



aquanex  
nex gen R32 inverter


# Heat Pump Water Heaters

## Application Manual

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MWH Series - Space Heating / Boiler Replacement models

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Heating Capacity  
3.4kW – 200kW



# Heat Pump Water Heaters for Space Heating

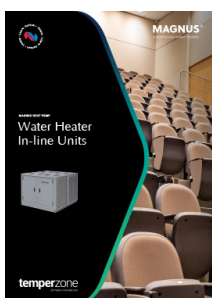
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Other relevant documents:

- Specification Sheets (model specific)
- Installation & Maintenance
- R32 Handling: Water Heating Units



*Overview brochure available*



# Heat Pump Water Heaters MWH Series

Aquanex heat pump water heaters by Temperzone utilise the highest efficiency technologies to minimize energy consumption. The MWH Series is specifically designed to deliver heated water to space heating applications. They reduce dependence on combustion of fossil fuels by using clean energy sources. Durability and reliability are also key features.





# Heat Pump Water Heaters MWH Series

## General

### Introduction

Aquanex hot water heat pumps by Temperzone provide ideal heating solutions as we move to a sustainable future using cleaner energy sources.

Aquanex Series heat pumps utilize the highest efficiency technologies to minimise energy consumption and are not dependent on combustion of fossil fuels. They can deliver up to 3.5 times the heating energy output for every unit of electrical energy consumed.

Aquanex MWH Series heat pump units are specifically designed to deliver heated water for space heating HVAC applications. Where a proposed design is not covered in this manual, please contact Temperzone for assistance.

The Thermoshell® is designed to operate direct in-line with flow pumps, and with a minimum temperature difference of 5K across the heat exchanger.

### MWH typical applications include:

- Space heating - with or without zone controls (zone controls supplied by others)
- Boiler replacement. The units will supply heated water at up to 55 °C (settable during commissioning), for a range of heating applications such as radiator panels, AHU coils
- Fresh air tempering coils
- Reheat coils as part of humidity control
- Pre-heat coils, for full fresh air systems during low ambient conditions
- AHU heating coils
- Electric heater bank replacement
- Retirement homes
- Hotels and resorts

**Exclusions:** Not suitable for direct heating of chlorinated pool or spa systems. If there is a requirement for process heating in high ambient temperatures (ie summer operation), consult Temperzone with details of application type, load and location ambient conditions, so we can assess product suitability.

Where there is a requirement for multiple units servicing the same heating system, links and control must be provided and managed by others via an external BMS system, and additional hardware installed external to the unit.

Refer to Temperzone for any applications outside the examples shown in this manual or system tolerances outside those specified in product specification documents – available at [www.temperzone.com](http://www.temperzone.com).





# Heat Pump Water Heaters

## MWH Series

### Features

#### Low GWP

MWH models utilise R32 refrigerant, which has significantly less Global Warming Potential (GWP 675 vs 2088) when compared to R410A units or fuel burning alternatives.

#### Energy Efficient

Each MWH system is comprised of a refrigeration system with highly efficient Thermoshell® heat exchangers to extract 'free' heat from the ambient air and transfer it directly to water, and from there to your space heating heat exchanger, eg fan coil unit.

#### Performance

For every 1kW of energy input, up to 3.5 kW of energy output is produced, depending on the ambient conditions.

#### Cost Effective

The MWH range eliminates the need for an intermediate buffer tank\*, improving both the efficiency and cost effectiveness of the installed system.. High temperature differential, low variable water flows and low pressure drop contribute to reduced installation cost.

#### Thermoshell® Technology

The unit includes a compact long-life highly efficient water heat exchanger design. It has a low pressure drop compared to plate heat exchangers.

#### Compressor

MWH units have one or more variable capacity inverter compressor which use less energy than alternative types of compressor. Each compressor is hermetically sealed, quiet running and supported on rubber mounts to minimise vibration.

#### Soft Starting

Inverter compressors are soft starting therefore have none of the problems associated with high in-rush current.

#### Water Pump

Each unit (excluding MWH 2000) has

the option of including an in-built high efficiency variable speed BLDC pump.

#### Durable

Heat exchange coils comprise aluminium corrugated plate fins on mechanically expanded rifled copper tube. Coil fins are epoxy coated for extra protection in corrosive environments, e.g. salt laden sea air. Each MWH unit's cabinet is constructed from high grade galvanised steel - polyester powder coated (grey) for all weather protection and is rated IP 44. External fasteners are SKT® coated steel – marine grade.

#### Insulation

Units are insulated to prevent external condensation forming on the cabinet exterior. The insulation is foil faced and meets fire test standards AS 1530.3 (1989) and BS 476 parts 6 & 7. Internal piping is also insulated to minimise any heat loss.

#### Control

Each MWH 900/2000 includes a Programmed Logic Controller (PLC) which is pre-wired within the unit. PLC is optional on smaller models. Refer page 36 for more information. BMS control options are available, eg Modbus using UC8, or BACnet (requires PLC).

#### Quiet

The unit's coil design permits low fan speeds and hence low noise levels. The compressor is isolated in a built-in, insulated compartment to minimise noise.

#### Wiring

A control panel, located in each MWH unit, is fully wired ready to accept the main power supply. The electrical supply required is: 3 phase 400 V a.c. 50 Hz, plus neutral and earth.

Each system complies with the requirements of the Regulatory Compliance Mark (RCM) for appliance safety (AS/NZS 60335.1 & 60335.2.40) and EMC (AS/NZS 61000.6.8 residential commercial and light industrial).

#### Peace of Mind

Temperzone operates a quality management system that conforms to AS/NZS ISO 9001:2015. The company's products have been selected, against worldwide competition, for use in some of the most exclusive projects – chosen because of their proven efficiency, durability, performance, reliability and value.

#### Accessory

Condensate drain connection kit (25mm OD) – supplied (excl. MWH 2000).

#### Unit Protection

1. HP/LP for loss of water flow or refrigerant.
2. Anti-rapid cycle timer and internal overload for compressors
3. Circuit breaker control circuits.
4. Time-and-temperature controlled electronic de-ice switch minimises icing up of the outdoor coil during heating cycle at low ambients.
5. Sensor fault indication.
6. Compressor minimum run time to ensure oil return.

#### Self Diagnostics

The Unit Controller (UC8) has a LED display to indicate faults and running conditions. A non-specific fault indicator is included for interface to external systems via the optional relay board.

#### Options

1. Water pump – with or without
2. Electronic Vapour Injection (EVI) - for enhanced low ambient performance



# Heat Pump Water Heaters MWH Series

## 1. OVERVIEW

The Aquanex MWH units from Temperzone are designed as In-Line heat-pump water heaters for a range of HVAC applications. The units are based on the synergistic combination of variable capacity (inverter) compressor technology, combined with variable speed EC pumps. In many applications this removes the need for an intermediate buffer tank, significantly improving both the efficiency and cost effectiveness of the installed system. At the heart of all the units is the Thermoshell® fouling resistant heat-exchanger. The unique fouling resistant properties of the Thermoshell® allows units to operate efficiently over many years of service.

The MWH range has been developed for heating applications, and primarily supported by the HVAC Industry. The range offers exceptional turn-down capacity, increasing the control and stability of a heating or cooling application.

**It is essential that this Application Manual be understood prior to the design of the water heating system to ensure the system operates both correctly and efficiently.** Where a proposed design is not covered in this manual, please contact Temperzone for assistance. This manual will be available through <https://www.temperzone.com/> and will be updated as more applications are developed and supported.

Temperzone offers “application specific” heat-pump water heating products for underfloor heating (MWU), potable/domestic water heating (MWS) and for direct swimming pool heating (MWP). For these applications, please refer to separate Applications Manuals.

Any application must comply with local/national codes and regulations.

### ⚠ IMPORTANT

The Aquanex MWH range is designed for use with **R32 refrigerant** (Class A2L) because of its low GWP. Refer to Installation Instructions for guidelines on the handling of units using R32 refrigerant, eg storage, ventilation and minimum floor area requirements.



# Heat Pump Water Heaters MWH Series

## 2. PRINCIPLE OF OPERATION

### Conventional boiler based primary / secondary heating circuits.

Conventional boiler based hydronic heating circuits are typically configured as primary/secondary circuits, separated by a buffer tank or calorifier. The buffer tank/calorifier is maintained at a set-temperature and prevents short-cycling of the boiler during periods of low heating demand.

Both the primary and secondary pumps are typically designed for a 5K temperature supply/return temperature differential at full capacity. This leads to considerable mixing between the supply and return flows within the buffer tank. This mixing of the supply and return flows has minimal impact on the efficiency of the boiler, which in most cases is relatively temperature independent – the exception being condensing boilers.

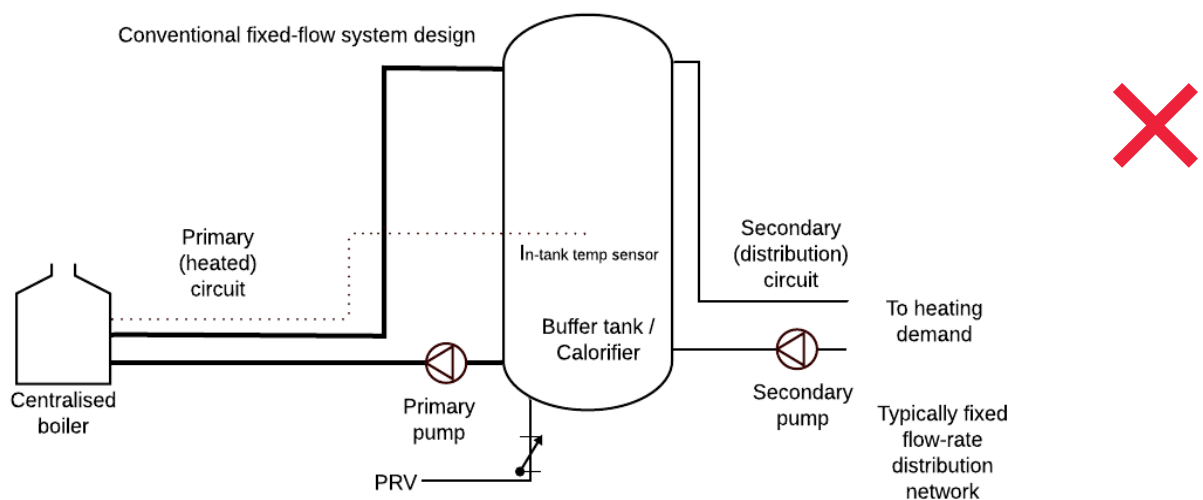


Figure 1. Conventional System design based on boiler systems incorporating an intermediate buffer tank, and a fixed flow-rate distribution network.

