Application Guide

MITSUBISHI ELECTRIC

QAHV-N560YA-HPB

Application Guidance

Version 1.3

Contents

Important to Note

The information included in this document gives guidance on how to apply Mitsubishi Electric's QAHV heat pump. The sizing of the system should be undertaken by a competent person where the selection has considered the load required according to the intended use. The reader should note the specific differences between CO2 heat pumps and more traditional HFC type heat pumps. **A technical submission document should be issued with every product selection and forms part of the warranty condition, please speak to a Mitsubishi Electric account manager or sales channel partner for more information.** This document should also be read in conjunction with the Databook, installation manual and service handbook. Mitsubishi Electric accept no liability for system design and all information is provided in good faith. Any information reproduced has been done so under the Open Government License (OGL) which can be viewed here:

https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

Links to the databook, installation manual and service manual can be found below.

https://library.mitsubishielectric.co.uk/pdf/book/QAHV-N560YA-HPB_Databook_MEES21K138#page-1

https://library.mitsubishielectric.co.uk/pdf/book/QAHV_N560YA_HPB_Installation_Manual#page-1

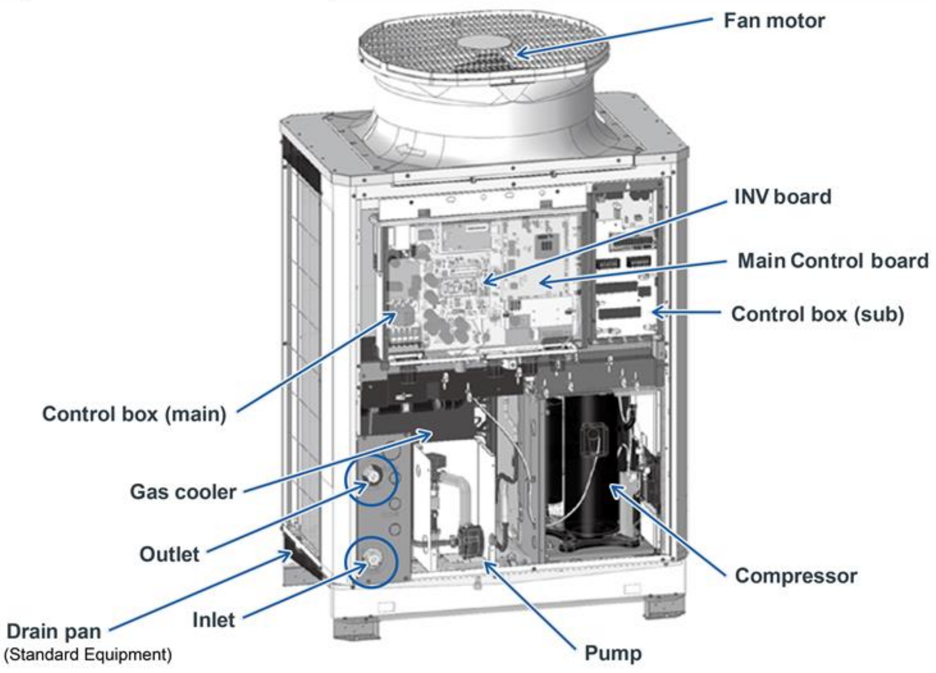
https://library.mitsubishielectric.co.uk/pdf/book/QAHV_N560YA_HPB_Service_Manual#page-1

1. Unit Description

The QAHV-N560-YA (QAHV) is a modular heat pump that has been developed specifically to generate hot water for sanitary purposes. The QAHV unit uses ultra-low GWP CO_2 (R744) refrigerant and is capable of flow temperatures from 55°C to 90°C with high efficiency. The QAHV operates in a transcritical refrigerant cycle. This is where heat is rejected into the water by de-superheating the CO_2 vapour at supercritical pressure in a unique counter flow gas cooler. This cycle is why it is important to target a low return temperature to the QAHV, if the return temperature into the gas cooler is high then the ability to de-superheat the refrigerant is reduced and so therefore is the capacity and efficiency. The guidance in this document aims to provide application methods to reduce the return temperature to the QAHV.

2. Product Structure

The unit has a single fan deck with a bell mouth shaped hood achieving reduction in fan rotation resulting in reduced input power to the fan. All major components such as the pump, compressor and control box are located and accessed via the front panel.



3. CAD /REVIT Files

Use the below link to access QAHV REVIT and CAD files.

https://www.mepcontent.com/en/bim-files/detail/27898/qahv-n560ya-hpb--bs-/?type=article_&ref=mepcontent&clc=WW

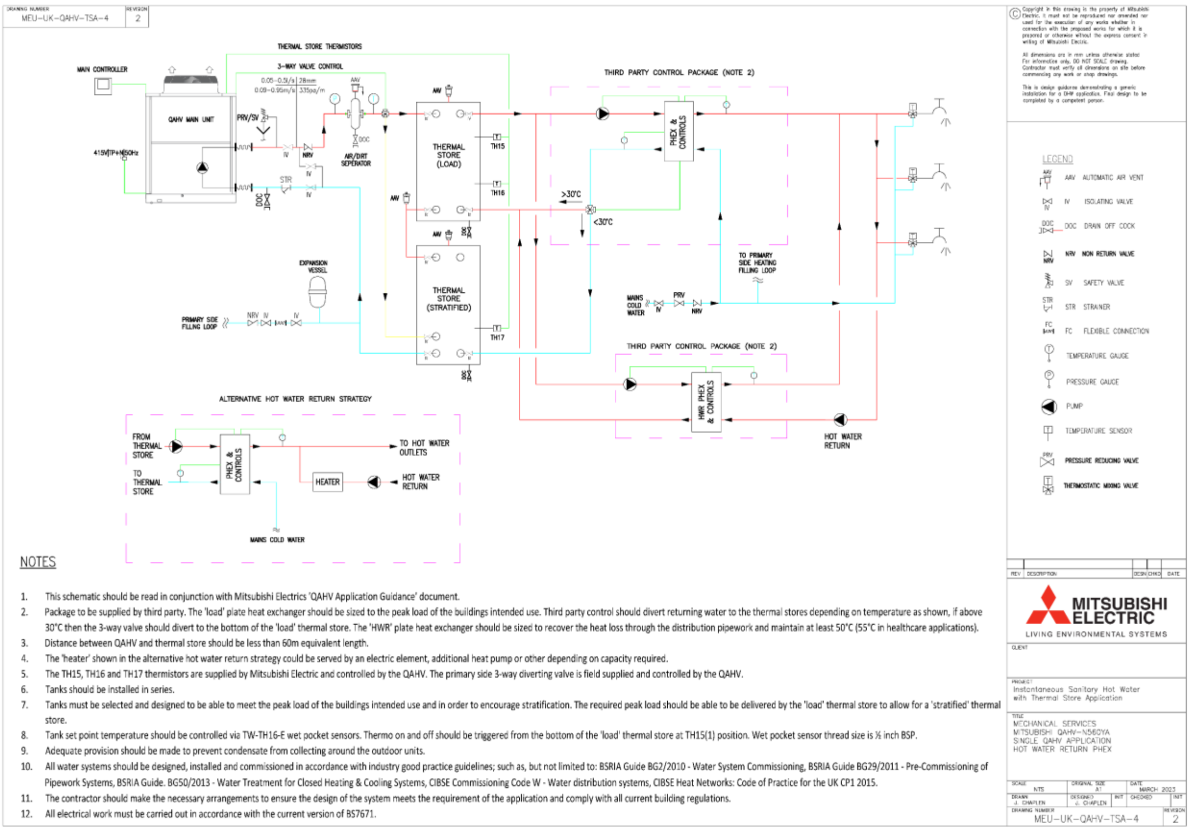
4. Basic System Configuration Types

This application guidance considers two main application configurations, as per the below.

Instantaneous DHW with Thermal Store

Cold mains water is passed through a plate heat exchanger to generate hot water for sanitary use. The mains cold water exchanges heat with water drawn, using a third-party pump, from the top of a thermal store with the return going back into the bottom of the store. The temperature in the thermal store is maintained by the QAHV.

The benefit of this system type is the reduced risk and mitigation measures required to manage legionella. There is also no need for the thermal stores to be WRAS approved. The drawback of this system is that the design and control of the plate heat exchanger and pump must be managed by a third party. The QAHV package in this system type is only maintaining the temperature in the thermal stores.

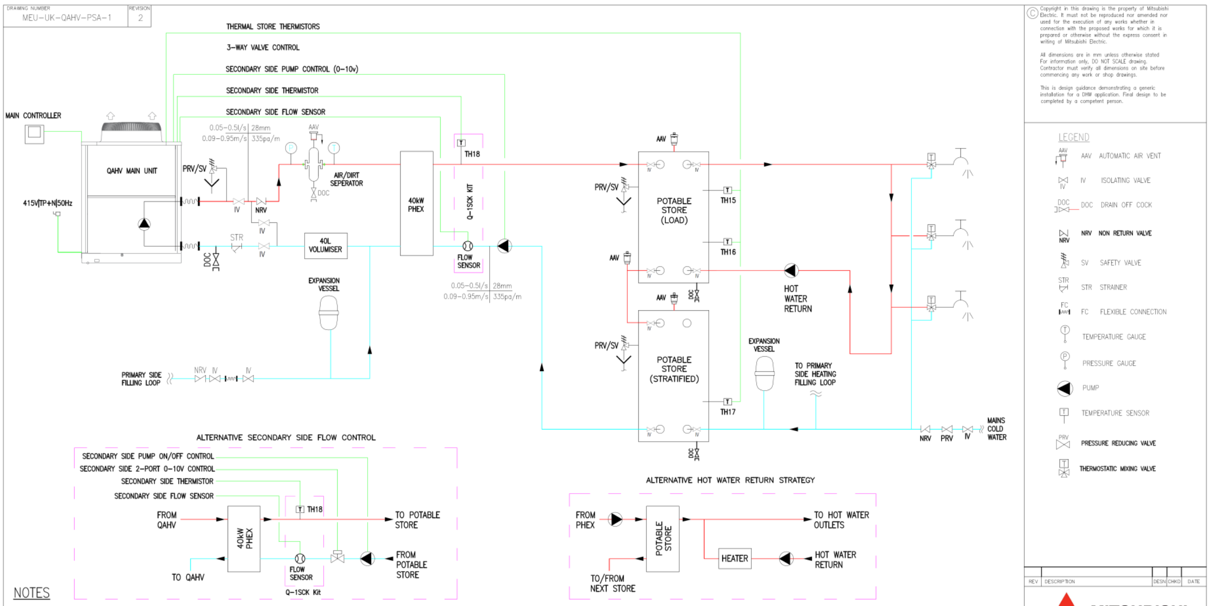


Potable Store with Plate Heat Exchanger

Cold mains water is fed into the bottom of the potable storage vessel whilst hot water is drawn from the top of the vessel to the outlets. To heat the potable store, cold water is drawn from the bottom of the vessel to the plate heat exchanger using a pump controlled by the QAHV, the cold water exchanges heat across the plate with the flow from the QAHV and is delivered into the top of the potable store. The QAHV has its own integral pump and manages the speed of both pumps based on the temperature and flow rates measured using the Mitsubishi Electric Q-1SCK kit.

The benefit of this system is that all control is provided by Mitsubishi Electric equipment and can be seen as a single package. The potable store, plate heat exchanger and secondary side pump are third party items and must be selected by a competent person.

The drawback of this system is the management of legionella bacteria growth in the potable store. This system type also requires more accessories.



