Contents

Project name: Oxford House
Quote Reference: QUO-0101-276729/0
Prepared by: S Rushton

Water Usage

Storage Size	Litres	2000
Re-heat time	Minutes	116.3

QAHV Heat Pumps

Number of QAHV units		2
External Ambient Design Condition	°C	-2
Peak capacity at design condition	kW	36.1

Required Accessories

Number of cylinders	Units	4
Number of secondary pumps and Q-1SCK kits	Kits	2
Number of field supply PHEXs	Units	2
Number of TW-TH16-E x 3 sensor kits	Kits	2

SCOP

Area	London
SCOP	3.94

Assumptions

Selection based on IOP guidance with water stored at 65°C and with a 70°C flow temperature from the heat-pump.

33% has been added to the stored volume to account for losses.

SCOP calculated from temperature data from CIBSE guide J tables 4.9, 4.11 and 4.12, and assumes a constant 17°C cold water inlet temp.

The estimated daily delivered kWh has been calculated using the stored water demand shown on page 2, and assumes that this will be heated 3 times a day.

Daily Delivered kWh	**420**

QAHV energy input calculated from QAHV $SCOP_{DHW}$.
Boiler energy input is calculated from the boiler efficiency.

QAHV kWh Input	**107**
Gas Boiler kWh Input (η97%)	**433**

Using grid emmision factors from HM Greenbook*, the 15 year estimated carbon emissions are displayed in Figure 6. See table 1 and 2a of link:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002889/data-tables-1-19.xlsx