**Heat Pump Water Heaters** on the other hand, are significantly impacted by the supply and return temperatures through the system. The efficiency (COP) of heat pumps is maximized when:

- The supply temperature is reduced.
- The return water temperature is reduced.
- The temperature differential across the heat-pump is increased.





# Heat Pump Water Heaters MWH Series

## Principle of Operation (continued)

### Effect on heat pump water heater efficiency

Conventional primary/secondary hydronic system designs significantly reduce heat-pump efficiency due to the mixing which occurs within the junctional buffer tanks. The Aquanex range of heat pump water heaters have been designed to maximize the efficiency and cost-effectiveness of applying heat pump technology to water heating applications. The components and control logic in each Aquanex heat-pump water heater is optimised for a specific application to improve system efficiency, reduce installed costs, and increase the durability of the systems.

The Aquanex MWH Series of units are dedicated to typical HVAC applications of space and process heating. Each unit uses variable capacity (inverter) compressor technology to match the supply of heating with the real-time demand. The Aquanex heat pump water heaters and chillers provide a 1:6 turn-down ratio per compressor stage to allow to heating demand to be matched as closely as possible.

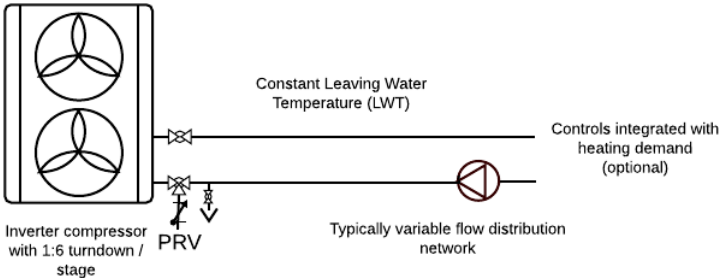


Figure 2. Aquanex In-Line Heat-pump water heater, variable flow system design,

The Aquanex MWH Series of units are designed to be operated as part of a variable flow rate closed circuit in-line heating and/or cooling system. This contrasts with the more conventional boiler-based systems with fixed flow-rate secondary circuits. In these systems, water flow which is not needed to meet the heating or cooling demand is bypassed back to the buffer tank / calorifier.

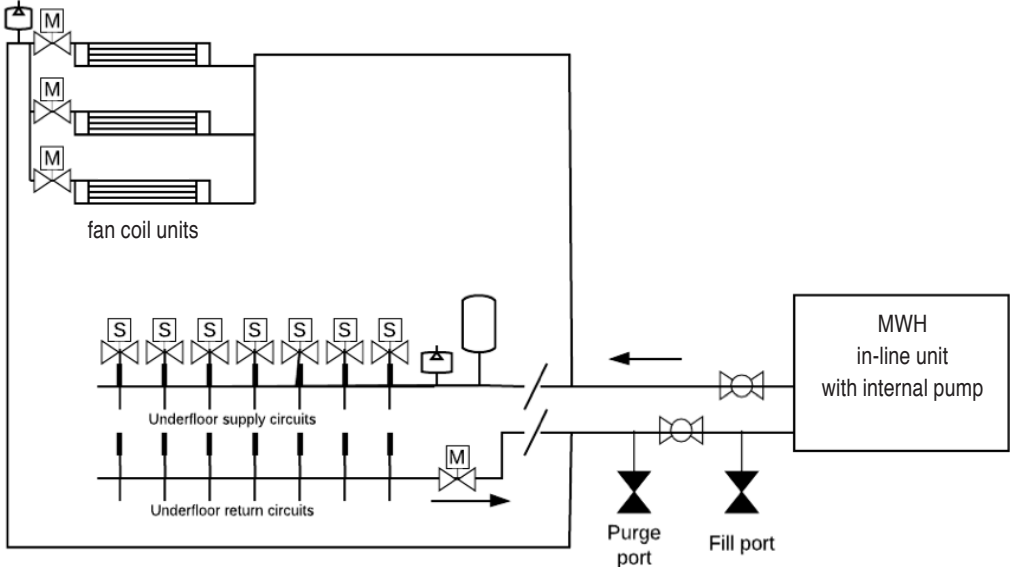


Figure 3: Fixed flow-rate secondary circuit, incorporating diverting valves to control heating demand to each zone.





# Heat Pump Water Heaters MWH Series

## Principle of Operation (continued)

Regardless of whether a buffer tank or calorifier is used, the high fixed flow rates lead to considerable mixing of the supply and return temperatures to the boiler.

The Aquanex In-Line approach prevents this mixing of the supply and return water flows through the system. All water processed by the Aquanex unit is required to be passed through a heat-exchanger prior to returning to the unit. This also maximizes the temperature differential across the heat-pump, which maximizes system efficiency.

### Design Leaving Water Temperature

The units are designed to provide water at a selected leaving water temperature, which is referred to as the 'Design Leaving Water Temperature'. The unit will control the compressor capacity to provide water at this temperature in heating or cooling mode, as applicable. This approach also allows the Aquanex unit to balance the heating/cooling demand with the supply of heated and chilled water.

A key design change required for successful utilization of these products is to control heating supply to meet the heat demand through varying the water flow-rate through the system instead of directly controlling the compressor speed. The compressor speed/capacity is then indirectly controlled in response to the leaving water temperature (LWT) and the water flow rate.

This results in a unit which responds relatively quickly to changes in the heating demand, enhancing system efficiency. During periods of low heating demand, the unit will occasionally cycle on and off to maintain the circuit temperature for as long as the controller requires. A minimum water volume in the system assists low load situations by reducing the cycling of the system and also supports the de-ice function.



# Heat Pump Water Heaters MWH Series

## Principle of Operation (continued)

### Part Load Operation

When correctly sized and installed, the Aquanex units will operate under part-load conditions most of the operating time. This significantly increases the efficiency of the unit, with the peak efficiency of the inverter compressor occurring in the 30 – 50% speed range. Operating most of the time under relatively mild conditions greatly increases the durability of the refrigeration system and allows the performance characteristics of heat-pump water heating technology to be supported in the application.

### System Integration

The Aquanex MWH units are required to be fully integrated into the heating water system, so the unit can correctly control to the required temperatures. An integrated programmed logic controller (PLC) is available to provide 'turn key' controls for single load Leaving Air Temperature/ Return Air Temperature (LAT/RAT) control applications, and is provided for stage control and defrost management of multiple compressor models (MWH 900, 2000). This allows true 'plug and play' unit operation. This Application Manual outlines the requirements for integrating the Aquanex MWH units into common HVAC applications.

Aquanex MWH units can be applied to most medium temperature water HVAC applications through applying the design principles in this manual. Whilst there are some differences to conventional hydronic design required, many retrofit applications can be successfully converted from a boiler to heat-pump-based heating system.

Other benefits are:

- Reduced condensing temperatures leading to increased system reliability and durability.
- Reduced system installation costs, through a reduction in installed components.
- Reduced complexity of controls in most applications, as the compressor capacity is adjusted automatically by the unit.



# Heat Pump Water Heaters MWH Series

## 3. DESIGN CONSIDERATIONS

### Principle of Operation

The MWH range is designed to deliver a near continuous supply of heated water at the required temperature during operation, within the turn-down capacity of the unit. The unit has an inlet and outlet water temperature sensor, and the inverter speed is controlled to maintain a constant Leaving Water Temperature (LWT). The temperature differential between the inlet and outlet sensors, combined with the flow rate determines the heating capacity required by the system, which is met by automatically adjusting the compressor speed. The compressor turn-down allows heating demand and supply to be balanced.

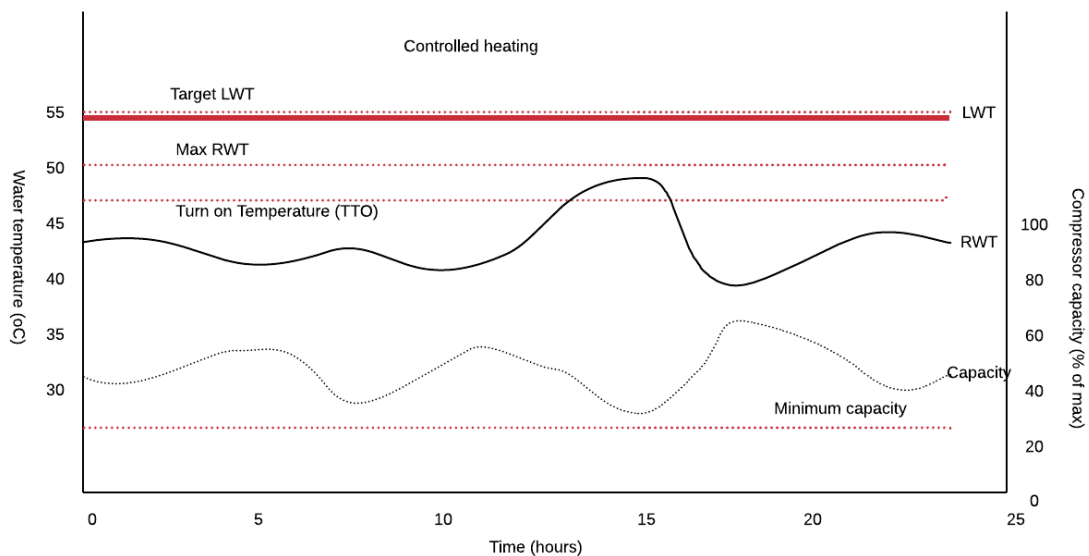


Figure 4: Controlled Heating Principle

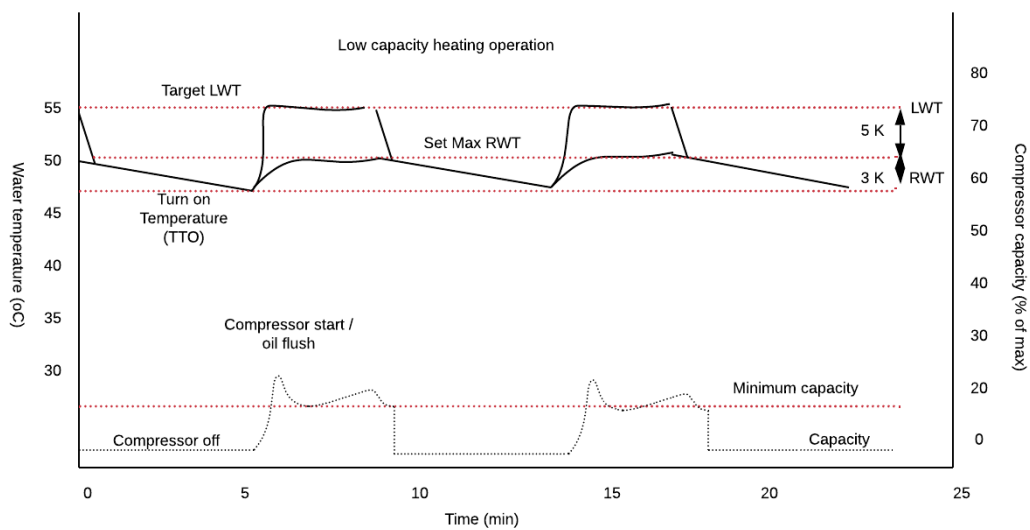


# Heat Pump Water Heaters MWH Series

## Design Considerations (continued)

### Low-Capacity Operation

Under low heating load conditions, the compressor will operate at minimum speed after the initial start-up period. Should the heating output at minimum speed exceed the heating demand, the compressor will stop operation until the loop cools by a default of 8K. This feature recognizes that under low load conditions there is minimal heating demand on the system and prevents short cycling of the system.