NOTES

1. This schematic should be read in conjunction with Mitsubishi Electrics 'QAHV Application Guidance' document.
2. The 'heater' shown in the alternative hot water return strategy could be served by an electric element or other method depending on capacity required.
3. The Q-1SCK kit (flow sensor & TH18 thermistor), TH15, TH16 and TH17 thermistors are supplied by Mitsubishi Electric and controlled by the QAHV.
4. The 3-way diverting valve, secondary side pump and 2 port valve (shown in the alternative method) are field supplied but controlled by the QAHV.
5. QAHV internal primary side pump is variable speed (0-30l/m) and is able to provide 77kPA external head at 17l/m, maximum distance of 60m equivalent length from QAHV to PHEX.
6. Tanks should be installed in series.
7. Tanks must be selected and designed to be able to meet the peak load of the buildings intended use and in order to encourage stratification. The required peak load should be able to be delivered by the 'load' store to allow for a 'stratified' store.
8. Tank set point temperature should be controlled via TW-TH16-E wet pocket sensors. Thermo on and off should be triggered from the bottom of the 'load' thermal store at TH16 position. The wet pocket sensor thread size is ½ inch BSP.
9. Adequate provision should be made to prevent condensate from collecting around the outdoor units.
10. All water systems should be designed, installed and commissioned in accordance with industry good practice guidelines; such as, but not limited to: BSRIA Guide BG2/2010 - Water System Commissioning, BSRIA Guide BG29/2011 - Pre-Commissioning of Pipework Systems, BSRIA Guide. BG50/2013 - Water Treatment for Closed Heating & Cooling Systems, CIBSE Commissioning Code W - Water distribution systems, CIBSE Heat Networks: Code of Practice for the UK CP1 2015.
11. The contractor should make the necessary arrangements to ensure the design of the system meets the requirement of the application and comply with all current building regulations.
12. All electrical work must be carried out in accordance with the current version of BS7671.

5. Instantaneous Sanitary Hot Water with Thermal Store Application

The instantaneous sanitary hot water with thermal store application needs to consider the following points in the design process.

- Peak load calculation (primary/secondary)
- Plate heat exchanger design
- Pump control
- Thermal store sizing
- QAHV selection
- Hot water return strategy

Please see appendix 1 and 2 for example detailed schematics.

5.1 Peak Load Calculation

The peak load of the building (secondary side) must be calculated for the intended use by a competent person. The secondary side peak load is the maximum hot water demand required to be delivered to the hot water outlets for a defined period, Table 2.10 from CIBSE Guide G provides guidance of peak hot water demand depending on building usage. For example, CIBSE Guide G recommends that the peak hot water period in a 4/5 star hotel will last for 1 hour and the design should allow for 35-50 litres per person. Therefore, 100 guests using 35 litres during the peak period would result in 3,500 litres of water being used at 60°C supply temperature in 1 hour. To deliver this the hot water system must be able to deliver 0.972 litres per second, lifting from mains cold water to 60°C.

The plate heat exchanger must be sized to be able to deliver the peak load and is a third party supply item. If it is assumed that, in the example above, the mains cold water is 10°C, then the plate heat exchanger would need to deliver 203.1kW of capacity.

The design of plate heat exchanger must also consider the approach temperature. The approach temperature is the difference between the temperature supplied into the plate from the thermal store and the hot water supply temperature from the plate heat exchanger. The smaller the approach the more efficient the heat exchange process is and the larger the heat exchange surface. For example, if the plate has an approach of 15°K then we would need to store at least 75℃ temperature water in the thermal store to deliver 60°C to the outlets.

To deliver the required capacity on the secondary side, a calculation of the required primary side capacity must be undertaken. The plate heat exchanger manufacturer should be able provide the requirements of the primary side temperature and flow rate, for example Table 1 below shows the secondary side peak load (draw off capacity) and how much primary side load (heating water demand) is required at different defined storage temperature (65-90℃). For the example above, the primary side would need to deliver approximately 59.5 l/m to deliver the 0.972 l/s (58 l/m) of secondary side load with a thermal storage temperature of 75℃.

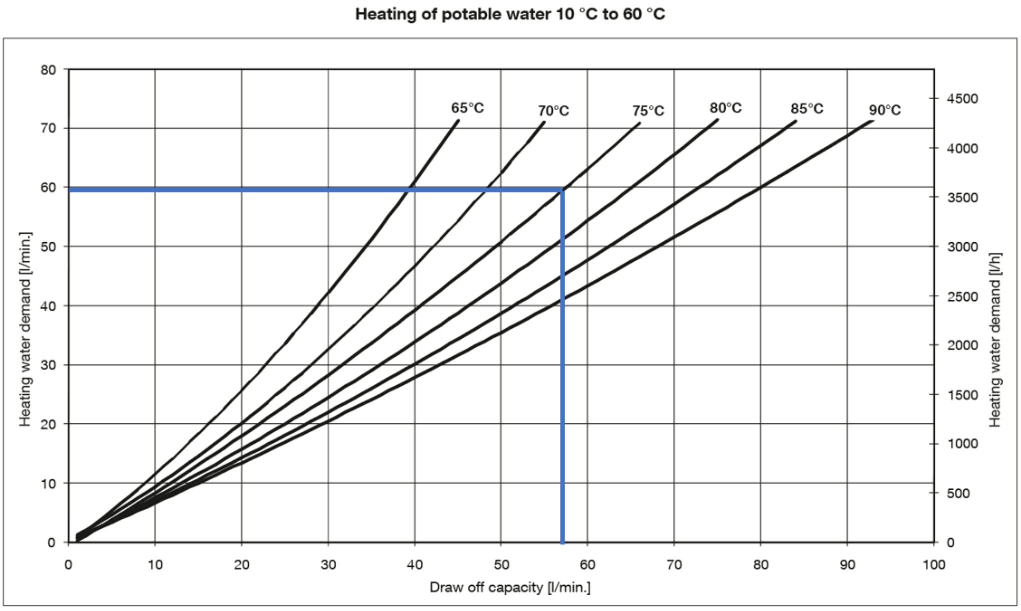


Table 1 - Draw off capacity and Heating Water Demand

The temperature delivered to the plate heat exchanger from the thermal store will also affect the return temperature to the store. Table 2 below shows an example data set describing the relationship of the secondary side peak load (draw off capacity) and the temperature returned to the thermal store (return temperature) for various primary side flow temperatures (65-90℃). For example, if a primary side flow temperature of 75℃ is used then the plate heat exchanger will return approximately 27℃ to the thermal store. The return temperature to the thermal store will change depending on the demand on the secondary side and this level of information should be able to be provided by the plate heat exchanger manufacturer. This information is important to understand when sizing the QAHV's for recovery time.

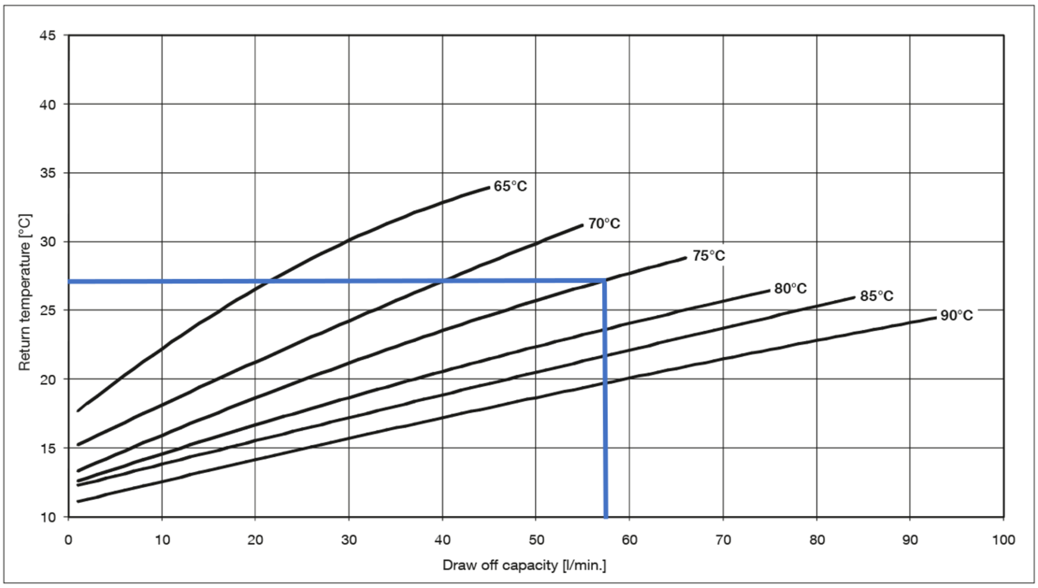


Table 2 - Draw off Capacity and Return Temperature

5.2 Thermal Store Sizing

The thermal store needs to be able to deliver the calculated primary load for the peak period. Based on the example of a 1 hour peak period the thermal store would need to deliver 3,570 litres of water at 75℃. It is recommended that the thermal store be sized 30% larger than the peak period, this is to ensure that there is a percentage of the thermal store that can be stored at a lower temperature and therefore achieve stratification. For this example, the total thermal store volume should be at least 4,641 litres.

Consideration must be given to the number of vessels used to store the required volume; it is recommended that the volume is divided equally across at least 2 vessels with the majority of 30% extra storage in a dedicated 'stratified' store to promote stratification. For example, the 4,641 litres required in the above example could be delivered using 4 no. 1250 litre vessels (as per below), with the first 4 vessels in the series being kept at 75°C and the last store being stratified.

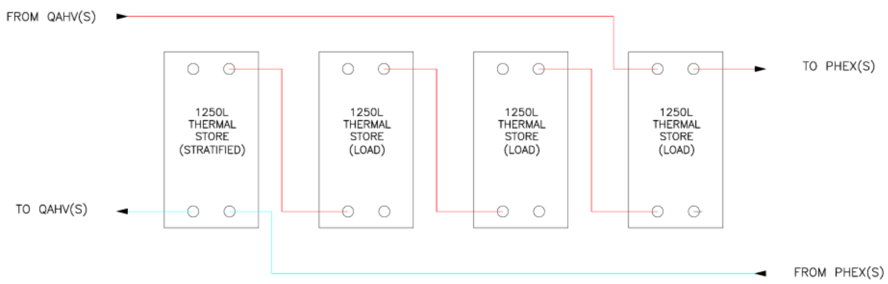


Fig 1 – Thermal store design example

5.3 Pump Control

A pump is required on the primary side of the plate heat exchanger to circulate the required load between the stores and the plate heat exchanger. The duty of the pump should be controlled based on the flow temperature of the sanitary hot water, for example, if the temperature at T1 increases above the set point (60°C in the example here) then the duty of the pump can reduce to reduce capacity delivered across the plate exchanger. This control helps to reduce energy usage and maintain low return temperatures during periods of low load. The pump needs to be sized to be able to deliver the required primary flow rate and overcome the resistance of the plate heat exchanger, pipework, bends and valves etc.

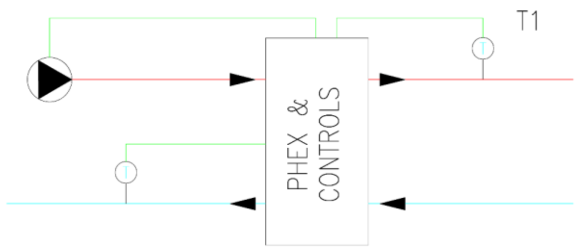


Fig 2 – Primary pump control example

5.4 QAHV Selection

The sizing of the plate heat exchanger, thermal store and pump is made to ensure that the peak period can be met. The sizing of the QAHV must be made to ensure an adequate recovery time can be met to be able to meet the peak period and other load periods during the day. CIBSE Guide G provides guidance on target recovery times for different building types, for example for a 5-star hotel CIBSE Guide G recommends a recovery of 1-hour. However, it is strongly recommended that analysis should be made by the designer to understand the daily load profile to ensure the correct sizing of the QAHV's to meet the required recovery.