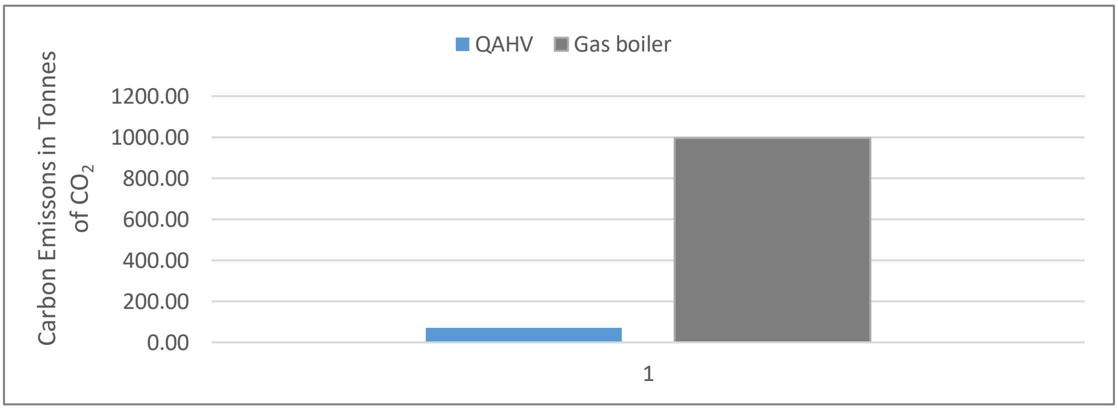
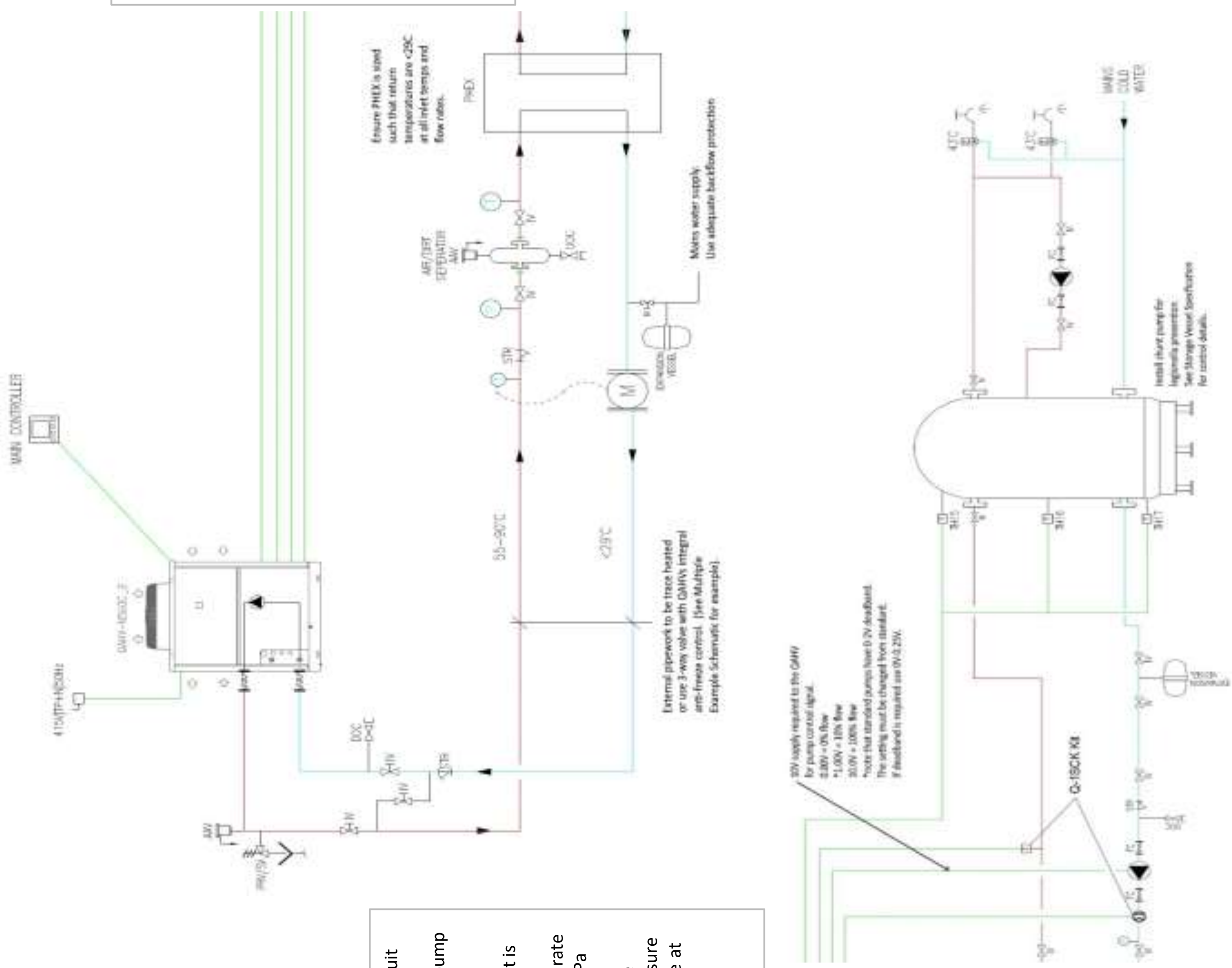


Figure 6 - Estimated 15 Year Carbon Emissions

This calculation demonstrates an estimated 15 year carbon saving of:

Carbon Saving	**93%**

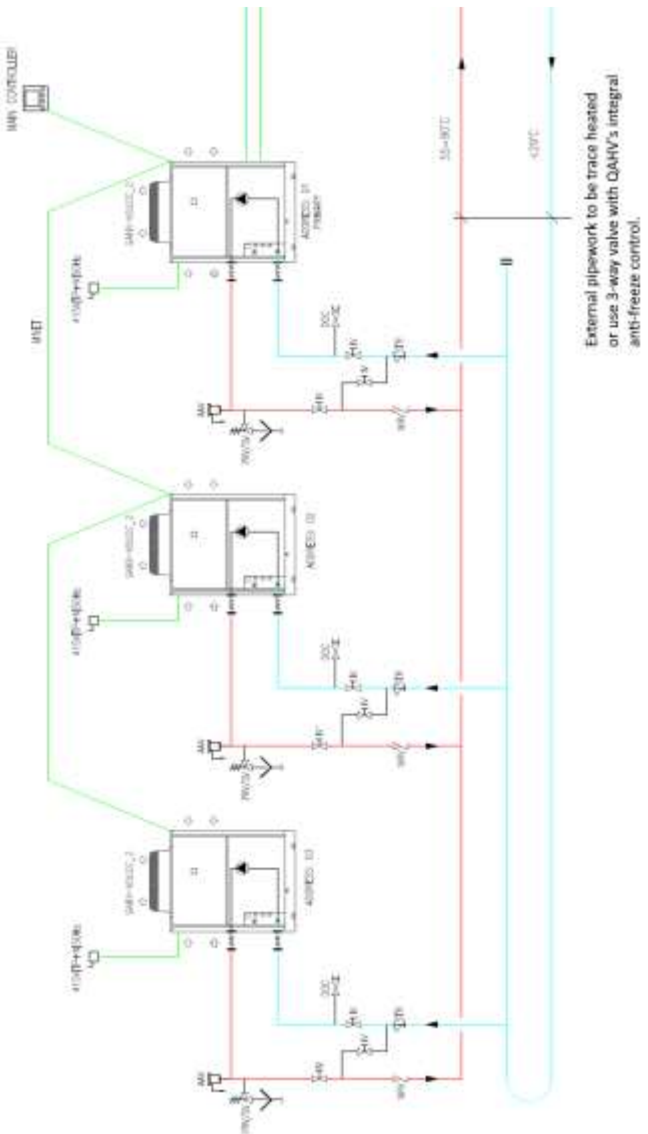
This is an example schematic containing multiple field supply items. Design to be completed by a competent person.