With a LWT of 55°C, the unit will stop the compressor when the RWT is hotter than 50°C. The water loop is required to cool by 3K (to 47°C) before the compressor restarts. This approach allows the water loop to cycle between 47 – 55°C during periods of low heating demand.

In situations of critical low loads there may be a requirement to add volume to discharge of unit by use of vessel/tank in the supply pipe work to service low load prior to the unit starting again.

Note: A minimum water volume is also required in the system for de-ice function. Refer page 35 for outlet tank volume requirements to reduce the affect of de-ice on LWT in low ambient temperature conditions.



# Heat Pump Water Heaters MWH Series

## Design Considerations (continued)

### Multi-Stage Control

Units with multiple compressors (MWH 900, 2000) servicing a single water circuit use a Programmed Logic Controller (PLC) to manage the staging of the compressors. This allows each active compressor to operate within the most efficient speed range to maximise part load performance. The PLC also manages the EC pump speed/duty in single load Leaving Air Temperature/ Return Air Temperature (LAT/RAT) or FCU control applications, with the stages managed to meet the demand.

Note: When units are used for multiple zones, the pump must run at constant pressure while PLC just manages staging and de-ice management.

The unit controller for each stage independently controls the compressor speed to maintain the LWT of each operating stage to the Design LWT. The PLC monitors the compressor speed of each unit controller and starts/stops each compressor as required to keep all compressors operating in the “efficient zone”. Once all compressors available are operating, then each compressor will operate at the speed required to meet the heating demand.

Where a stage requires to enter a de-ice cycle, the PLC will prevent another stage from starting a de-ice cycle until the current de-ice cycle is completed.

The PLC also manages compressor rotation to ensure consistent run-hours across each refrigeration system.

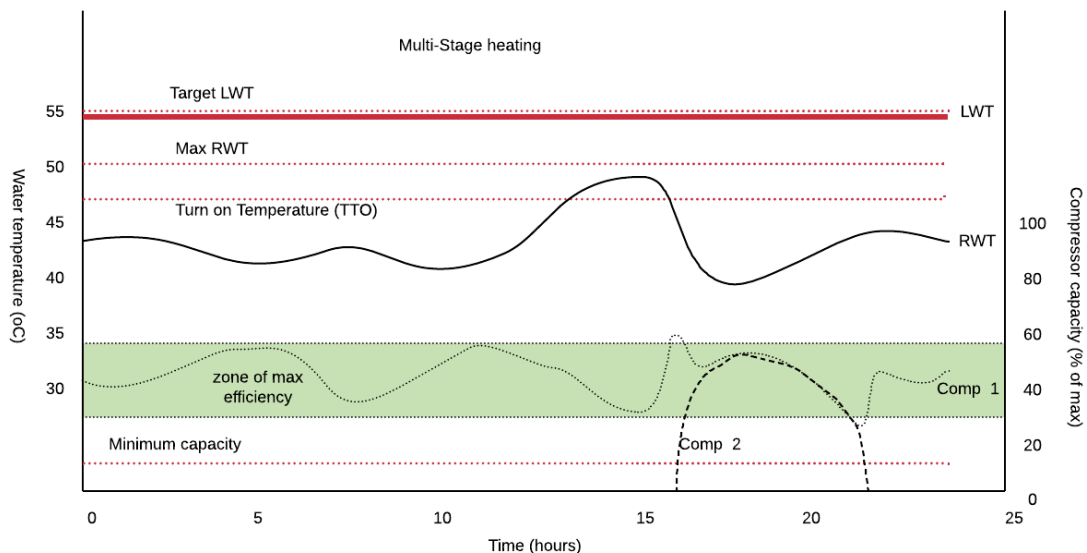


Figure 5: Multi-stage inverter control

# Heat Pump Water Heaters MWH Series



## Design Considerations (continued)

### General Design Requirements

The Aquanex MWH units are highly efficient and reliable water heaters and chillers where correctly applied. In order to maximize the efficiency of the system, the following factors are required to be considered:

- Minimise the leaving water temperature to meet the heating demand.
- Minimise the return water temperature.
- Maximise the ambient air temperature.
- Minimise the use of maximum compressor speed (high heating demand), and short cycling of the unit (low heating demand), by not over or under specifying the size of the unit.
- Avoid the use of in series heat-exchangers. Supply the water at the temperature most appropriate for the heating demand, instead of using a secondary heating loop. It is generally more efficient to separate heating loads into different temperatures, rather than supplying a primary circuit at the highest temperature.

### Potential Energy Efficiency Reducers:

- Restricted Air Flows. Installations where a micro-climate develops around the unit (ie too closed-in areas). Ensure the cold air for heat pumps (or hot air for chillers) can be effectively dispersed from the surrounding area. Installations where plants or other objects restrict airflow through the unit coils. The de-ice settings assume the unit coil has an unobstructed supply of air and the minimum clearance is adhered to. Ensure fences, etc., around the unit do not create a micro-climate around the unit, eg pooling of cold air. Discharge air must be free to disperse away from the site.
- Excessive pump flow rates. The use of high-powered pumps significantly decreases the efficiency of the unit by increasing the return water temperature to the unit. Exceeding the recommended flow rate has minimal effect on heat transfer within the Thermoshell heat-exchanger but deteriorates the efficiency of the units.
- Under-sizing of piping to/from the unit. Particularly relevant to site refurbishments. Pipes that are too small will increase resistance and decrease efficiency. Size pipes to match the inlet/outlet size of the MWH unit.
- Lengthy Pipe Runs. Locate the unit as close as practical to the heating/cooling demand and limit the number of 90 degree bends used. This will reduce system resistance and assist pump operation.
- Under-sized pump. Calculate the external system resistance and compare against the pump head specified for the appropriate sized MWH model. An external pump may be required to boost pump performance.
- Thermal inertia. A minimum water volume is required in the system to permit de-ice functionality (refer page 35). It will also assist operation in low load situations when short cycling could occur.

# Heat Pump Water Heaters MWH Series



## Design Considerations (continued)

### Provide Adequate Clearance

Mounting and positioning instructions are covered in the unit 'Installation & Maintenance' instructions.

The Aquanex MWH unit should be externally installed (ie outdoors). Where installation is desired internally, sufficient ventilation must be provided to maintain the internal air temperature no lower than 5K below the external ambient air temperature. It is possible to duct the exhaust air from the unit, however the external static at the fan must be less than 5 Pa (and 100 Pa for MWH 2000). If ducting the exhaust air, it is recommended that an additional in-line fan be installed in the duct to maintain airflow through the unit, if required.

In all installations, it is preferred that the coil be installed perpendicular to the wall. In installations where this is not possible, the coil must be installed at the distance specified in each model's Specification Sheet from a wall. There must be no restriction to the airflow above the unit.

Note: The exhaust air from the unit in heating is very cold when the unit operates at full capacity and may be well below the freezing temperature. Take care when selecting the installation position that the exhaust air from the unit will not be under a window or plants which are cold sensitive. It is possible to get condensation on surfaces above the unit exhaust air which may deteriorate some surfaces. Any overhead ducting should be insulated.

### Filling / Purging Port (External)

A filling port is required to be installed at the unit. It is essential the filling port is located on the return water (water inlet) to the unit. Either install two manual ball valves, with a filling port in-between, or install a dedicated filling port valve. The pump installed within the MWH units (where selected) is not self-priming and air remaining in the system will result in the pump not operating. It is recommended that the system have a permanently connected automatic filling port to prevent loss of heating service from loss of system water loop pressure. Recommended minimum water pressure is 0.5 bar (50 kPa) if no head valve has been stated.

### Air Relief Vents

Air relief vents are an essential part of all closed circuit water heating systems and should be located at the highest points in the circuit. The relief vents slowly remove the bubbles of air in the water, which are produced when the water is heated (the solubility of dissolved gases in water decreases with increasing temperature). When the water cools, remaining air in the system is slowly absorbed by the water, and is released again after heating. This process slowly removes all the air over a period of time.

### Expansion Vessels

The installation of an expansion vessel is essential on closed loop systems for reliable service. This also applies to systems where the water loop volume is small, and/or where the water temperature is expected to be stable. The expansion vessel expands and contracts to maintain a neutral position. It needs to be set and checked it matches the system pressure.

Temperzone has a range of expansion vessels available that are renowned for their compact size and durability.

The expansion vessel needs be set and pumped at the same static pressure and air ambient temperature as the total system static pressure. This ensures water expands/contracts from a neutral position.

# Heat Pump Water Heaters MWH Series



## 4. TYPICAL APPLICATIONS SUPPORTED

The MWH units can be applied to a wide range of applications, where the required water temperatures of the heating demand ranges between 4 – 55°C. This range covers most HVAC applications.

Currently supported applications for the units are:

- Boiler replacement projects ([refer Section 6](#)).
- Electric Heater Bank replacement ([refer Section 7](#)).
- Fresh air tempering (LAT Control) ([refer Section 8](#)).
- Pool heating from a primary circuit ([refer Section 9](#)).
- Multi-zone Packaged heating systems (eg Temperzone HWP and CWP model ranges) ([refer Section 10](#)).

Other applications requiring external controls by others:

- Multi-AHU heating coils with supply air or return air control.
- Multi-zone Fan Coil heating systems (eg Temperzone IMDL and IMD model ranges).
- Residential heating system with fan assisted radiators.
- Residential underfloor/heating (fan coil) installations.





# Heat Pump Water Heaters MWH Series

## 5. UNIT SELECTION

The MWH units range in capacity from 25 kW – 200 kW (heating).

All units operate off a three phase power supply.

It is important to size the unit so the maximum capacity is required to meet the maximum likely load for the climate. This allows the unit to operate for most of the time within the turn-down range of the compressor. If the heating demand is too high for the capacity of the unit, then the compressor will operate too long at a high speed, with reduced efficiency.

	Stages	Turn-down	Minimum Water Temp.	Maximum Water Temp.*
MWH 900	2	1:12	20°C	55°C
MWH 2000	4	1:24	20°C	55°C

\* Achievable with EVI version of unit – recommended for improved performance at low ambient conditions. Design temperature is 45°C.