For example, to recover 3,570 litres of water from 27℃ to 75℃ in 1 hour would require 199kW of capacity, this would require 6 no. QAHV units. If it is confirmed, by the designer, that a 2-hour recovery time is appropriate then that same example will require 99.5kW of capacity which would require 3 no. QAHV units. Capacity tables to enable basic product selection appear in the QAHV Databook which can be found using the below link. The QAHV must be selected to meet the required capacity output at the worst case external ambient temperature. Please speak to Mitsubishi Electric to request a technical selection based on your project requirements.

https://library.mitsubishielectric.co.uk/pdf/book/QAHV-N560YA-HPB_Databook_MEES21K138#page-12-13

5.5 Hot Water Return

Consideration must be made to hot water return on the primary and secondary side, it is important to try and limit the amount of high temperature water returning to the 'stratified' thermal store. Current HSE guidance states that the temperature within the hot water return pipe should not be less than 50℃ (55℃ for healthcare applications). There are three methods that can be used on the secondary (potable) side:

- Dedicated hot water return PHEX method (preferred)
- Flow sensor/switch method
- Alternative method

In the 'Dedicated hot water return PHEX method' an independent plate heat exchanger is installed to provide capacity to the returning hot water. It is recommended that the primary flow is delivered from the main hot water distribution pipe and the primary return is delivered back to the last 'load' store in the series. This dedicated plate heat exchanger should be sized to recover the heat loss of the recirculation system, which will vary depending on the length, size and insulation of the pipework. It is recommended that the pump between the thermal stores and the dedicated hot water return plate heat exchanger is controlled based on the flow temperature from the dedicated hot water return PHEX, if it is measured that the temperature in the hot water return pipework is less than 50℃ (*55℃ in healthcare) then the pump should operate to draw capacity from the thermal store. The following shows a schematic layout of the 'Dedicated hot water return PHEX method'.

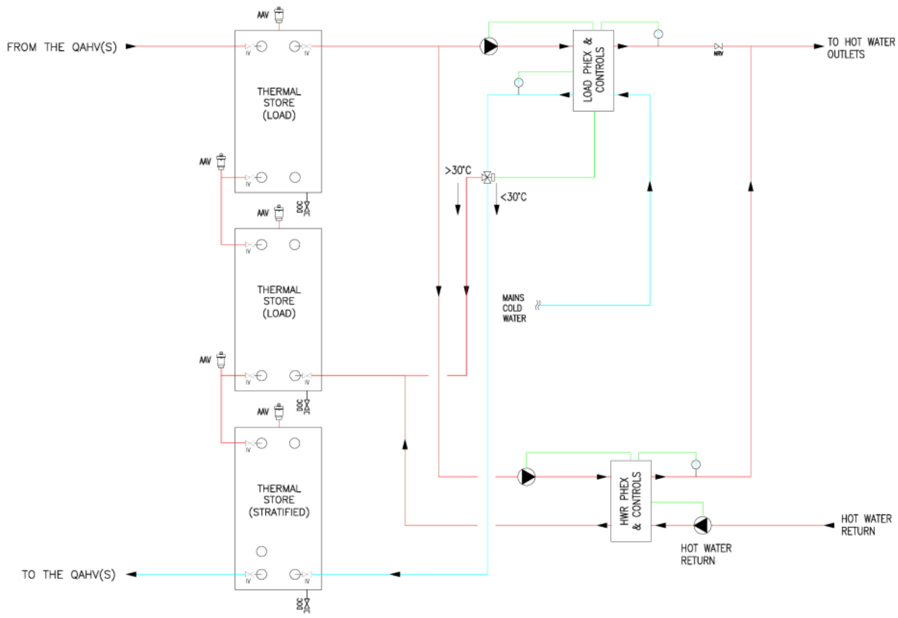


Fig 3 – Dedicated hot water return PHEX method example

In the 'flow sensor/switch method' it is recommended that a flow sensor/switch is installed in the position shown below. When the flow sensor/switch detects flow on the incoming mains the control package should stop the operation of the hot water return pump. This will allow the best opportunity for a colder return temperature to the bottom of the 'Stratified Thermal Store' to maintain capacity and efficiency of the system.

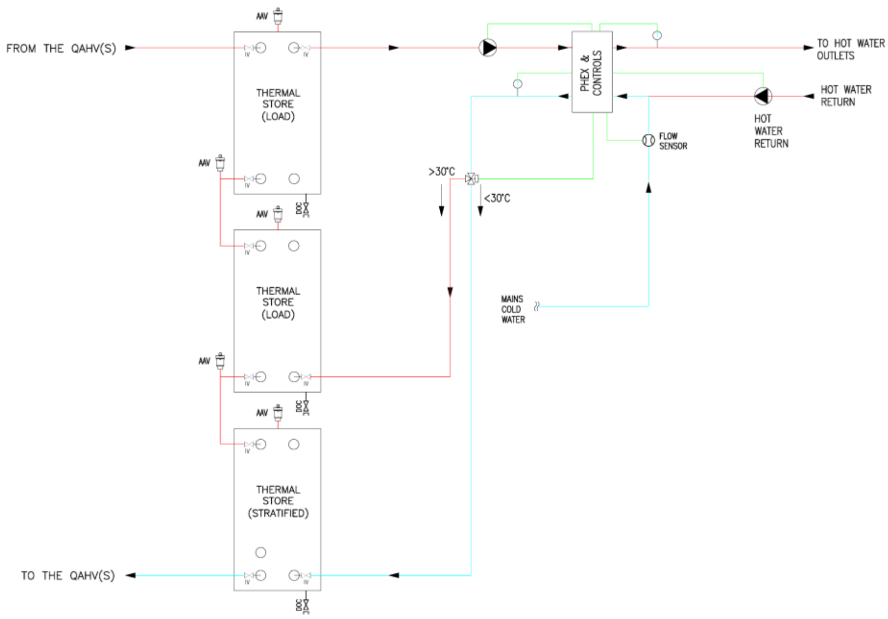


Fig 4 - Flow sensor/switch method example

In the 'alternative method' the hot water return pipework bypasses the plate heat exchanger. The temperature in the hot water return pipework is maintained above 50℃ (*55℃ in healthcare) by an alternative heating method, this could be an electric element, trace heating, an additional heat pump or other method depending on the capacity required. This alternative heating method should be sized to recover the heat loss of the recirculation system, which will vary depending on the length, size and insulation of the pipework.

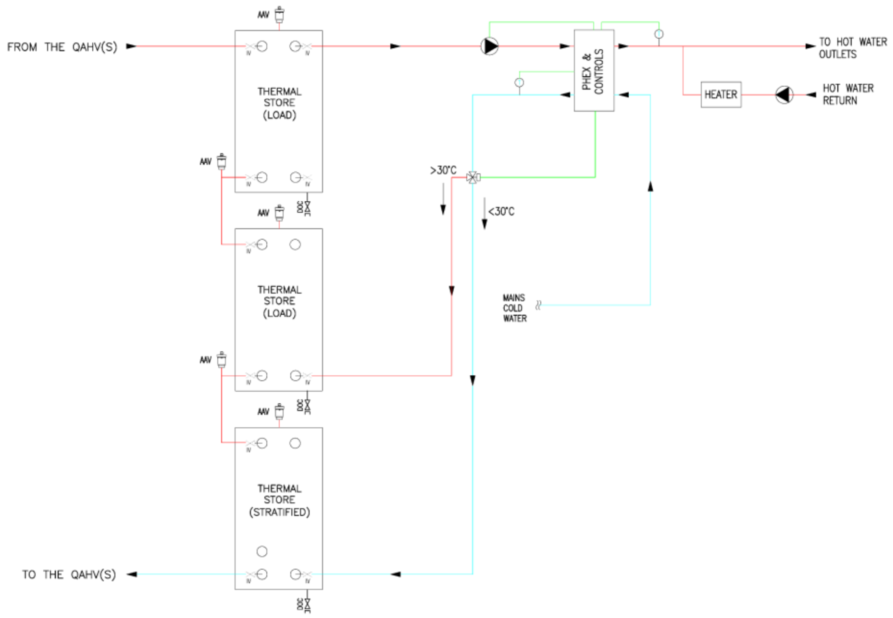


Fig 5 – Alternative method example

To protect stratification in the thermal store during periods of low demand (using all 3 of the above methods) it is recommended to install a 3-way temperature controlled diverter valve, shown above. The valve should divert water to the last 'load' store in the series if the temperature is above 30℃, if the temperature is less than 30℃ then the return is piped into the bottom of the 'stratified' tank.

6. Potable Store with PHEX Application

The potable store with plate heat exchanger application needs to consider the following points in the design process.

- Hot water load calculation
- Potable store size
- QAHV selection
- Plate heat exchanger design
- Minimum primary volume
- Secondary side control
- Hot water return strategy

Please see appendix 3 and 4 for example detailed schematics.

6.1 Hot Water Load Calculation

The hot water load of the building must be calculated for the intended use by a competent person. Table 2.11 from CIBSE Guide G provides recommendations for how much hot water will be used during a 24-hour period for various types of buildings and use. For example, CIBSE guide G suggests that a single person, staying in a 5 star hotel, will use 136 litres of water at 65°C during a 24-hour period. Therefore, 100 guests (excluding any restaurant requirement) would use 13,600 litres of hot water during a 24-hour period. The designer should carefully consider how this total hot water load will be spread across the day as it will have an impact on hot water storage, recovery time and therefore the amount of QAHV's required.

When assessing the hot water production requirements for a building it is also necessary to determine the peak demand. The peak demand is the volume of hot water required during the building's period of greatest usage. This may be over an hour, or shorter period dependant on the occupants and activities taking place.

6.2 Potable Store Size

The amount of stored potable hot water required to be able to deliver this load should be carefully considered and the designer should consider the required recovery time for the intended use. Table 2.11 of CISBE Guide G provides recommendations on the required storage to meet the 24-hour hot water usage, based on a 2 hour recovery time. For example, CIBSE guide G suggests that 45 litres of 65°C hot water per person should be stored in a 5-star hotel. Therefore, 100 guests would require a potable store of 4,500 litres at 65°C. It is recommended that the potable store be sized 30% larger than required, this is to ensure that there is a percentage of the potable store that can be stored at a lower temperature and achieve stratification. For this example, the total potable store volume should be at least 5,850 litres.

It should also be checked that this volume is suitable to cover the peak demand.

Consideration must be given to the number of vessels used to store the required volume, it is recommended that the volume is divided equally across at least 2 vessels with the majority of 30% extra storage in a dedicated 'stratified' vessel to promote stratification. For example, the 5,850 litres required in the above example could be delivered using 4 no. 1500 litre vessels (as per below), with the first 3 vessels in the series being kept at 65°C and the last store being stratified.