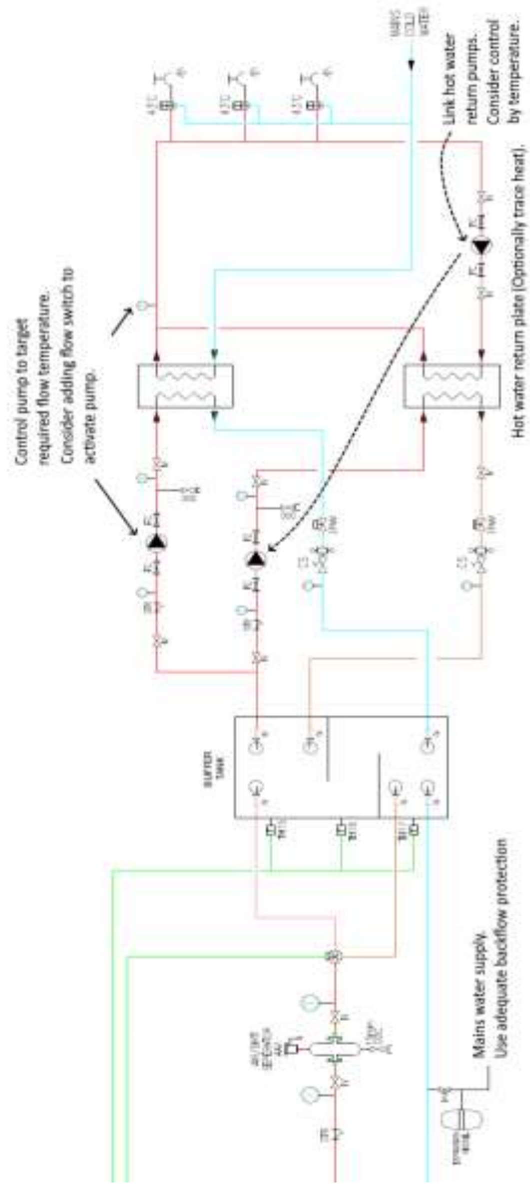


- Minimum primary water circuit volume is 40 litres.
- Water pressure at the heat-pump must be < 5 bar.
- Maximum flow velocity in primary and secondary circuit is 30 l/m.
- Nominal primary circuit flow rate is 17 l/s and can achieve 77kPa head at this flow rate.
- Size primary system pressure drop at 77kPa and 17 l/s. Ensure pipe velocities are acceptable at 30 l/m.
- Maximum distance between

This is an example schematic containing multiple field supply items. Design to be completed by a competent person.