Note: Use of glycol to cope with low ambient conditions will affect the capacity available. It is responsibility of customer to make an allowance for any reduction of capacity due to glycol type and percentage used.

For any application where there is critical LWT requirements and ambient conditions are below 10°C, there will be a requirement for additional supply water volume to reduce the defrost effect on LWT. Please refer to deviation reduction from LWT set point, at volumes shown on graphs (p.35).

Refer MWH Product Review, Technical Data or Specification Sheets for detailed product information.



# Heat Pump Water Heaters MWH Series

## Unit Selection (continued)

### Water Flow Rates

Conventionally the flow rates through hydronic systems are based on a design temperature differential across the heater of 5K at maximum capacity. When applying Aquanex In-Line heating systems, a 5K design flow rate will lead to the unit poorly controlling the heating load and degraded efficiency of the system.

The maximum system capacity with a Aquanex In-Line system occurs when the temperature differential across the supply and return flows is at its greatest, as this is when the heating demand is absorbing the maximum amount of energy out of the system. As the temperature differentials reduce (less heating demand), then capacity of the unit reduces to maintain the design LWT from the unit.

Designing systems based on water flow rates has the additional advantage of significantly reducing the pump power required for a hydronic system. This is particularly the case when selecting permanent magnet pumps (BLDC) such as from the Wilo Stratos range (available from Temperzone).

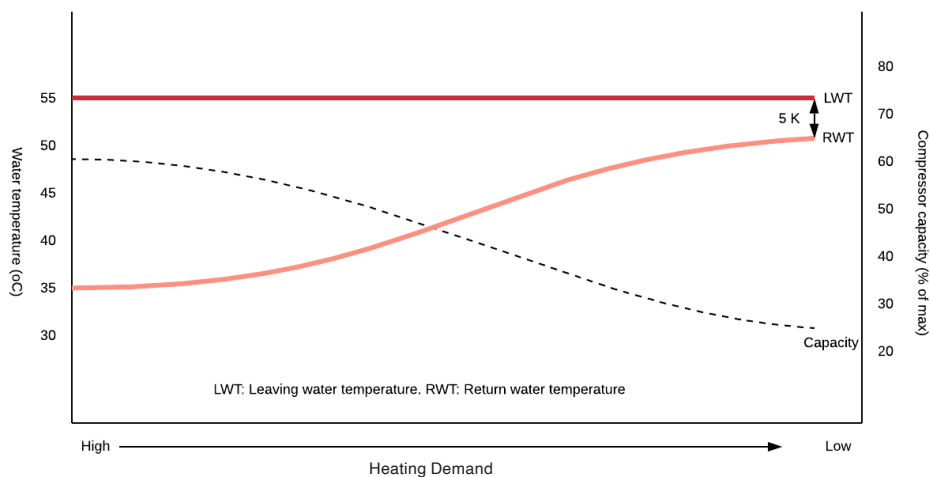


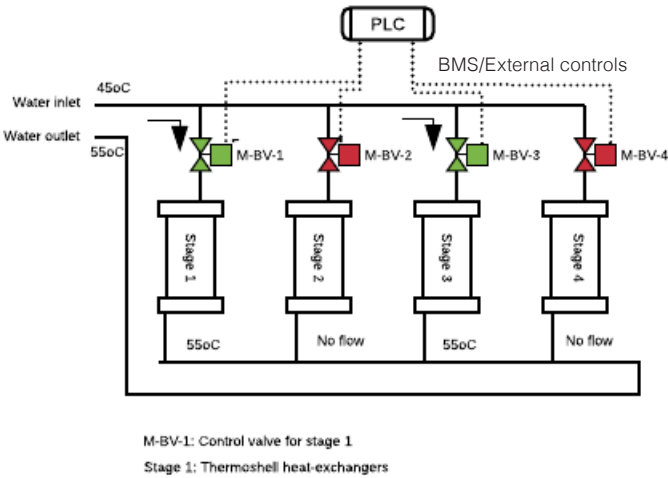
Figure 6: Relationship between supply/return water temperatures, and compressor capacity for the Aquanex In-Line systems.



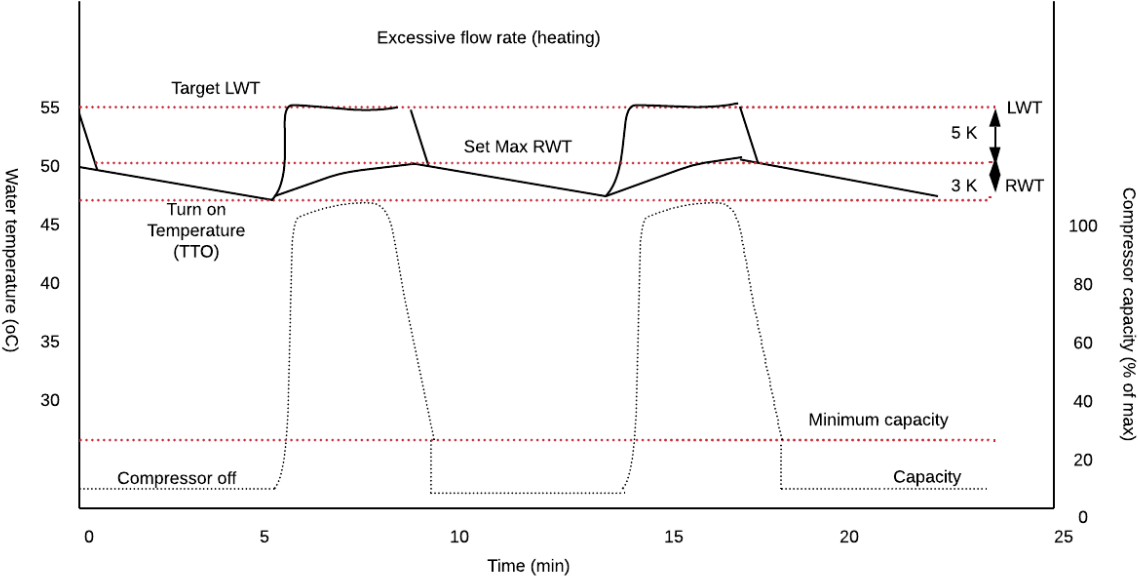
# Heat Pump Water Heaters MWH Series

## Unit Selection (continued)

MWH 900, 2000 units with multiple compressors are fitted with an internal motorised ball valve for each stage. This valve prevents water flow through non-operating stages, which would otherwise mix return water with supply water. During periods of reduced heating demand, the water flow rate through 'the system' will also typically reduce, allowing reduced water flow through the Aquanex unit. **It is recommended that constant pressure pump control be used** on systems with pumps not controlled by the PLC to reduce water flow during periods of low heating demand.



During commissioning, the maximum flow rate and pressure should be set so under full heating, the unit will reach the target LWT at maximum compressor capacity once the return loop temperatures reach a stable operating temperature. Excessive water flow rate will lead to a loss of control feedback to the unit, and the compressor will tend to operate in an **On/Off/On** pattern.



For Operational Limits refer to the Product Review brochure and/or Specification Sheet for each model available at [www.temperzone.biz](http://www.temperzone.biz).



# Heat Pump Water Heaters MWH Series

## 6. SUPPORTED APPLICATIONS: Boiler Replacement

The Aquanex MWH units are designed for space heating applications, and where sufficient heating can be achieved with a 55°C (or less) supply water temperature, the MWH units provide an efficient and cost-effective solution to boiler replacement projects through the removal of the primary heating circuit, and directly supplying the heat to the distribution loop (eg radiators, fan-coils, etc.).

Often the most expensive part of changing the heating system is the internal distribution network – radiators, ceiling panels, fan coils etc. Where these are still in good condition, it is often most cost-effective to remove the primary network but re-use the secondary (distribution) network. In many buildings, the temperatures of the secondary circuit are in the 55 - 65°C range. Many of these systems can be converted to Aquanex MWH system with strategically placed fan coils to increase the temperature in a few cooler areas where necessary.

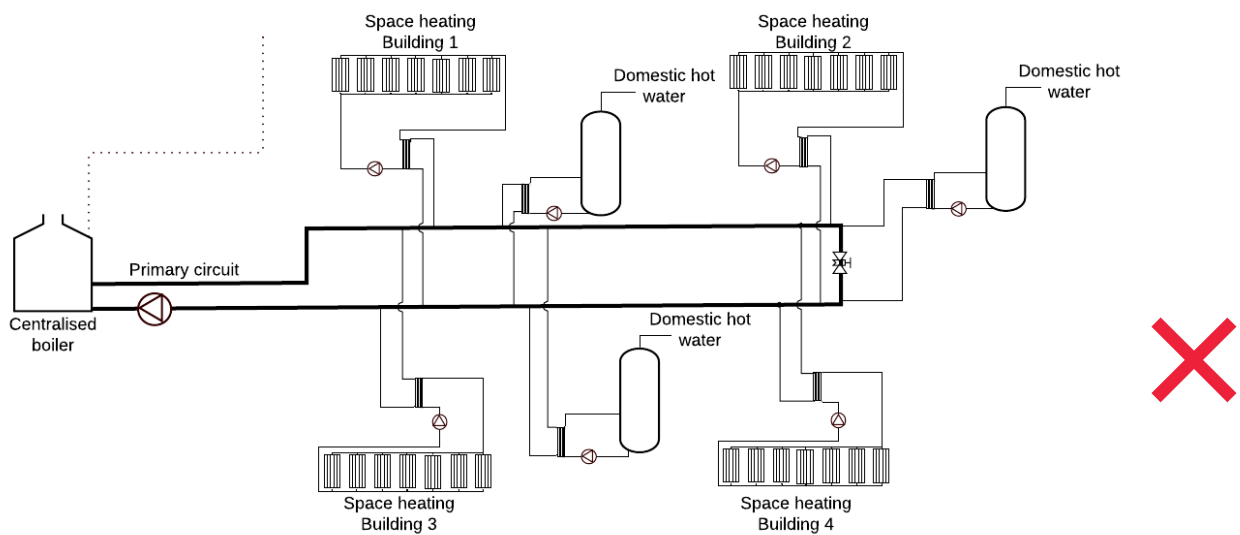


Figure 7: Conventional central boiler system with both space and potable water heating from the primary circuit.