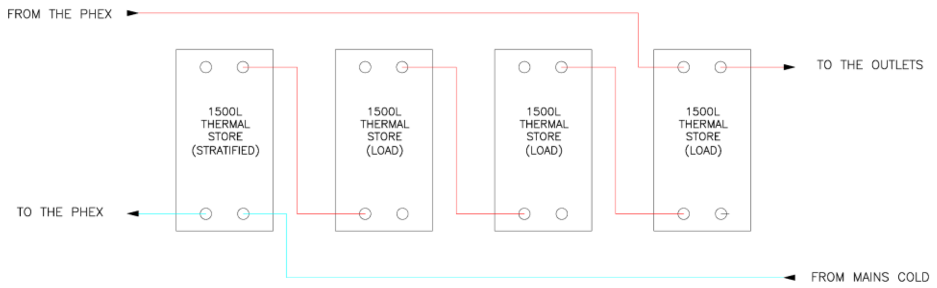


Fig 6 – Thermal store design example

6.3 QAHV Selection

The hot water load calculation and potable store sizing is made to ensure that the requirement for the intended use can be met. The sizing of the QAHV must be made to ensure an adequate recovery time can be met. CIBSE Guide G recommends a recovery of 2 hours. However, it is strongly recommended that analysis should be made by the designer to understand the daily load profile and peak load to ensure the correct sizing of the QAHV's to meet the required recovery.

For example, to recover 4,500 litres of water from 10℃ to 65℃ in 2 hours would require 146.6kW of capacity, this would require 5 no. QAHV units. If it is confirmed, by the designer, that a 3-hour recovery time is appropriate then that same example will require 95.8kW of capacity which would require 3 no. QAHV units. Capacity tables to enable basic product selection appear in the QAHV Databook which can be found using the below link. The QAHV must be selected to meet the required capacity output at the worst case external ambient temperature. Please contact Mitsubishi Electric for full technical selections.

https://library.mitsubishielectric.co.uk/pdf/book/QAHV-N560YA-HPB_Databook_MEES21K138#page-12-13

6.4 Plate Heat Exchanger Design

A plate heat exchanger must be used to create a primary and secondary side. The plate heat exchanger should be sized to deliver 40kW based on the required secondary side flow temperature with a main cold water inlet into the secondary side. The approach of the plate heat exchanger should not be more than 5°K. Each QAHV in the system will require it's own 40kW plate heat exchanger. Based on the above example of needing to lift water from 10℃ to 65℃ the follow advice would be recommended.

1. Heat exchanger capacity = 40kW
2. Secondary side outlet hot water temperature = 65°C
3. QAHV outlet hot water temperature = 70°C
4. Secondary side inlet water temperature = 10°C
5. QAHV inlet water temperature = 15°C
6. Used flow rate = 10.4 l/m

It is important that the plate heat exchanger has a shearing stress higher of 16Pa or higher at the required flow rate. A shearing stress of 16 Pa or higher is required to reduce the amount of scale that adheres. The plate heat exchanger should also be capable of allowing a maximum flow rate up to 30l/m. The flow rate will only ever be at maximum when the return temperature to the QAHV is approximately 63°C, during this period the capacity available will reduce.

6.4 Minimum Primary Volume

Each QAHV requires a 40 litre minimum circuit volume. A volumiser should be added to the primary water circuit as per the below.

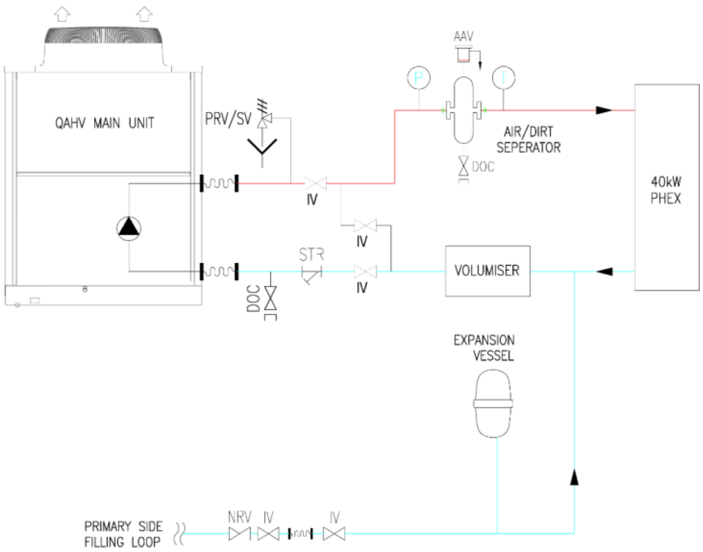


Fig 7 – Minimum primary volume example

6.5 Secondary Side Pump & Control

The QAHV controls the flow rate on the secondary of the plate heat exchanger by monitoring the flow rate and flow temperature and adjusting the duty of the secondary side pump, the below show a schematic representation.

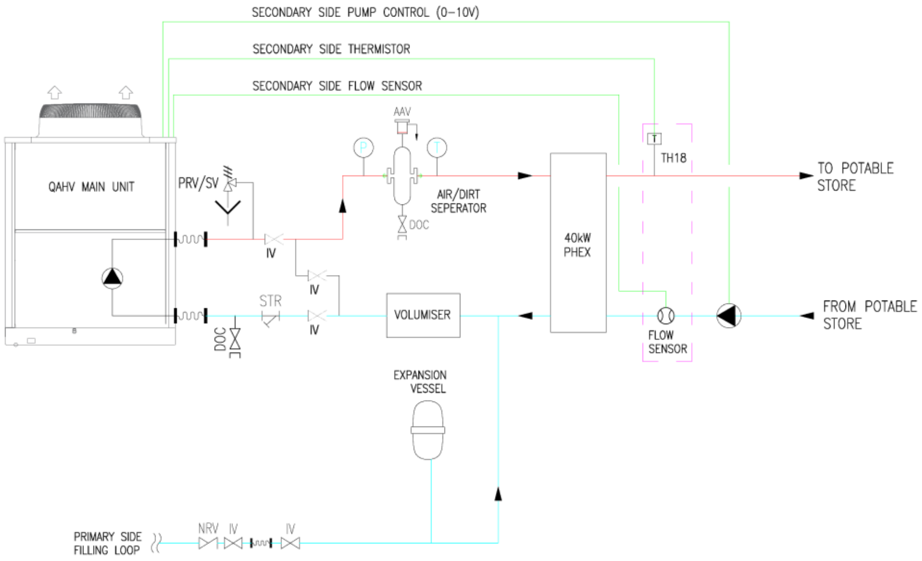


Fig 8 – Secondary side pump, flow sensor and thermistor example

The QAHV operates both sides of the plate heat exchanger to ensure that the secondary side flow temperature is in accordance with the set point. Therefore, the flow rate on the secondary side is adjusted to ensure the target flow temperature is achieved, if the return temperature to the plate heat exchanger increases then the QAHV will increase the flow rate to maintain the delta T and capacity. The primary side pump is inside the QAHV and requires no additional selection or commissioning. The secondary side pump is field supplied and must be selected to ensure the below:

1. It has adequate head to overcome the resistance in the pipe work and plate heat exchanger etc.
2. It can operate with a range of 3-30l/m
3. It can accept a 0-10V input control signal
4. It can output a constant 10, 12 or 24V* to the QAHV terminal board.

*Note that if only a 24V output is available from the pump then a DC to DC convertor must be used to drop the voltage to 10 or 12V.

The temperature and flow are monitored on the secondary side using the Mitsubishi Electric Q-1SCK kit. This kit contains a TH-TW16-E wet pocket senser and inline flow sensor, installation details can be found below.

https://library.mitsubishielectric.co.uk/pdf/book/QAHV-N560YA-HPB_Databook_MEES21K138#page-10-11.

Additionally, a 2-port or 3-way valve can be used to control the flow on the secondary side. In this case, the QAHV will control an actuator on the 2/3-port valve using a 0-10V control signal and provide the pump with an ON/OFF signal. Detail can be found in the product Databook.

https://library.mitsubishielectric.co.uk/pdf/book/QAHV-N560YA-HPB_Databook_MEES21K138#page-42-43

6.6 Hot Water Return Strategy

Consideration must be made to hot water return on the potable side, it is important to try and limit the amount of high temperature water returning to the 'stratified' store. Current HSE guidance states that the temperature within the hot water return pipe should not be less than 50℃ (55℃ for healthcare applications). There are two methods that can be used on the potable side;

- Standard method
- Alternative method

In the 'standard method' the hot water return is pumped back into the bottom of the first 'load' store as shown below.

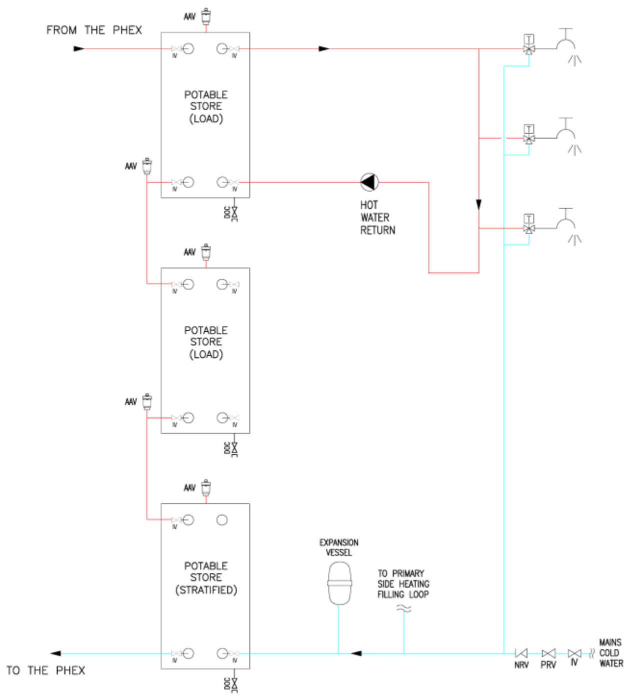


Fig 9 – Standard method example

It is not advised to pump this back into any other load tanks as this can generate a bypass circuit between the first store and any stores between as shown below. This can happen when the flow rate of the hot water return pump is higher than the combined QAHV flow rate and the system is operating in hot water recovery mode.

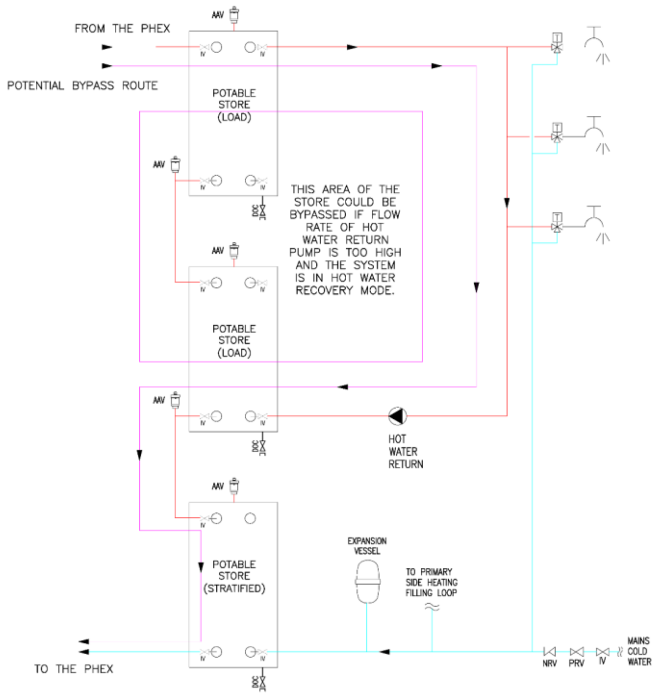


Fig 10 – Possible bypass circuit example

In the 'alternative method' the hot water return pipework bypasses the potable store. The temperature in the hot water return pipework is maintained above 50℃ (*55℃ in healthcare) by an alternative heating method, this could be an electric element or other method depending on the capacity required. This alternative heating method should be sized to recover the heat loss of the distribution system, which will vary depending on the length, size and insulation of the pipework.