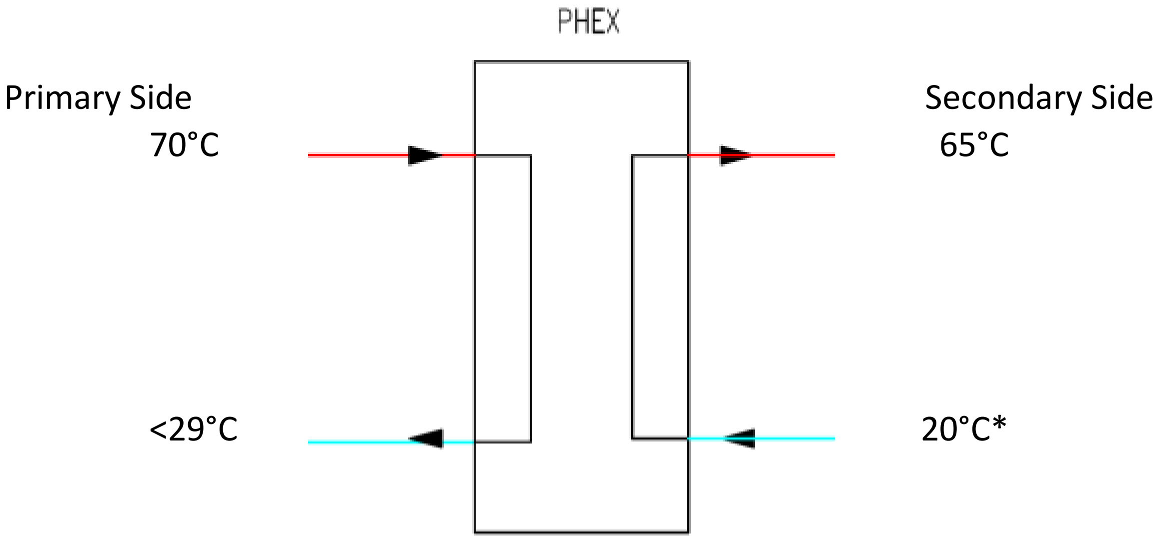
Note that the field supply plates heat exchangers and pumps in this example are NOT controlled by the QAHV or other ME equipment.





- Minimum primary water circuit volume is 40 litres.
- Water pressure at the heat-pump must be < 5 bar.
- Maximum flow velocity in each QAHV circuit is 30 l/m.
- EACH QAHV nominal flow rate is 17 l/s and can achieve 77kPa head at this flow rate.
- Size each QAHV primary system pressure drop at 77kPa and 17 l/s.
- Ensure each QAHV circuit velocities are acceptable at 30 l/m.
- Maximum distance between QAHV unit and buffer to be 60m.

The PHEX's are a field supplied item and need to be selected according to the following information. Consult the data-book for more details.
For DHW use WRAS approved plate heat exchangers are recommended.



1. Heat exchanger capacity must be sized to provide 40kW of capacity.
2. Select a heat exchanger of which the temperature difference between the primary and secondary flows and returns will be 5°C or below. E.g. 70C/65C and 20C/25C.
3. Ensure that the pressure rating of the heat exchanger is suitable for the application. Pay particular attention to the plate location and the height of the building.
4. The maximum nominal flow rate of the heat-pump is 17 l/m. However, select a heat exchanger that can operate at up to 30 l/m.
5. Ensure that the shearing stress at the flow rate to be used will be 16 Pa or more in order to reduce scaling.