# Heat Pump Water Heaters MWH Series

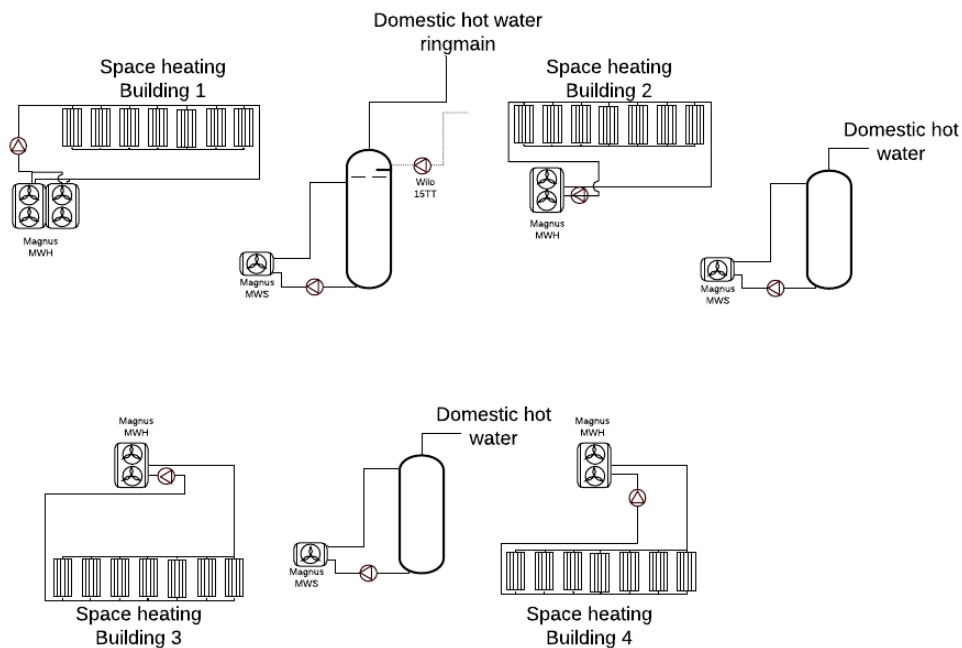
## Boiler Replacement (continued)

There are two main approaches for converting these systems to heat-pump water heated systems. In all applications, the space and potable water heating demand should be separated:

1. Distributed Heat-pump system, and
2. Flow/Return Header systems.

### Distributed Heat Pump Systems

This approach suits lower density building sites, where several Aquanex units can be positioned around the buildings. The distributed approach provides the most efficient solution due to the reduction in distribution heat losses, and usually, reduced pump energy required. (Note: Aquanex MWS potable water units are not yet available in Australia).





# Heat Pump Water Heaters MWH Series

## Boiler Replacement (continued)

### Flow/Return Header Systems

In higher density building sites it may be a requirement to directly heat through a centralised flow / return header. In these applications, the secondary (distribution) circuit must be directly heated from the header (i.e. no further heat-exchangers between the header and the radiators / fan coils). **The potable hot water system must be heated separately.**

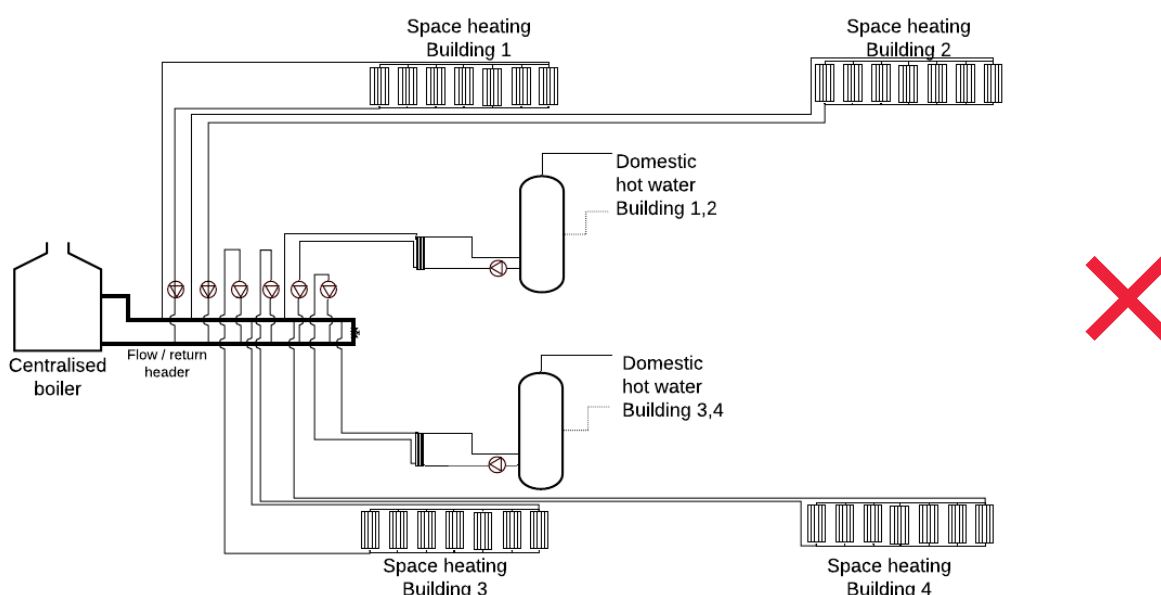


Figure 8: Central boiler supplying heating through a flow / return header.

It is important to ensure that all the water flowing from the “Flow” header passes through a radiator / fan coil before returning to the “Return” header, i.e. there are no bypass circuits, or diverting valves. The MWH unit connects directly to the flow/return headers so that the greater the temperature differential, the more effective the conversion to a Aquanex MWH will be.

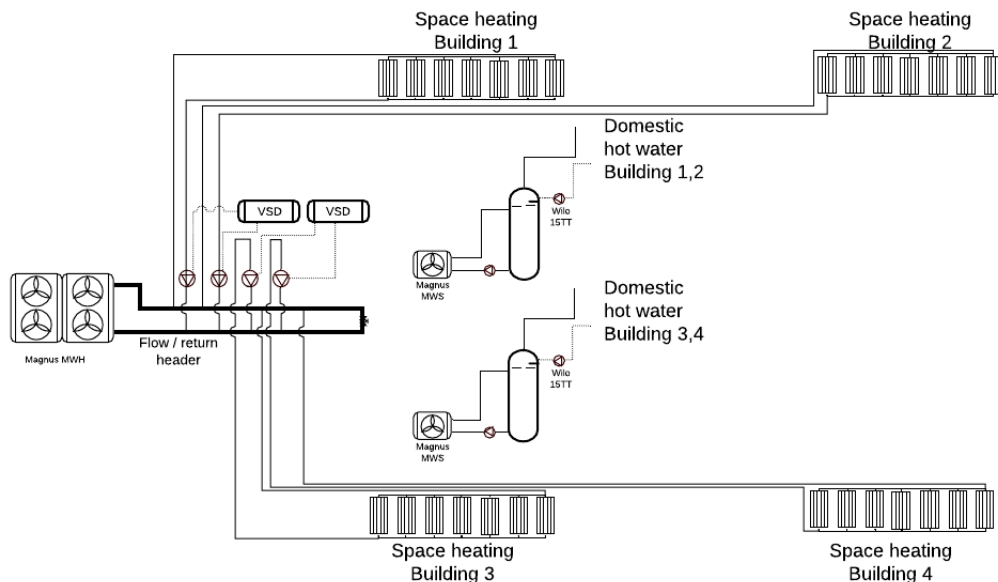
This often requires adding a variable speed drive (VSD) to the individual pumps, to control the building heating demand through controlling the water flow. The speed of the pumps must be controlled to prevent the return header from exceeding 50°C. The lower the return header average temperature, the greater the efficiency of the system.

Note: When Aquanex units are connected to a common flow/return header, the pumps are external to the unit (on the headers), and therefore the model selected should not contain an internal pump.



# Heat Pump Water Heaters MWH Series

## Boiler Replacement (continued)



### Approach to applying the MWH range to Boiler Replacement projects:

- Separate the heat demand being supplied by the primary circuit into the individual temperatures and demands. For example, separate space heating from domestic hot water heating. This allows the demand which is seasonal to be supplied independently to demand which is required all year.
- Ensure that there is no bypass for the water to return to the heat pump without having passed through a heat exchanger.
- Where high temperature heat demand is required consider what proportion of the total heating demand the high temperature demand contributes. Where this demand is relatively small, then supply this demand separately, ie avoid degrading the efficiency of the total system for a relatively small high temperature demand (eg steam for sterilisation).
- Consider a distributed heating system on low density sites. This approach uses a several smaller units positioned around the site instead of a centralized system. This typically reduces the distribution losses substantially by supplying the heat close to the place of demand.
- Where there is a reduction in the supply water temperature from using heat-pump technology, consider where supplementary heating can be added in a few areas using ducted fan coil / fan assisted radiators rather than increasing the temperature of the entire system. The efficiency of all heat-pump systems degrades with an increase operating temperature.
- Consider if the existing fans in fan coils / fan assisted radiators can be upgraded to a higher airflow, BLDC fan to increase airflow under maximum heating demand conditions.
- Control zone temperature through varying the water flow rate through the system. This can be either through varying pump flow rates, through opening and closing zone control valves, or two-way flow reducing valves. Avoid the use of diverting valves on MWH systems.
- Consider replacing the existing fixed speed pump with EC pump such as from the *Wilo* Stratos or GiGa range (available from Temperzone). Pump power is increased to the cube of water flow rate, so there are substantial energy savings from reducing pump speed under part load conditions. This particularly applies to zoned system designs.
- Where pumps existing pumps are being retained, consider adding a VSD drive, controlling to constant pressure in the absence of PID based temperature / flow control of the system.

# Heat Pump Water Heaters MWH Series



## 7. SUPPORTED APPLICATIONS: Electric Heater Bank Replacement

Electric heater banks have been widely used in HVAC applications to provide space heating, re-heat for humidity control, and head pressure control during the initial heat-up of cold buildings during winter. In many instances it is economical to replace the electric heater bank with a water coil in the system (typically in the AHU / Rooftop unit, or the supply air duct), and provide the heating energy with a Aquanex MWH unit.

This approach leads to a substantial reduction in the energy use of the HVAC system, and generally significantly improved control over the heating system. In many instances, the removal of the electric heater bank will reduce the site peak electricity demand, leading to a reduction in electricity supply charges.

The In-Line approach of the Aquanex system, combined with the included PLC/BMS controlling to either supply or return air temperature enables these projects to be installed with 'Turn Key' controls.