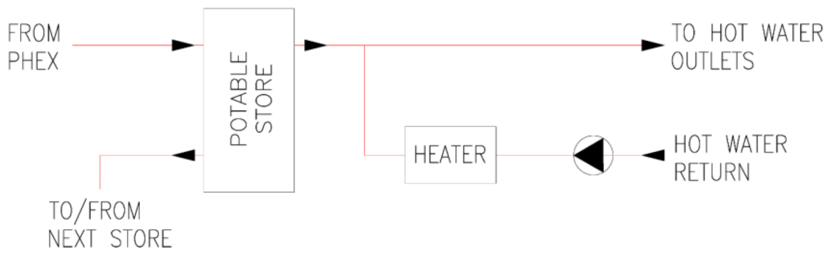


Fig 11 – Alternative method example

7. Anti-freeze Control

The QAHV heat-pump is an externally located unit. Therefore, the water in the pipework between the internally located hot water stores and the heat pump is at risk of freezing. The QAHV has several potential countermeasures which are outlined below.

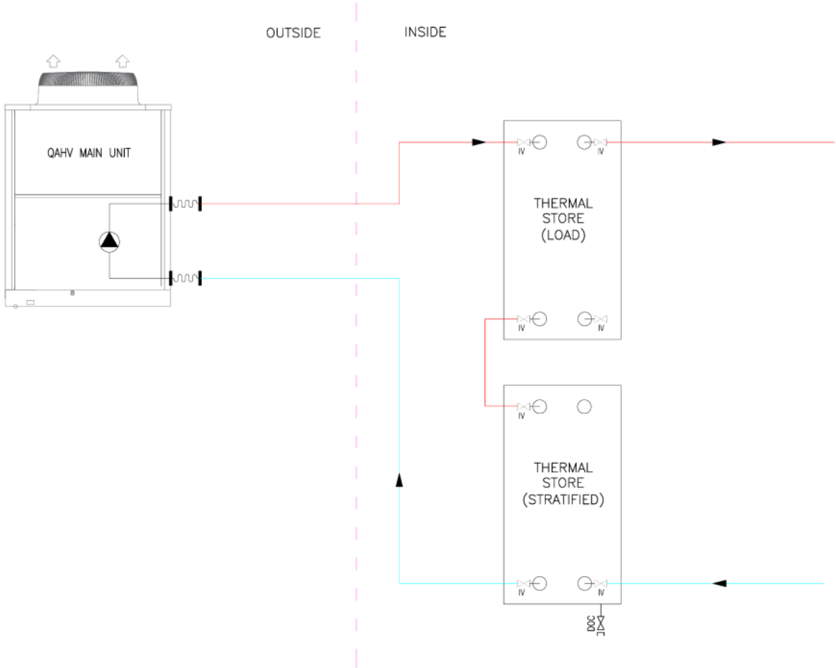


Fig 12 – Anti-freeze risk example

7.1 Countermeasure 1. Pump will run when pipe-freezing risk is detected.

This is the default factory setting if no further frost protection is provided. Inside the QAHV there are 3 sensors used for anti-freeze mode initiation:

- TH12, Inlet water temperature
- TH11, Outlet water temperature
- TH9, External temperature

If either of TH11 or TH12 are below 3C AND TH9 is below 1C, then the pump will operate circulating water between the cylinder and the heat pump until either TH11 or TH12 has reached 5C. Heat will be drawn from the cylinder to raise the pipe temperature.

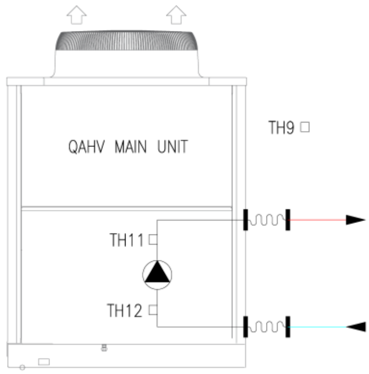


Fig 13 – Location of sensors

7.2 Countermeasure 2. Compressor and Pump will run when pipe-freezing risk is detected.

In addition to countermeasure 1, if dip switch SW2-5 is set to 'ON' then the compressor will operate to add heat.

7.3 Countermeasure 3. 3-way valve

When anti-freeze mode is engaged as described in countermeasure 1, contacts at terminal TB8, connections 86 and 87 will be closed (non-voltage). This can be used to drive an external 3 way valve to divert the cold water into a different location in the hot water cylinder. This prevents cold water being pumped into the top of the 'load' store as shown below.

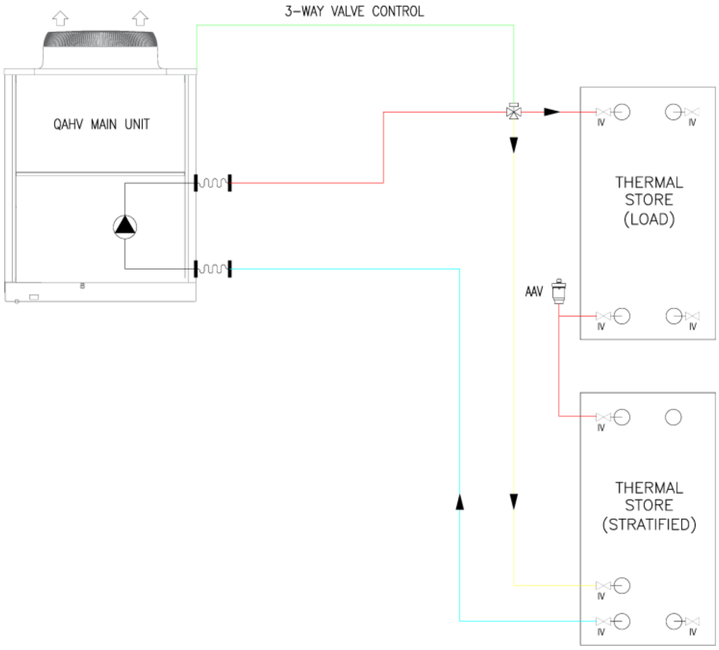


Fig 14 – 3-way valve anti-freeze example

7.4 Countermeasure 4. Trace heating.

A third party trace heating system could be used to trace heat the external pipe-work when, say, the external temperature dropped below 5C.

Glycol is commonly used to prevent freezing, but it is not recommended. A large volume of propylene glycol would need to be used in this case. The high temperatures that the QAHV can achieve may cause the glycol to decompose. Organic glycols can corrode copper due to oxidation at high temperatures. Any degradation in the initial quality of the glycol, and the change in viscosity with temperature, will cause errors as the QAHV unit creates a flow rate map during initial commissioning.

8. Piping Design

8.1 Pipe Sizing

The QAHV contains an internal inverter driven pump. It is not recommended to exceed a total of 60m equivalent pipe length between the QAHV and stores or secondary plate heat exchanger. The below table shows the pressure loss and flow velocities for various sizes of water pipe (copper) using a water temperature of 70°C. It is recommended that 28mm (OD) is used to each QAHV, to maintain a pressure loss of < 350 Pa/m and maintain the water velocity between 0.5 – 1.5 m/s. If multiple QAHV's are installed together (using the Instantaneous Sanitary Hot Water with Thermal Store Application) then the pipework should be sized appropriately.

Flow Rate (l/m)	Pipe OD (mm)	Pressure Loss (Pa/m)	Flow Velocity (m/s)
14	22	413	0.89
	28	119	0.53
	35	42	0.34
30	22	1166	1.59
	28	335	0.95
	35	117	0.61

Table 3 – Pressure loss and flow velocity at 14l/m and peak (30l/m) flow rates for a single QAHV unit with pipe sizes 22mm OD, 28mm OD and 35mm OD, copper pipe to table X dimensions.

8.2 Pump Curve

The below displays the available external head of the internal pump.

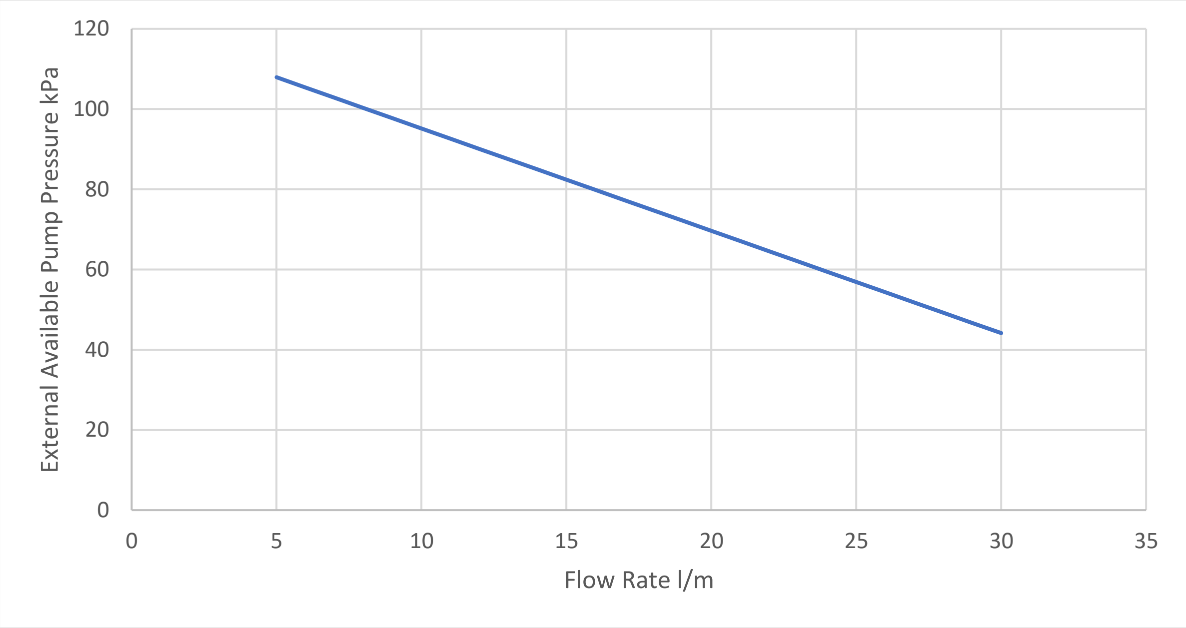


Fig 15 – Available external pump head

The total head available from the pump is 85kPa at 14 l/m flow rate. However, the designer must understand that the peak flow rate may be 30 l/m if the return temperature increases towards 63°C.

9. Unit Control

The QAHV uses sensors for detecting temperatures at different points in the stores, which in turn are used to start and stop the QAHV heat pump. The TW-TH16-E sensors are wet pocket (i.e. come into direct contact with the water) which use RC 1/2 inch screw connections.