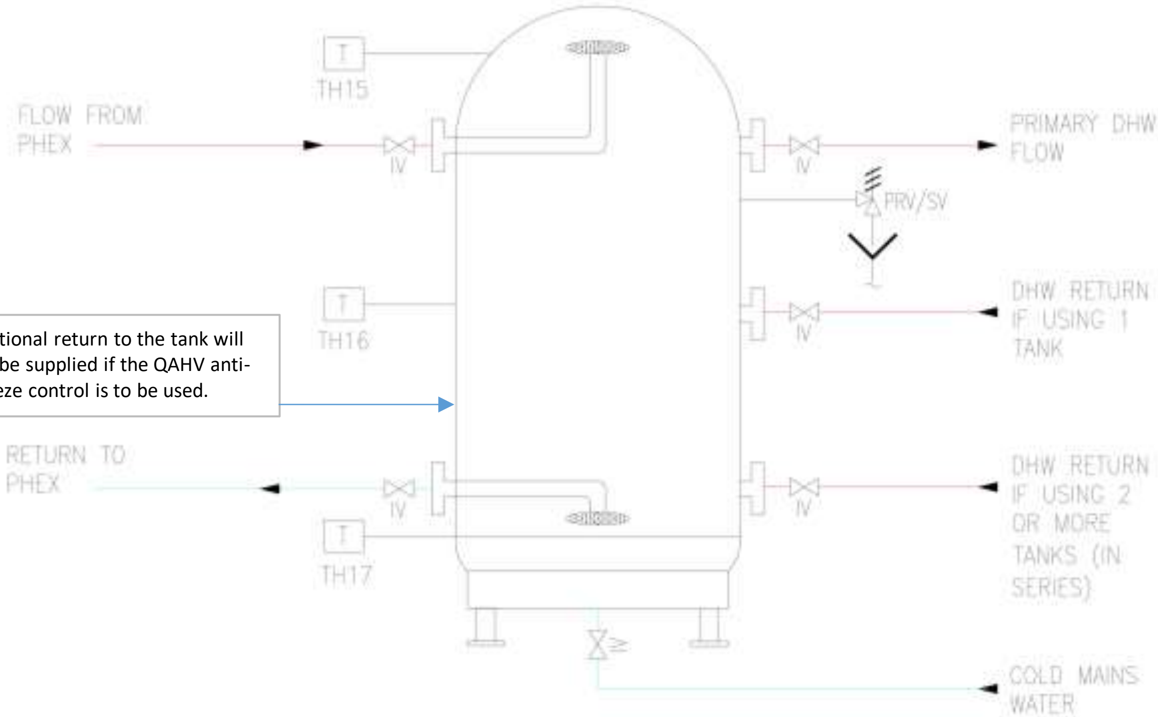
Calculate the shearing stress using the following formula.

$$\tau = \frac{\Delta P}{4} * \frac{\text{Representative length of 1 channel}}{\text{Effective length}}$$

*6. Select a plate heat exchanger that will return <29C to the heat-pump under all cold water inlet conditions to maintain efficiency. Lower return temperatures will provide efficiency gains. Return temperatures >29C will result in capacity reductions.

Storage vessels are a field supplied product and should be specified with the following features: A height to width ratio of 3:1, low velocity diffusers installed on the flow and return from the QAHV to the vessel, wet pockets for sensors TH15, TH16 and TH17 of size 1/2 inch BSP. Tank design must be optimised to encourage statification in order to lower the return temperature to the QAHV which will improve efficiency.

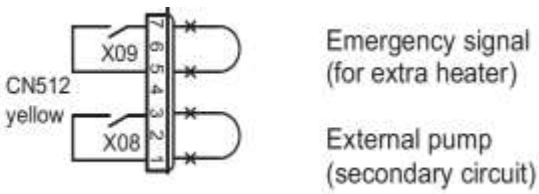
An additional return to the tank will need to be supplied if the QAHV anti-freeze control is to be used.



If a cylinder is used for DHW stored water legionella protection can be achieved by:

a) Daily heating the cylinder above 60C by setting the QAHV to heat until TH17 has reached 60C.

b) A shunt pump between the primary DHW flow and cold mains water inlet that is set to operate after the QAHV heating cycle has completed.



Pins 1 and 3 of CN512 are closed (VFC) when the secondary pump is operating. After pump operation has finished the contact will open. This closed to open condition can be used as a 'QAHV heating end' signal to start the shunt

Note: Indirect buffer vessels have no need for legionella control.

Sanitary hot water services are provided by the use of the high temperature QAHV CO_2 heat pump. The QAHV unit(s) supply hot water to*:

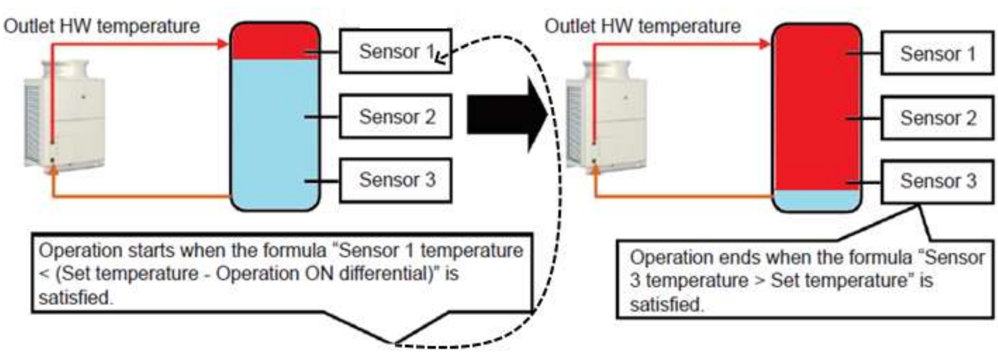
a) Direct hot water cylinders with the QAHV hydraulically separated by a plate heat exchanger. (See single QAHV schematic for example).