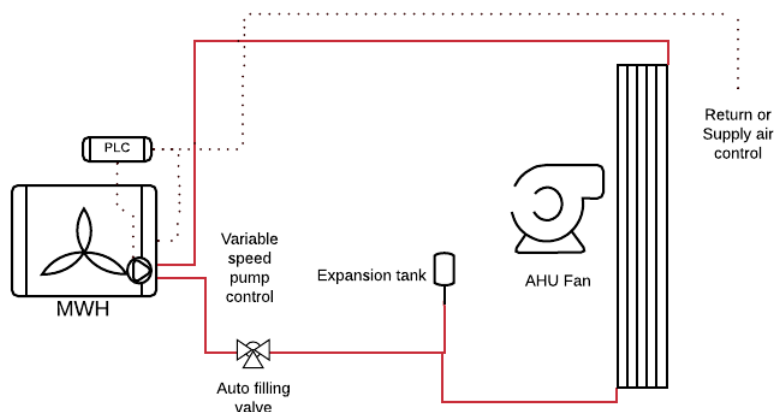


Figure 9: Example of single air-handler with variable speed pump control

### Approach to applying the MWH range to Electric Heater Bank projects:

- Review the operation of the existing electric heater bank, if a replacement project. Are all stages operational? How effective has the control of the stages been? Consider if through better control of staging, a reduced heating capacity could be equally effective in the application. From this review, determine the heating capacity required from the MWH unit.
- Consult the MWH Technical Data to determine the unit output at the design condition for the location. Consider the time of day that heating is required. Typically, during the coldest period of the day, full heating capacity is not required (ie the store is closed, or the thermostat has a set-back function enabled).
- Measure the space available for the water coil within the AHU or the supply air duct. Determine the airflow through the existing system and consider the ability of the supply air fan to provide the additional static pressure required from the water heating coil. Account for the reduction in airflow from an additional coil.
- Using coil calculation software, enter the maximum size of single row coil which fits within the space available. Determine the heating capacity of the coil at a water entry temperature of 45–55°C, and a water exit temperature of 30–40°C, and with ample circuits. If the coil cannot comfortably provide enough heating capacity, then increase the coil to two rows.





# Heat Pump Water Heaters MWH Series

## Electric Heater Bank Replacement (continued)

- Once excess heating capacity has been determined, then optimise the coil by:
  - Reducing the Design LWT selected (i.e. reduce to 45°C, etc.)
  - Decreasing the number of circuits, and reducing the water exit temperature to increase the temperature differential across the coil.
  - Decreasing the fin density of the coil. Generally, a two-row coil with low fin density is a better solution than a single row coil with high fin density.
  - Take note of the water flow rate required, and the calculated coil pressure drop.

The Aquanex MWH units are supplied with EC pumps as an option (except MWH 2000). The standard pump is expected to meet the requirements of most applications for the units. All models have the option for the pump to be excluded, so as to use an external pump instead. Please consult with the Temperzone Sales team. Note: Ensure the pump selection is based on delivering the required heating capacity under the conditions that full heating capacity is required.

### Generally:

- Full heating capacity is not required once the building has reached the target temperature.
- Full heating capacity is required at the Design Ambient condition. The expected heating capacity of the MWH unit will usually differ from the Rated capacity under this condition.
- Over-sizing the pump will lead to reduced control of the heating system, and increased pump power use reducing the efficiency of the system.



# Heat Pump Water Heaters MWH Series

## 8. SUPPORTED APPLICATIONS: Fresh Air Tempering (LAT Control)

Aquanex MWH units are particularly well suited for Fresh Air Tempering applications as the return water temperature can be maintained at a low temperature across a wide range of ambient conditions. This significantly increases the efficiency of the system, and particularly so when compared with a system design based around a buffer tank.

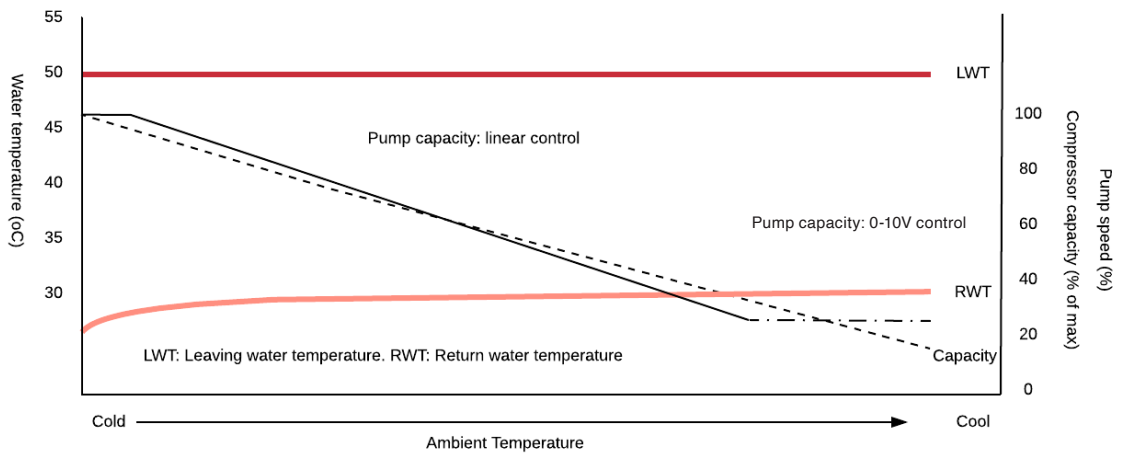


Figure 10: Control of fresh air-tempering systems based on the Aquanex In-Line design.

The compressor turn-down for Aquanex units is twice that of the pumps. The pump flow rate should be at maximum for the Design Ambient condition as once the pump reaches maximum speed, the ability to continue controlling to the target supply air temperature is reduced. Under mild conditions, the pump uses 0–10V modulating control to maintain the supply air temperature.

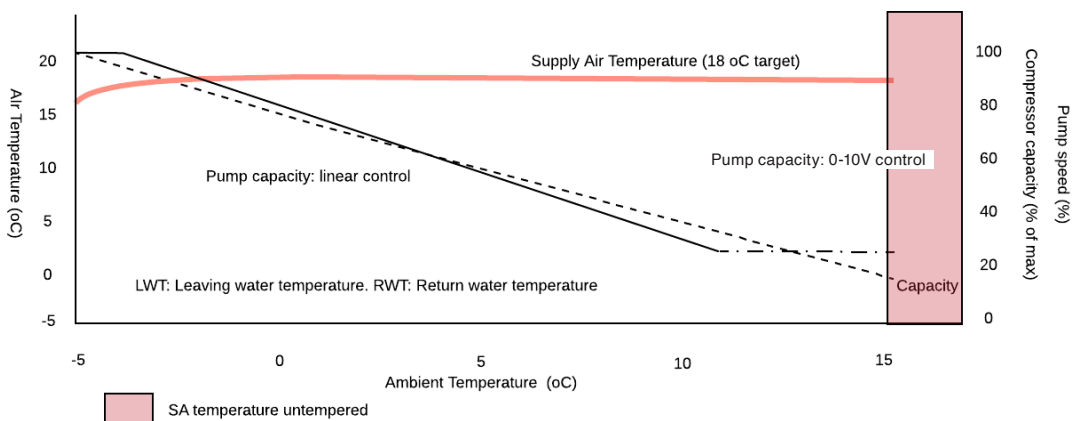


Figure 11: Control of supply air temperature.



# Heat Pump Water Heaters MWH Series

## Fresh Air Tempering (LAT Control) (continued)

### Requirements For MWH Single Load Application Air Heating (LAT/RAT Control)

Single Load LAT/RAT application is defined as a system where hot water will pass through a single/split coil, for one zone / AHU heating, without bypass, with one LAT sensor measuring off-coil temperature for control of the Aquanex unit and associated pump. If preferred, the sensor can be on the Return Air side of the coil (ie RAT Control) when there is mixed return air.

A Programmed Logic Controller (PLC) is required for this application with any of the MWH units available.

Software is included as a base program that manages the heat load demand via pump control and staging of compressors (when more than one compressor fitted). The current base program does not allow for any other components. **Any additional functions and sensors are outside the scope of the base program should be wired, managed/controlled by an external supervisory control system (ie external BMS).** Other options may be available in future once they have been tested and verified.

Note: The PLC facilitates high level BMS communication, ie BACnet.

Aquanex models MWH 900, 2000 come standard with a PLC fitted (ie Schneider M172). The PLC is pre-installed in these models to enable stage control and special de-ice functions of outdoor evaporator coil/coils regardless of the application. **For all other models the PLC is an option.**

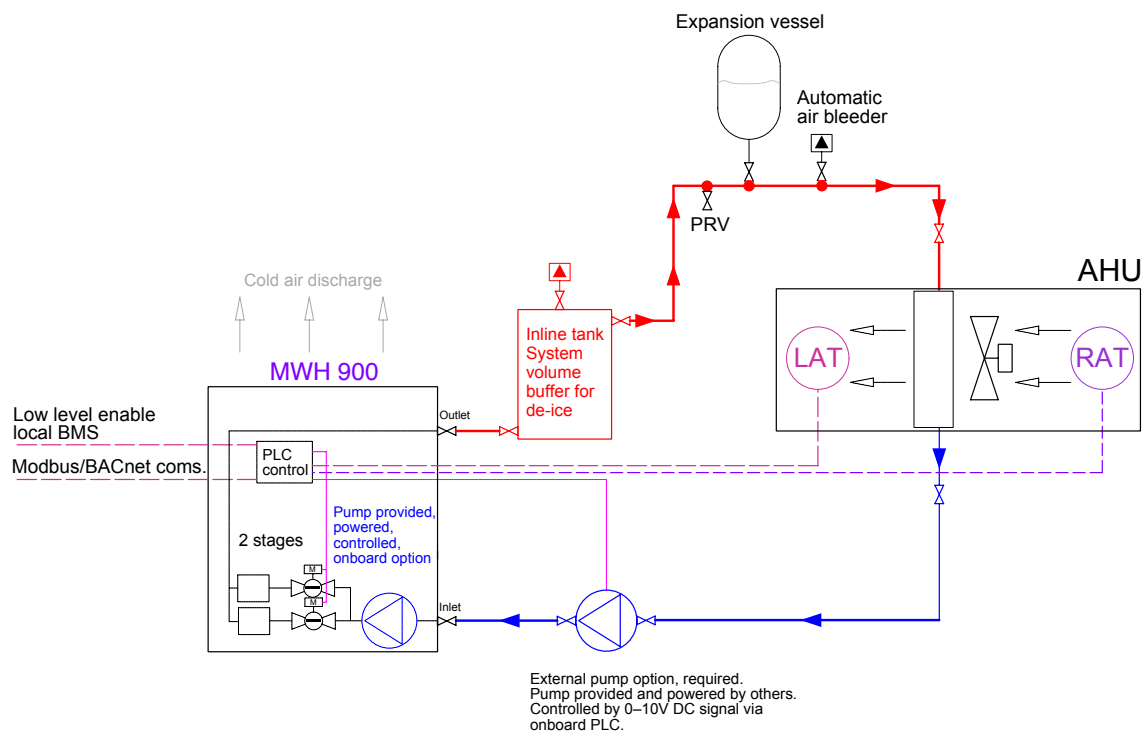


Figure 13: MWH 900 Fresh air tempering system with integrated storage.