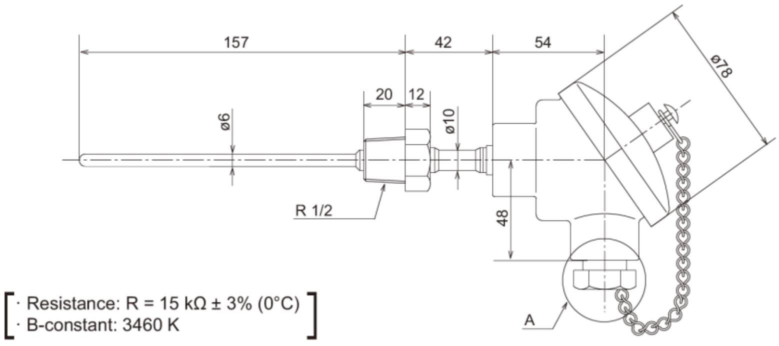


Fig 16 – TW-TH16-E external temperature sensor (TH15, TH16, TH17 and TH18)

There are 2 methods that can be used when using the TW-TH16-E sensors:

- The 3-sensor method
- The 6-sensor method

9.1 The 3-sensor method

The 3-sensor method uses 3 no. TW-TH16-E sensors to measure the temperature in 3 different locations across the stores. The 3-sensor method is only recommended when using 2 stores in series, it is recommended that 2 sensors (TH15 & TH16) are installed in the 'load' store and 1 sensor (TH17) in the 'stratified' store as per the below.

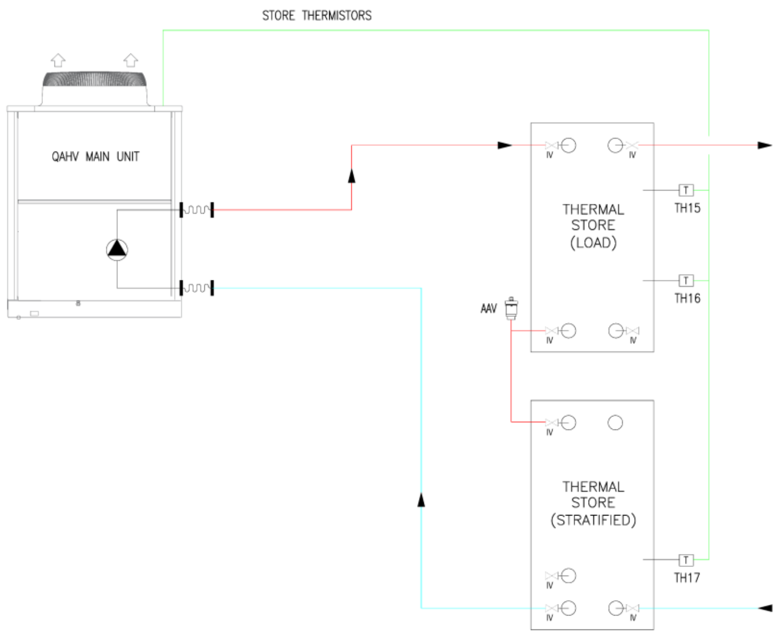


Fig 17 – 3-sensor method example

9.2 The 6-sensor method

The 6-sensor method uses 6 no. TW-TH16-E sensors to measure the temperature in 6 different locations across the stores. The 6-sensor method can only be used when there is 2 or more QAHV's installed, the below shows an example of how the sensors could be installed when using 3 stores in series.

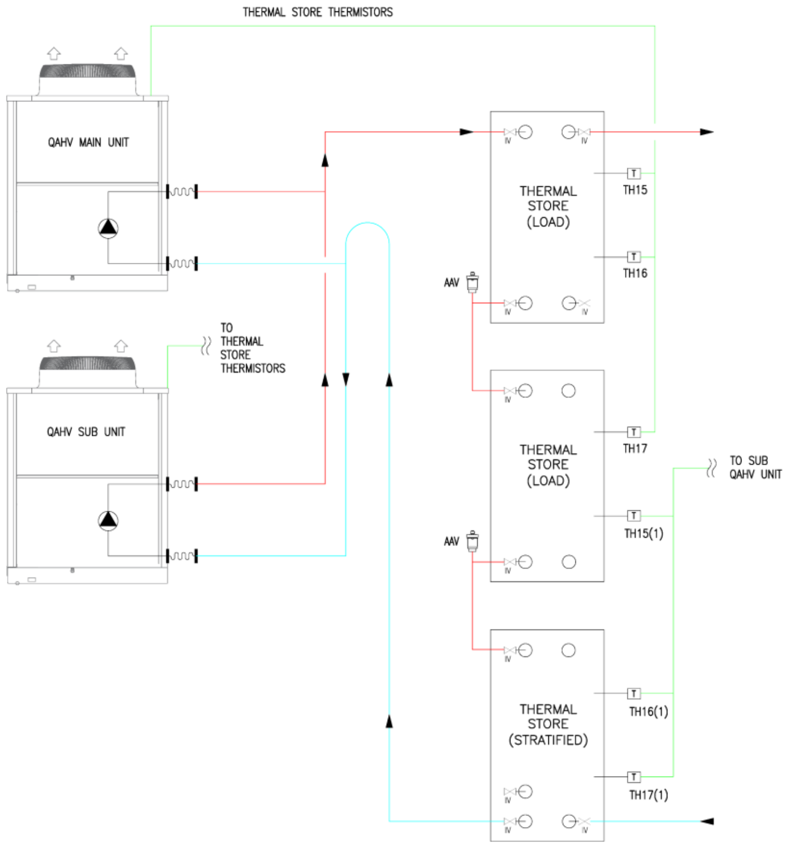


Fig 18 – 6-sensor method

9.3 Control strategy

There are 5 variables that can changed at point of commissioning to control the temperature in the stores.

- Hot water storage target temperature. The hot water storage target temperature should be set in accordance with the proposed design, this can be set between 40 – 90°C.
- Thermo on position. The 'thermo on' position is the sensor location used to trigger the QAHV(s) to operate and recover the hot water storage target temperature. This can be either TH15, TH16 or TH17.
- Thermo off position. The 'thermo off' position is the sensor location used to trigger the QAHV(s) to stop operation. This can be either TH15, TH16 or TH17.
- Temperature differential. The change in temperature from the 'hot water storage target' used to trigger a 'thermo on' command. This can be set from 0 – 30°K.
- Number of control modes. The QAHV can allow a maximum of 3 different control modes. A control mode is a defined 'thermo on' position, 'thermo off' position and 'temperature differential'.

If using the guidance from the above sections for hot water storage design, it is recommended that the 'thermo on' and 'thermo off' is triggered using a sensor positioned towards the bottom of the last 'load' store. In the 3 and 6-sensor examples shown here it would be recommended that TH16 and TH15(1) are used respectively.

The QAHV(s) would therefore heat the stores until TH16 or TH15(1) had reached the 'hot water storage target temperature', for example 65°C. The QAHV(s) will remain off until TH16 or TH15(1) sensor reads less than the 'hot water storage target temperature' minus the 'differential temperature'. For example, where the temperature differential is 10°K and the hot water storage target temperature is 65°C, heating will restart when the TH16 or TH15(1) sensor has reached 55°C.

10. BMS Points Register

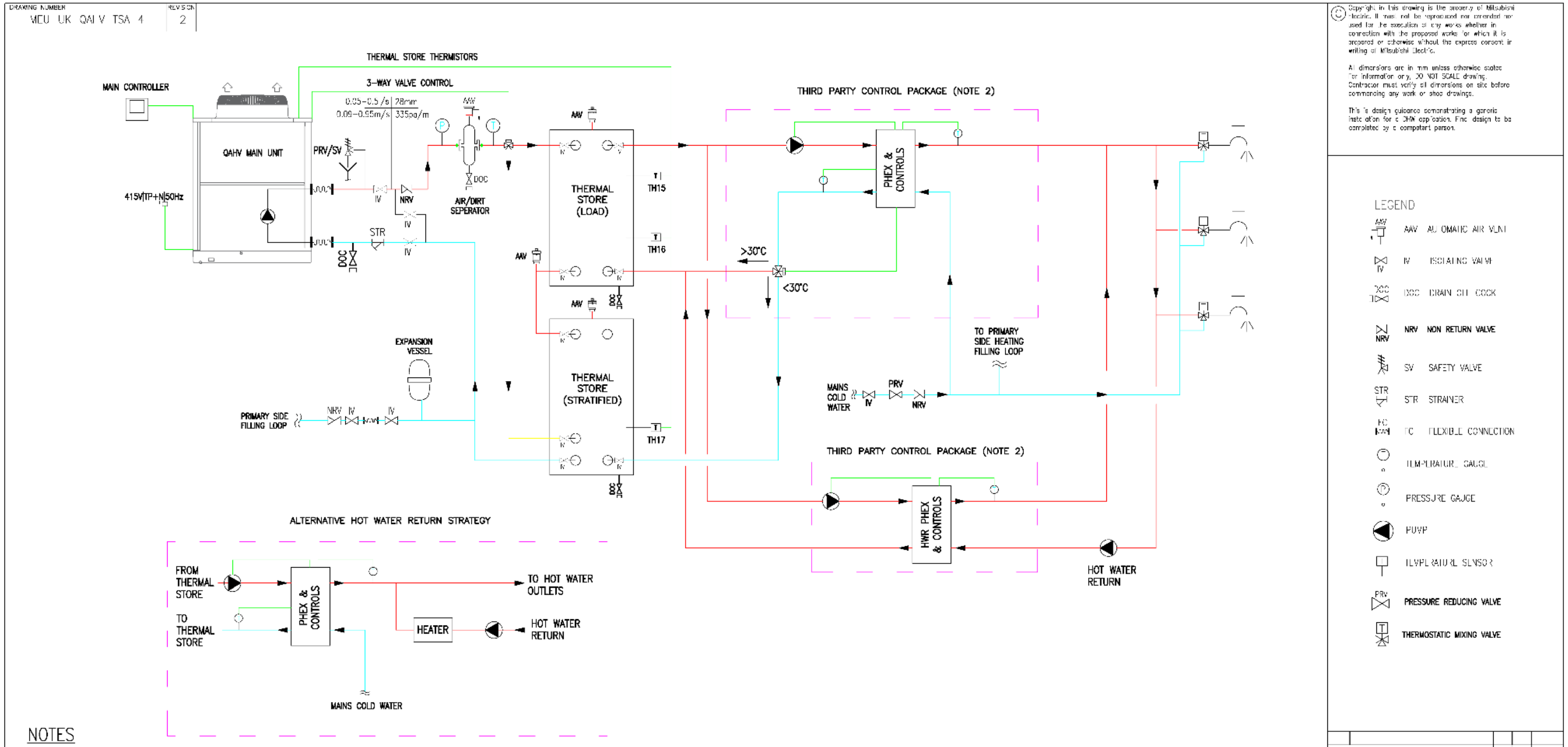
The below table provides basic information on some available readable and writable points for QAHV. More information can be found in the MelcoBEMS MINI interface manual using the below link.

https://library.mitsubishielectric.co.uk/pdf/book/MELCOBEMS_MINI__A1M__ATW_Modbus_Register_Tables.pdf#page-1

Register Name	Readable	Writable
Fault/Error	Yes	No
System On/Off	Yes	Yes
Operating Mode	Yes	Yes
Hot water storage target temperature (Thermo Off)	Yes	Yes
Capacity Mode	Yes	Yes
Capacity Control Ratio	Yes	Yes
Defrost Operation	Yes	No
Compressor Frequency	Yes	No
Outdoor Ambient Temperature	Yes	No
Flow Temperature	Yes	No
Return Temperature	Yes	No
TH15 Sensor Temperature (External Water Temperature 1)	Yes	No
TH17 Sensor Temperature (External Water Temperature 3)	Yes	No
TH15(1) Sensor Temperature (External Water Temperature 4)	Yes	No
TH17(1) Sensor Temperature (External Water Temperature 6)	Yes	No
Pump Operation	Yes	No
3-way Valve Control Operation	Yes	No
Evaporating Temperature	Yes	No
Condensing Temperature	Yes	No

Table 4 – BMS points (not exclusive)

