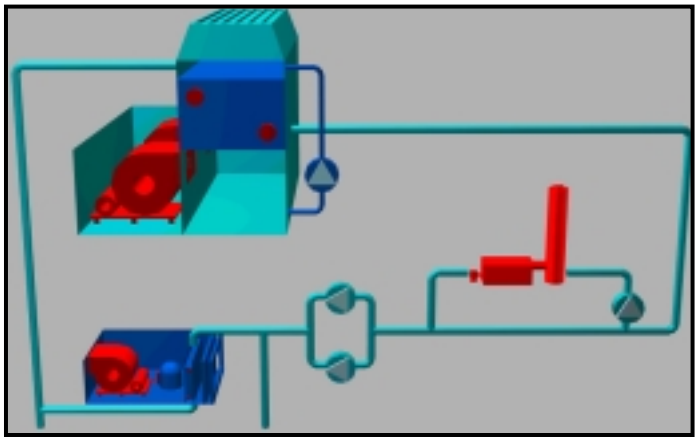
# Water Source Heat Pump Systems

## System Description

Water Source Heat Pumps (WSHPs) are individual air conditioner/heat pumps dedicated to each zone. Each WSHP has a refrigeration circuit within the unit that includes a reversing valve. One of the heat exchangers is refrigerant –to-water, while the other is refrigerant-to-air.

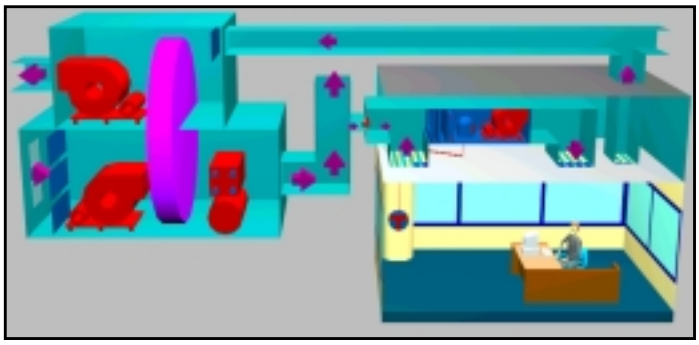
The heat pump capacity is matched to the design load of the zone it serves. The total WSHP capacity is the sum of the connected load rather than the block load. This means there is typically more installed capacity than the block design load.

Closed loop systems have all the WSHPs connected to a common water loop within the building. Each WSHP can either draw or reject heat from the loop to serve the needs of the zone it serves. This approach allows the heat collected from the core of the building (zones in cooling) to be used by the perimeter (zones in heating).



### Closed Loop

The closed loop consists of the WSHPs, main circulating pumps, a closed circuit cooler or cooling tower and heat exchanger and a boiler. The loop temperature is typically maintained between 70°F and 90°F. When the loop temperature approaches 90°F, the closed circuit cooler is used to reject heat from building. As the loop approaches 70°F, the boiler is used to heat the loop. In between 70 and 90°F, the energy is moved from one WSHP to another by the circulating water.



Each WSHP requires between 2.0 and 2.4 U.S. g.p.m. per ton. The system flow rate is the sum of all the WSHP flow rates. Variable flow systems can be used by installing isolating valves at each WSHP that close when the WSHP is not operating, and by adding VFDs to the pumps. This has two positive affects. First, the pumps and piping can be selected on block load capacity rather than the connected load. This will provide significant capital savings, helping to offset the cost of the isolating valves. Secondly, there will be pump power savings, particularly during part load conditions since only the required flow will be pumped.

### IAQ Considerations

WSHP systems typically require a dedicated ventilation system to supply each zone with ventilation air. ASHRAE Standard 62.1-1999 provides procedures for calculating ventilation rates to maintain minimum acceptable indoor air quality.

For cooler climates, the ventilation air must be tempered. It is possible not to air condition the ventilation air and add the ventilation cooling load to the WSHP load. This can reduce the capital cost, but during periods when the WSHP has cycled off, unconditioned air is introduced directly to the zone, which can create a humidity issue.

Precooling the ventilation air in the ventilation unit reduces the zone WSHP size and helps avoid dehumidification problems.

Ventilation systems are often ducted directly to the return air connection of the WSHPs. The proper ventilation requirement to each zone can be controlled if the ventilation air system is balanced during commissioning.

Adding energy recovery in the ventilation unit can significantly improve overall efficiency of the building.

## System Pros

- Very energy efficient since there is very little fan work and the heat in the building is moved from where there is too much to where it is needed.
- Ventilation air can be introduced directly to the zone.
- Easy to design and control. Individual zone control.
- Decentralized approach allows one unit to be serviced without affecting any other zone.
- Low capital cost.
- Straightforward to add energy recovery to ventilation system.

## System Cons

- Units are in occupied space. Service may interrupt the occupants.
- Sound concerns with fans and compressors directly in the space.
- A dedicated ventilation system is required.
- No diversity applied to capacity. The WSHP capacity is based on connected load, not block load.

### Energy Considerations

WSHP systems are very energy efficient because they can move energy from zone to zone within buildings. Adding variable flow to the building loop improves the efficiency further. If energy recovery is used for the ventilation air, WHSPs are one of the most efficient systems available. The following are some considerations outlined in ASHRAE Std 90.1-1999. The numbers in brackets refer to Std. 90.1-1999 sections.

- Energy efficiency tables for HVAC equipment (6.2.1).
- Equipment must be scheduled off automatically during unoccupied hours (6.2.3.1).
- Demand Controlled Ventilation is required for systems with at least 3,000 cfm of outdoor air and occupant density greater than 100 people per 1,000 $ft^2$ (6.2.3.9).
- Energy recovery is required for systems with at least 5,000 cfm supply air and a minimum of 70% outdoor air. This is specifically aimed at schools and labs (6.3.6.1).
- WSHP systems must have either a bypass line around the closed circuit cooler or low-leakage positive closure dampers on either the cooler inlet or discharge (6.3.2)
- Hydronic systems with a system pump power that exceeds 10 hp must employ variable flow and isolation valves at each terminal device. The system must be able to operate down to at least 50% of design flow. Individual pumps over 50 hp and 100 ft. head must have VFDs and consume no more than 30% design power at 50% design flow (6.3.4.1)
- Fan motors larger than 7½ hp on cooling towers must either have VFDs or be two speed. A control system is required to minimize power usage (6.3.5).

A thorough explanation of the Standard is beyond the scope of this document. The designer should have access to the Standard and a complete understanding of its contents. The ASHRAE 90.1-1999 Users Manual is also very helpful. ASHRAE considers Standard 90.1-1999 a high-profile standard and continuously updates it.

### Typical Applications

WSHP systems are very flexible and serve a wide range of applications.

Common applications include:

- Schools
- Office Buildings
- Medical Offices

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