# Heat Pump Water Heaters MWH Series

## Fresh Air Tempering (LAT Control) (continued)

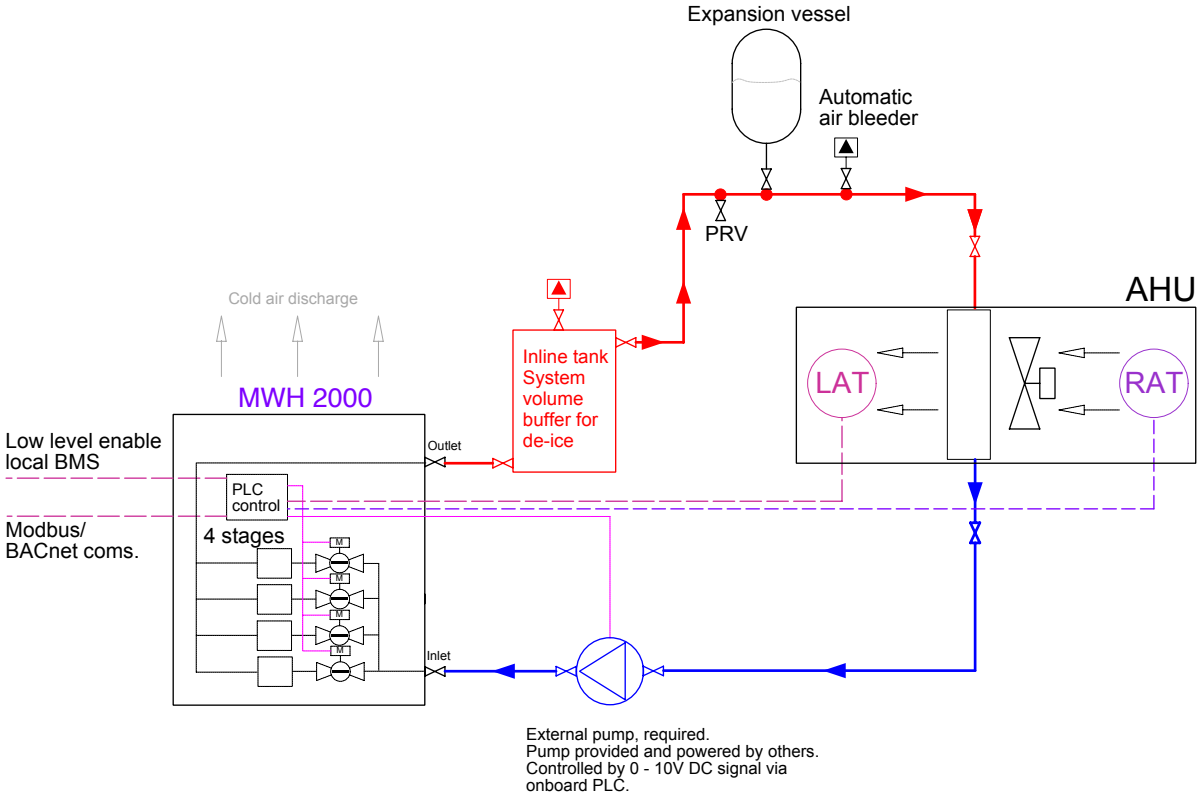


Figure 14: MWH 2000 Fresh air tempering system with integrated storage.



# Heat Pump Water Heaters MWH Series

## 9. SUPPORTED APPLICATIONS: Pool Heating from a Primary Circuit

The Aquanex series of heat pump water heaters includes a range of dedicated pool heaters (MWP models) suitable for both swimming pools and spa pools. These units contain titanium heat-exchangers, for direct expansion (DX) pool heating, which is generally the most efficient approach to pool heating.

The MWH units however are suitable heating a primary circuit where there are multiple pools being heated within a complex. This is often the case with commercial, or community pools. These installations are often pre-existing, with boilers providing the heating to the primary circuit. The primary loop allows different pools to be set to operate at different temperatures, and also allows pools to have differing water levels.

Indoor pools also generally have high ventilation and space heating requirements, which are provided by an AHU heated from a primary circuit. Multiple MWH 2000 units can be combined onto a common primary loop for community scale pools.

The MWH 2000 unit is the most suitable product for many of these installations. It contains 4 inverter stages and can be configured to heat pools via direct expansion (DX) method, as well as via a primary circuit.

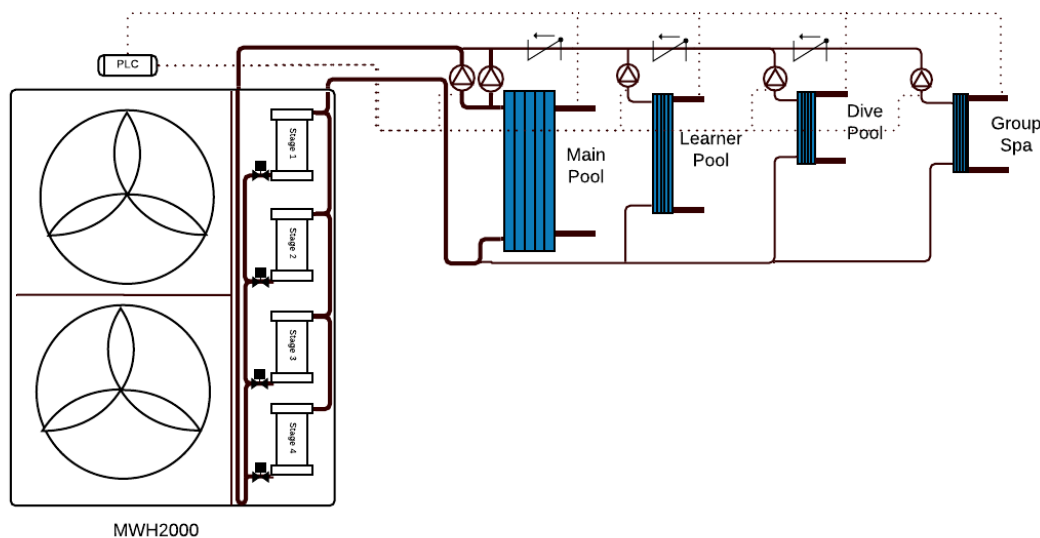


Fig. 15 MWH 2000 variable flow, single pass system design layout for pool heating from a primary circuit



# Heat Pump Water Heaters MWH Series

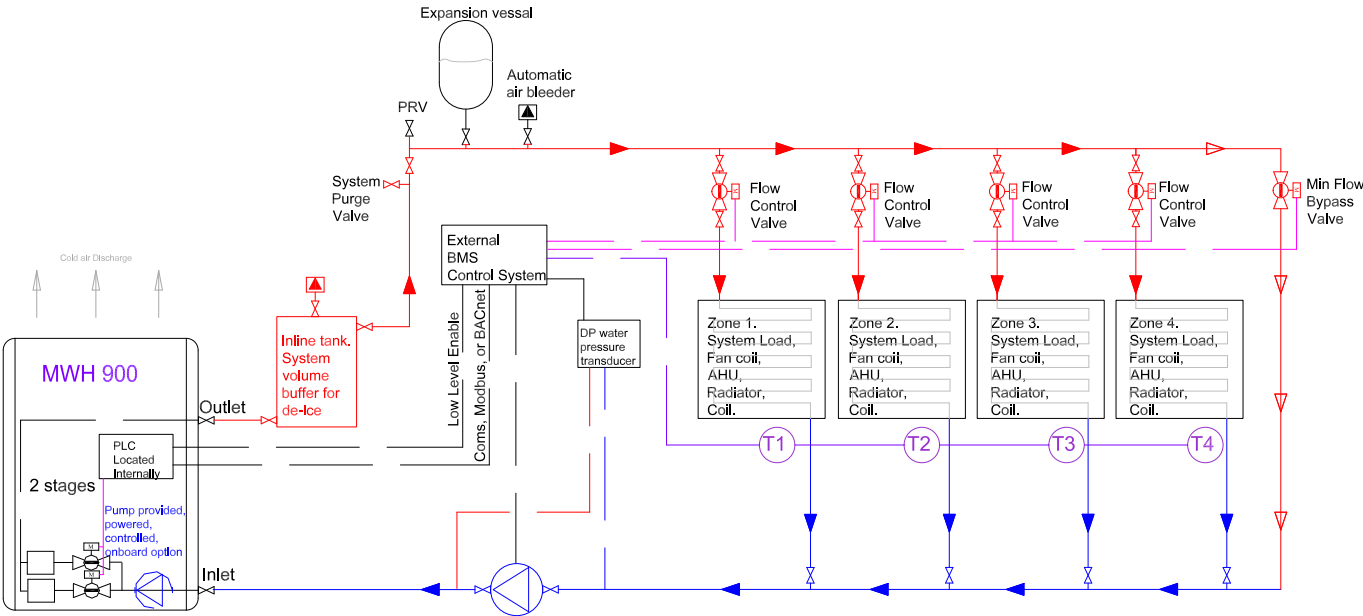
## 10. SUPPORTED APPLICATIONS: Zoned Space Heating Systems

The Aquanex MWH range allows for the design of two-pipe heating systems using a single water circuit for the application. An advantage to the In-Line approach of the Aquanex system is the reduced storage within the water loop.

Temperzone manufactures a range of units with highly efficient EC fan motors which are ideally suited for both zoned and un-zoned heating applications:

- HWP or CWP range water sourced packaged units
- IMDL-Y and IMD-Y range of fan coil units.