Appendix 1 - Single QAHV with Thermal Store and Instant PHEX



NOTES

1. This schematic should be read in conjunction with Mitsubishi Electrics 'QAHV Application Guidance' document.
2. Package to be supplied by third party. The 'load' plate heat exchanger should be sized to the peak load of the buildings intended use. Third party control should divert returning water to the thermal stores depending on temperature as shown, if above 30°C then the 3-way valve should divert to the bottom of the 'load' thermal store. The 'HWR' plate heat exchanger should be sized to recover the heat loss through the distribution pipework and maintain at least 50°C (55°C in healthcare applications).
3. Distance between QAHV and thermal store should be less than 60m equivalent length.
4. The 'heater' shown in the alternative hot water return strategy could be served by an electric element, additional heat pump or other depending on capacity required.
5. The TH15, TH16 and TH17 thermistors are supplied by Mitsubishi Electric and controlled by the QAHV. The primary side 3-way diverting valve is field supplied and controlled by the QAHV.
6. Tanks should be installed in series.
7. Tanks must be selected and designed to be able to meet the peak load of the buildings intended use and in order to encourage stratification. The required peak load should be able to be delivered by the 'load' thermal store to allow for a 'stratified' thermal store.
8. Tank set point temperature should be controlled via TW-TH16-E wet pocket sensors. Thermo on and off should be triggered from the bottom of the 'load' thermal store at TH15(1) position. Wet pocket sensor thread size is ½ inch BSP.
9. Adequate provision should be made to prevent condensate from collecting around the outdoor units.
10. All water systems should be designed, installed and commissioned in accordance with industry good practice guidelines; such as, but not limited to: BSRIA Guide BG2/2010 - Water System Commissioning, BSRIA Guide BG29/2011 - Pre-Commissioning of Pipework Systems, BSRIA Guide. BG50/2013 - Water Treatment for Closed Heating & Cooling Systems, CIBSE Commissioning Code W - Water distribution systems, CIBSE Heat Networks: Code of Practice for the UK CP1 2015.
11. The contractor should make the necessary arrangements to ensure the design of the system meets the requirement of the application and comply with all current building regulations.
12. All electrical work must be carried out in accordance with the current version of BS7671.

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

PROJECT: Instantaneous Sanitary Hot Water with Thermal Store Application

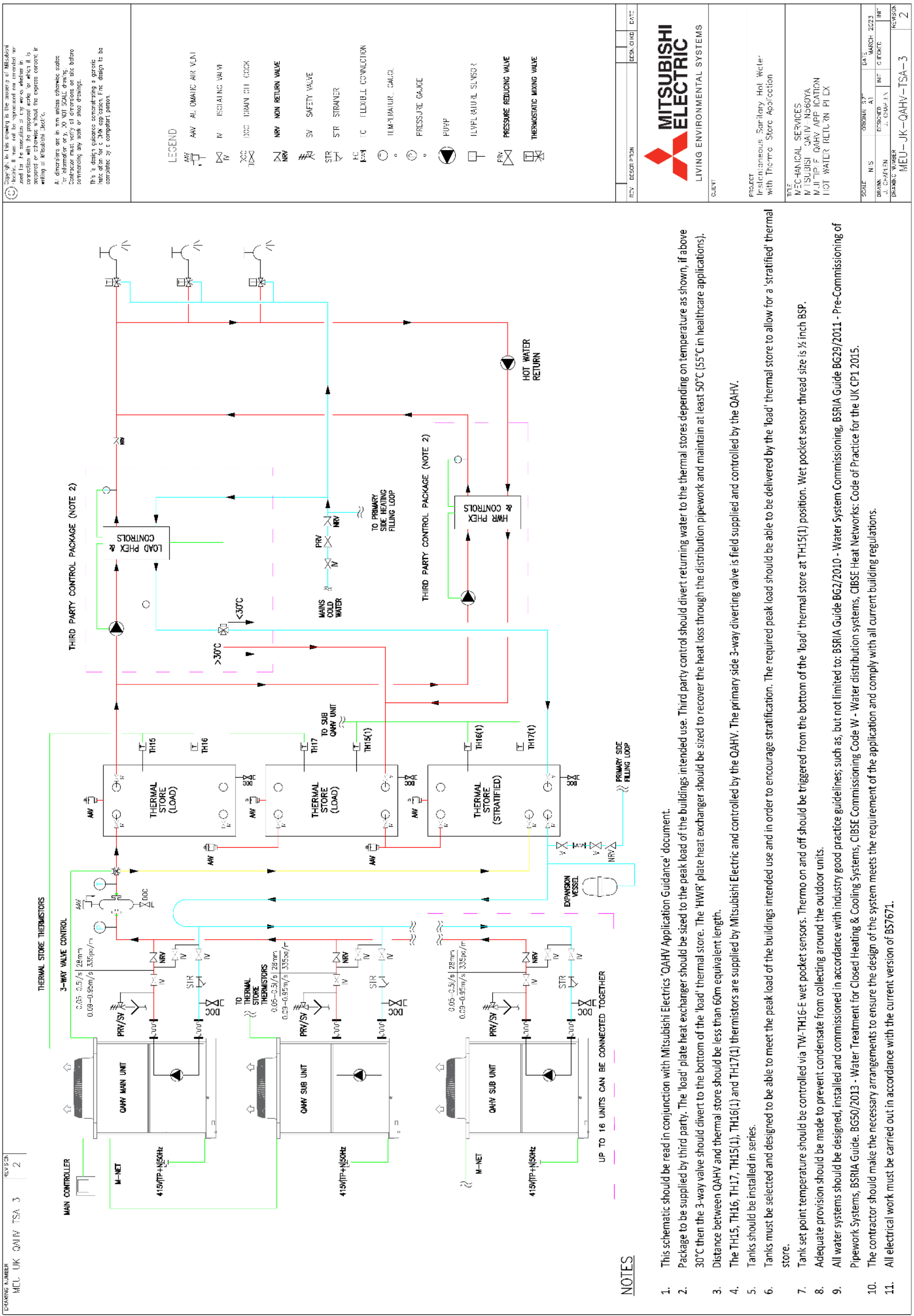
TITLE: MECHANICAL SERVICES MITSUBISHI QAHV N560YA SINGLE QAHV APPLICATION HOT WATER RETURN PHEX

SCALE: NTS | ORIGINAL SIZE: A1 | DATE: MARCH 2023

DRAWN: J. CHAPLEN | DESIGNED: J. CHAPLEN

DRAWING NUMBER: MEU-UK-QAHV-TSA-4 | REVISION: 2

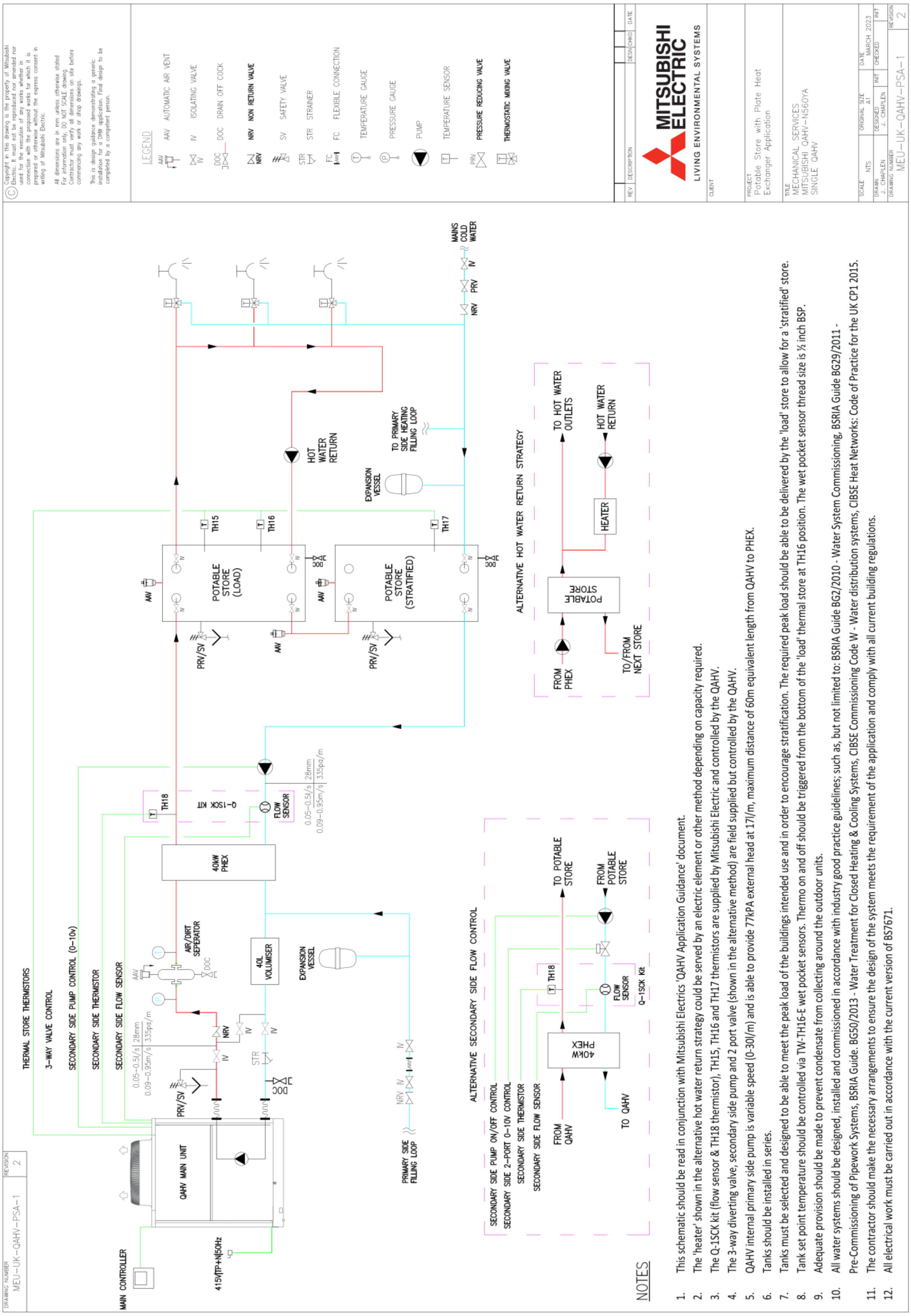
Appendix 2 – Multiple QAHV with Thermal Store and Instant PHEX



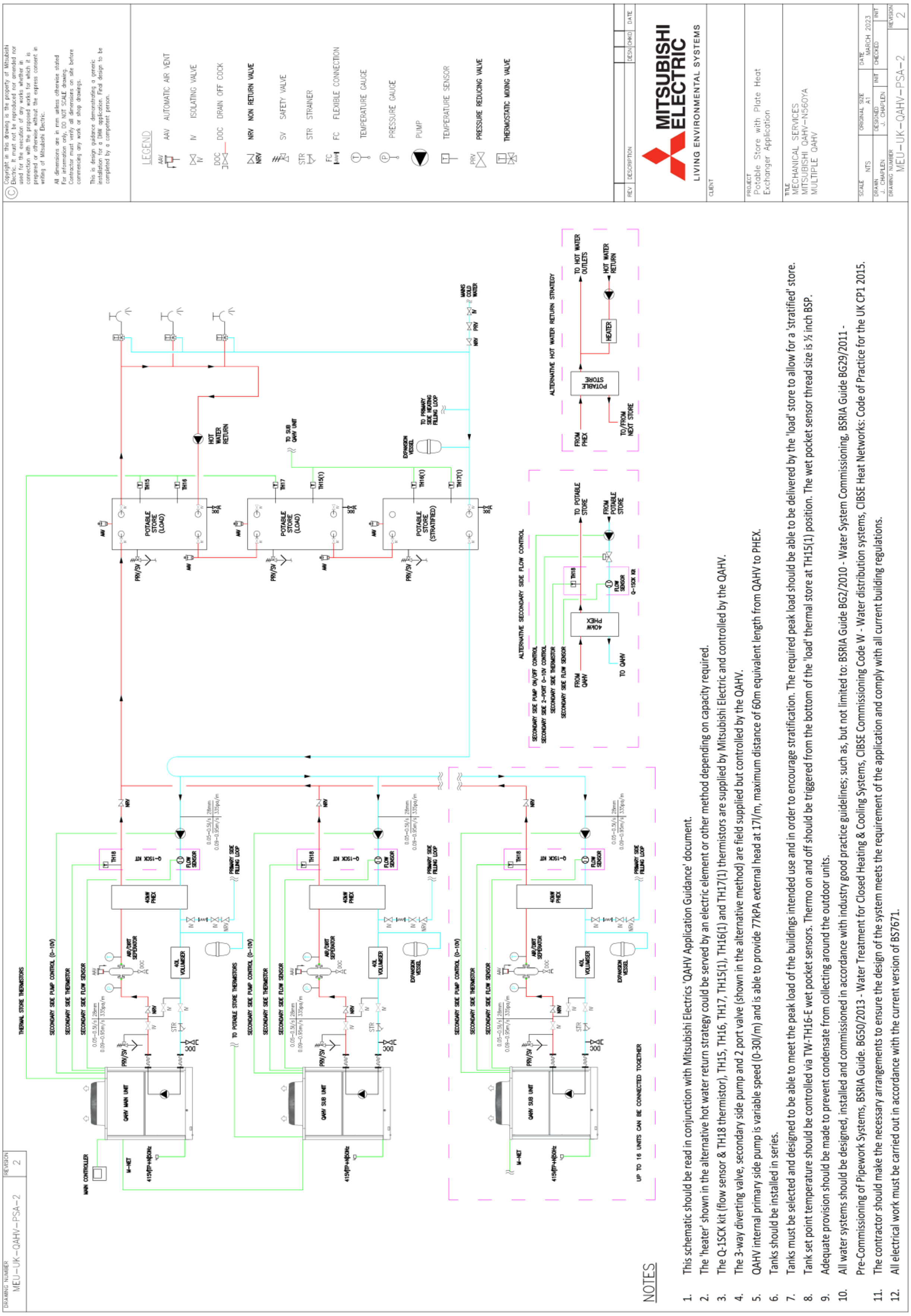
NOTES

1. This schematic should be read in conjunction with Mitsubishi Electrics 'QAHV Application Guidance' document.
2. Package to be supplied by third party. The 'load' plate heat exchanger should be sized to the peak load of the buildings intended use. Third party control should divert returning water to the thermal stores depending on temperature as shown, if above 30°C then the 3-way valve should divert to the bottom of the 'load' thermal store. The 'HWR' plate heat exchanger should be sized to recover the heat loss through the distribution pipework and maintain at least 50°C (55°C in healthcare applications).
3. Distance between QAHV and thermal store should be less than 60m equivalent length.
4. The TH15, TH16, TH17, TH15(1), TH16(1) and TH17(1) thermistors are supplied by Mitsubishi Electric and controlled by the QAHV. The primary side 3-way diverting valve is field supplied and controlled by the QAHV.
5. Tanks should be installed in series.
6. Tanks must be selected and designed to be able to meet the peak load of the buildings intended use and in order to encourage stratification. The required peak load should be able to be delivered by the 'load' thermal store to allow for a 'stratified' thermal store.
7. Tank set point temperature should be controlled via TW-TH16-E wet pocket sensors. Thermo on and off should be triggered from the bottom of the 'load' thermal store at TH15(1) position. Wet pocket sensor thread size is ½ inch BSP.
8. Adequate provision should be made to prevent condensate from collecting around the outdoor units.
9. All water systems should be designed, installed and commissioned in accordance with industry good practice guidelines; such as, but not limited to: BSRIA Guide BG2/2010 - Water System Commissioning, BSRIA Guide BG29/2011 - Pre-Commissioning of Pipework Systems, BSRIA Guide. BG50/2013 - Water Treatment for Closed Heating & Cooling Systems, CIBSE Commissioning Code W - Water distribution systems, CIBSE Heat Networks: Code of Practice for the UK CP1 2015.
10. The contractor should make the necessary arrangements to ensure the design of the system meets the requirement of the application and comply with all current building regulations.
11. All electrical work must be carried out in accordance with the current version of BS7671.

Appendix 3 - Single QAHV with Potable Store



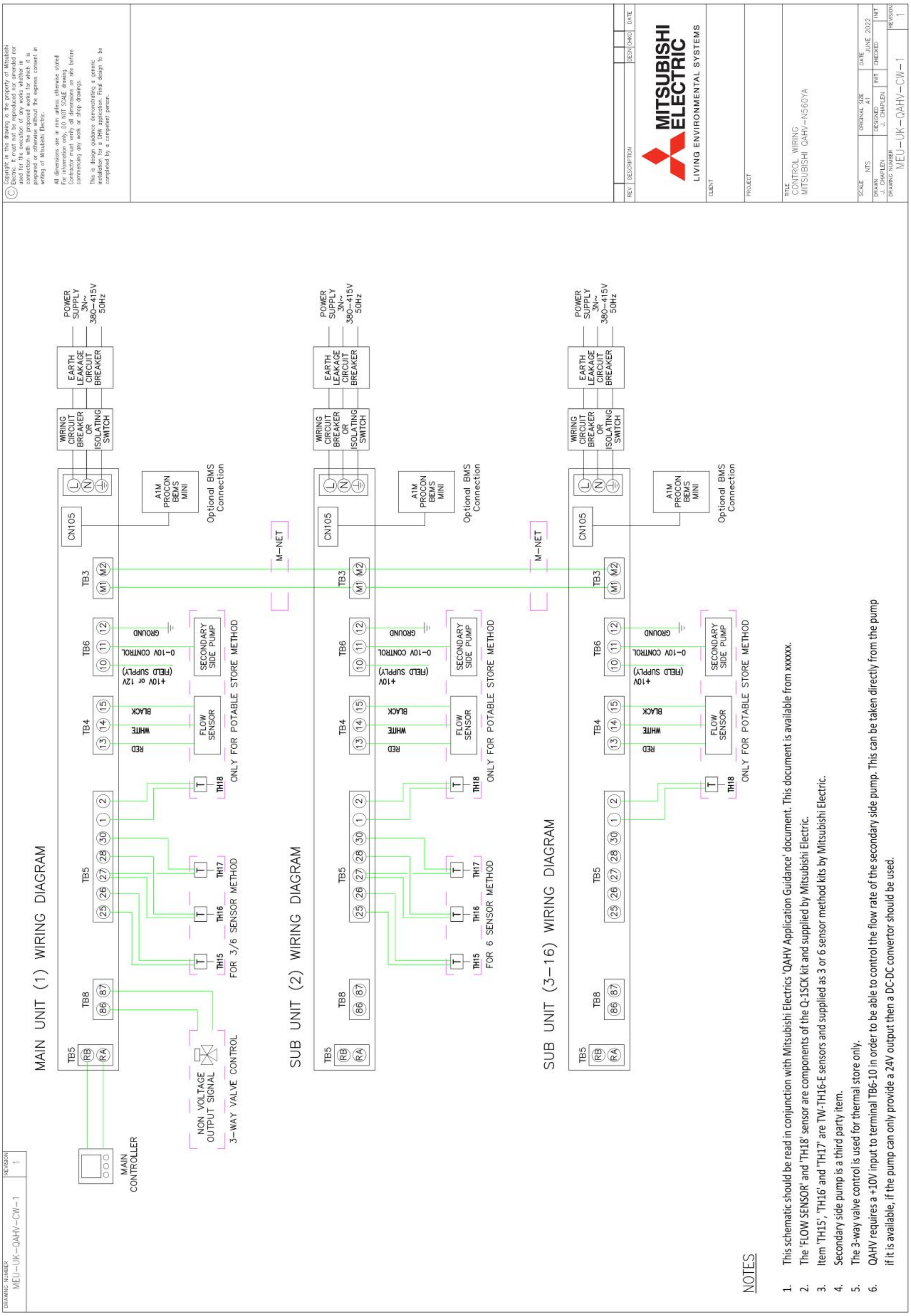
Appendix 4 – Multiple QAHV with Potable Store



NOTES

1. This schematic should be read in conjunction with Mitsubishi Electrics 'QAHV Application Guidance' document.
2. The 'heater' shown in the alternative hot water return strategy could be served by an electric element or other method depending on capacity required.
3. The Q-1SCK kit (flow sensor & TH18 thermistor), TH15, TH16, TH17, TH15(1), TH16(1) and TH17(1) thermistors are supplied by Mitsubishi Electric and controlled by the QAHV.
4. The 3-way diverting valve, secondary side pump and 2 port valve (shown in the alternative method) are field supplied but controlled by the QAHV.
5. QAHV internal primary side pump is variable speed (0-30l/m) and is able to provide 77KPA external head at 17l/m, maximum distance of 60m equivalent length from QAHV to PHEX.
6. Tanks should be installed in series.
7. Tanks must be selected and designed to be able to meet the peak load of the buildings intended use and in order to encourage stratification. The required peak load should be able to be delivered by the 'load' store to allow for a 'stratified' store.
8. Tank set point temperature should be controlled via TW-TH16-E wet pocket sensors. Thermo on and off should be triggered from the bottom of the 'load' thermal store at TH15(1) position. The wet pocket sensor thread size is ½ inch BSP.
9. Adequate provision should be made to prevent condensate from collecting around the outdoor units.
10. All water systems should be designed, installed and commissioned in accordance with industry good practice guidelines; such as, but not limited to: BSRIA Guide BG2/2010 - Water System Commissioning, BSRIA Guide BG29/2011 - Pre-Commissioning of Pipework Systems, BSRIA Guide. BG50/2013 - Water Treatment for Closed Heating & Cooling Systems, CIBSE Commissioning Code W - Water distribution systems, CIBSE Heat Networks: Code of Practice for the UK CP1 2015.
11. The contractor should make the necessary arrangements to ensure the design of the system meets the requirement of the application and comply with all current building regulations.
12. All electrical work must be carried out in accordance with the current version of BS7671.

Appendix 5 – Wiring Example



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Note: Refer to 'Installation Manual' and 'Instruction Book' for further 'Technical Information'. The fuse rating is for guidance only and please refer to the relevant databook for detailed specification. It is the responsibility of a qualified electrician/electrical engineer to select the correct cable size and fuse rating based on current regulation and site specific conditions. Mitsubishi Electric's air conditioning equipment and heat pump systems contain a fluorinated greenhouse gas, R410A (GWP:2088), R32 (GWP:675), R407C (GWP:1774), R134a (GWP:1430), R513A (GWP:631), R454B (GWP:466), R1234ze (GWP:7) or R1234yf (GWP:4). *These GWP values are based on Regulation (EU) No 517/2014 from IPCC 4th edition. In case of Regulation (EU) No.626/2011 from IPCC 3rd edition, these are as follows. R410A (GWP:1975), R32 (GWP:550), R407C (GWP:1650) or R134a (GWP:1300).