Fig. 17 MWH 900 variable flow, single pass system design layout for space heating/multiple load application

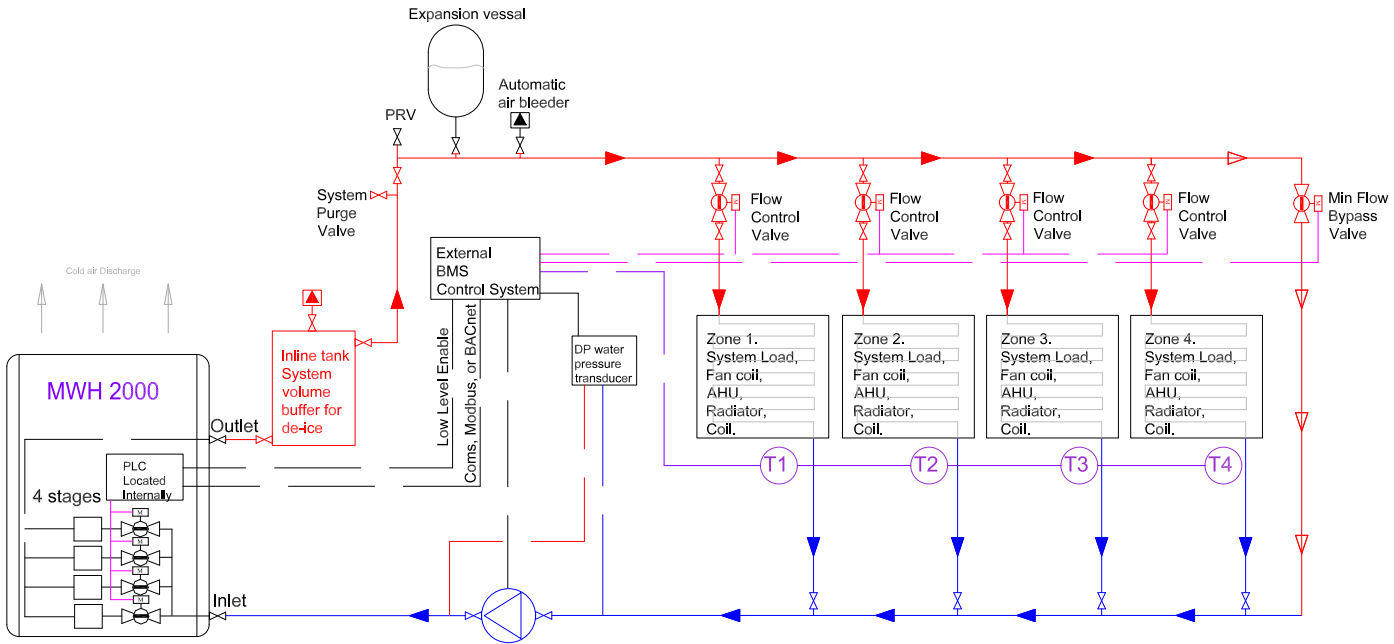


Pump sized to service total system resistance and flow rate required. Powered and Controlled externally by others. (Control of pump via pressure sensor and relevant software by others).



# Heat Pump Water Heaters MWH Series

## Zoned Space Heating Systems (continued)



Pump sized to service total system resistance and flow rate required. Powered and Controlled externally by others. (Control of pump via pressure sensor and relevant software by others).

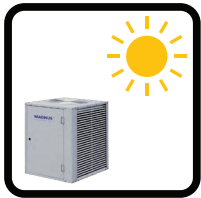
Fig. 18 MWH 2000 variable flow, single pass system design layout for space heating/multiple load application

Systems with a manifold providing zone control (eg radiator systems with/without zone control valves). Third party controls activate the manifold valves, external pumps and provide a low level command to activate the MWH/R and its variable speed pumps.



# Heat Pump Water Heaters MWH Series

## 11. Site Considerations



Aquanex heat pumps utilize the refrigeration process to extract heat from ambient air and deliver that heat to a duty requirement. The heat pump operates most efficiently at the highest ambient air temperature, so it is best to operate through the middle of the day rather than in the evenings.



The air discharging from the unit is quite cold and possibly below freezing temperature at low ambient conditions. Care should be taken that this air is not discharging under windows or plants which are sensitive to the cold. It is possible that condensation will form on surfaces above the unit so be cautious that these surfaces are not sensitive to deterioration from moisture.



Avoid installation in closed-in areas where the air recirculates through the unit and a cold micro-climate can develop around the unit diminishing its performance. If a unit is to be installed in an enclosed room or space (eg plant room, enclosed courtyard), then that space should be ventilated to prevent the enclosure temperature falling to less than 5 degrees below outside ambient temperature. The fan discharge from the unit may be ducted directly to outside the enclosure provided the air flow resistance does not exceed 5 Pa (100 Pa for MWH 2000). A boost extract fan may be required. Refer to Temperzone for advice on duct sizing.



It is a normal process for ice to form on the evaporator coil during operation at ambient temperatures below 5 degrees. Each Aquanex unit has a fully automated de-ice system.

Condensation will run continuously from the unit during operation – more so after a de-ice cycle has been completed and a large volume ice has been melted off the coil. Care should be taken with the installation where this condensate runs off to. If this condensate is likely to form a hazard on an access path then the unit should be placed in a drip tray and drained to a waste point.

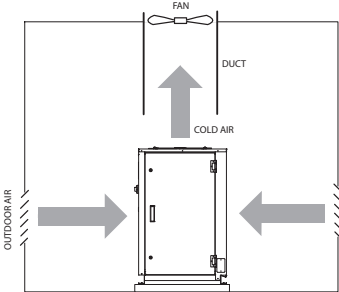
Any application and installation must comply with local/national codes and regulations, eg boundary noise limitations.

Follow these Installation Instructions to ensure optimum performance, reliability and durability.

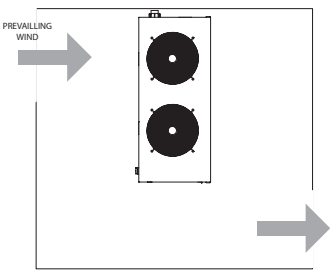
Units must be installed in accordance with all national and regional regulations and bylaws. National Health and Safety regulations must be followed to avoid personal injuries.

The appropriate local permits must be acquired and adhered to.

**WARNING:** Keep appliance area clear and free from combustible materials, gasoline and other flammable vapours and liquids.



Plant room



Enclosed space





# Heat Pump Water Heaters MWH Series

## Site Considerations (continued)

The Aquanex MWH heat pump should be located on a rigid base or foundation, eg concrete pad, and set on rubber vibration isolation pads.

Allow sufficient space around the unit to facilitate water pipe connection, future service, and maintenance requirements, working space in front of the electrical panel and unobstructed air flow through the unit. Refer to the minimum clearance requirements illustrated stipulated in the Specification Data sheet supplied for your model.

In all installations it is preferred that the coil be installed perpendicular to the wall. In installations where this is not possible, the unit must be installed with a minimum of 500mm clearance between the coil and the wall. If multiple units are installed adjacent there must be 1m clearance between facing coils.

Seismic restraints must be fitted if required (refer NZS 4104:1994, AS 1170.4).

The MWH Heat Pump should be located at close proximity to the space to be heated as practicably possible. Keep pipe length as short as possible with as few bends and restrictions as possible. Restricted flow may result in high pressure faults occurring. Connecting pipework may be insulated to minimize heat losses and prevent freezing in sub-zero ambient.

There must be no restriction to air flow above the unit.

*Refer MWH 'Installation & Maintenance' document for full details prior to any installation.*



# Heat Pump Water Heaters MWH Series

## 12. Low Ambient Considerations

MWH unit performance is highly dependant on the application of the units and the outdoor ambient conditions in which they operate. (Suitable applications and exclusions are already listed on page 4)

In low ambient conditions (ie less than 10°C) the unit will periodically operate in defrost mode to prevent icing-up of the outdoor coil. This usually means reversing the unit's refrigeration cycle for a few minutes during which time there is reduced heating output. This effect is less noticeable on multi-compressor models.

To reduce the deviation from LWT set point during defrost/de-ice operation, the below graphs provide a guide to in-line buffer tank volume required, fitted between MWH unit outlet and load.

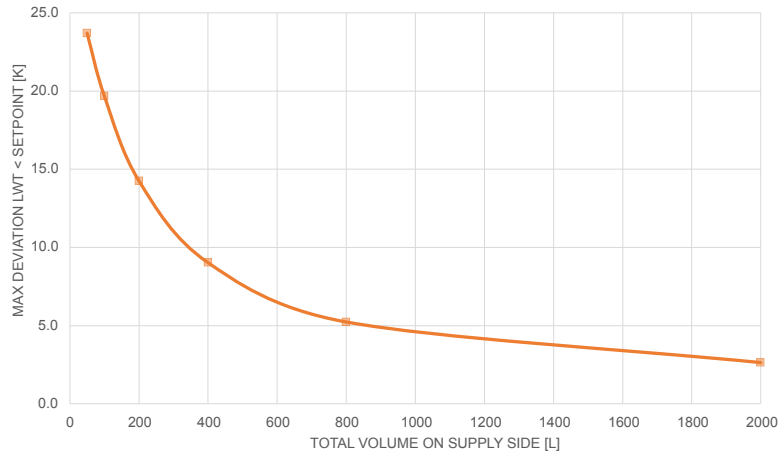
### Close/Critical Control of LWT

If the application requires a deviation from LWT less than 1–2 °C, we recommend some form of back-up heating is fitted to prevent LWT deviating beyond acceptable limits.

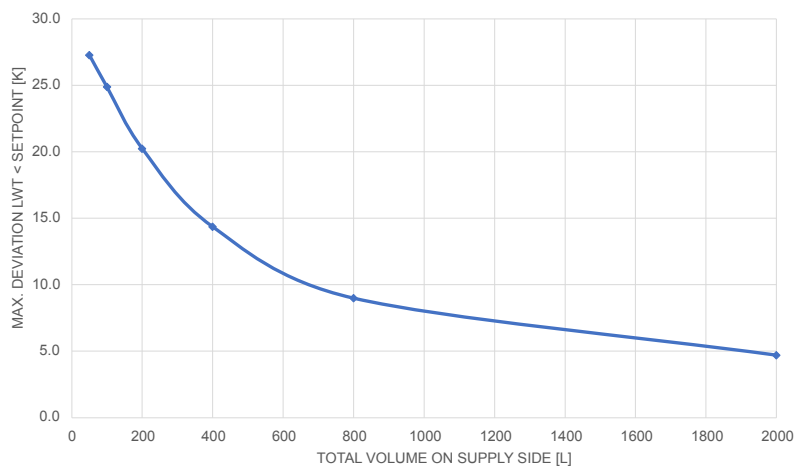
### In-Line Buffer Tanks

To reduce leaving water temperature (LWT) deviation when in defrost mode, the following graphs give a guide for system designers when calculating the appropriate supply side water volume for a 15k Design split.

MWH 900



MWH 2000





# Heat Pump Water Heaters MWH Series

## Controller

All MWH units are supplied with a UC8 Controller. An additional Programmed Logic Controller (PLC) comes standard on MWH 900/2000 multiple compressor units

The UC8 looks after the built-in system protection, while the PLC manages advanced application specific parameters, eg timer scheduling, compressor staging, external pumps, water valves.



UC8 Controller



PLC Controller by Schneider®

### PLC Control Options:

1. Low level hard wired control.
2. High level BMS control via BACnet over ethernet, or Modbus over RS485.

Refer MWH individual model 'Specification Sheet' for wiring diagram prior to any installation.

### **External Pump Control via BMS**

Contact Temperzone for information on interfacing a BMS to an External Pump via the PLC Controller.

### **Protection Against Freezing**

If the outdoor ambient temperature falls close to freezing point the external pump must continue to circulate water to prevent freezing, whether heating is called for or not.

### **De-Ice Cycle**

Under normal operation in cold conditions the coil will at times change to a white appearance as a frost forms. At the end of each de-ice cycle, the coil should be completely clear of ice.

With multiple compressor units, the PLC manages when each UC8 can to perform a de-ice.

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