b) Indirect buffer vessels which supply DHW via a plate heat exchanger. (See multiple example schematic).

Cold mains water/DHW return is fed into the bottom of the storage vessel whilst hot water is drawn from the top of the tank. Cold water is drawn from the bottom of the tank to the QAHV system by the QAHVs own integral pump. The water is heated in the QAHV and returned to the top of the cylinder. Optionally, the QAHV and tank can be hydraulically separated by a plate heat exchanger, flow sensor, temperature sensor and pump package.

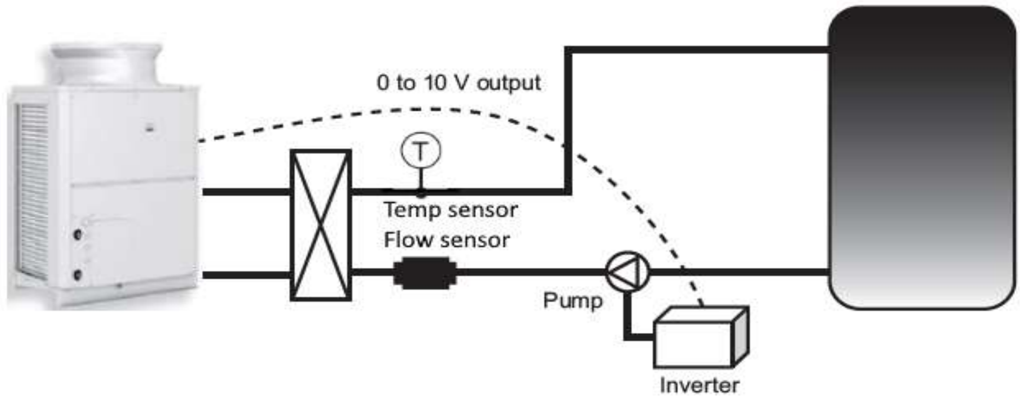
The integrated primary side water pump in the QAHV is capable of achieving a head of 77kPa at 17l/m. The QAHV should be placed no more than 60m from the tank, or from the optional plate HEX system. The primary circuit requires a minimum volume of 40 litres .

The temperature in the tank is monitored and controlled using the supplied TW-TH16-E wet pocket sensors. The QAHV will heat the tank until the pre-specified TW-TH16-E 'OFF' sensor has reached it's set-point, for example 65C. The QAHV will remain off (called 'thermo-off' mode) until the pre-specified 'ON' sensor reads less than setpoint temperature minus the differential temperature. For example, where the differential is 10K and the set-point temperature is 65C, heating will restart when the pre-defined 'ON' sensor has reached 55C.

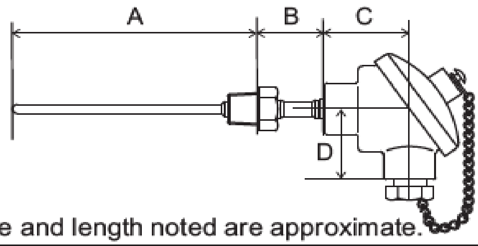


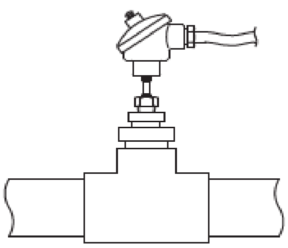
*Consult MEUK for other configurations.

The secondary side describes the system where a plate heat-exchanger is used to hydraulically separate the QAHV unit and the hot water tank. The temperature sensor and flow sensor are supplied by Mitsubishi as a Q-1SCK secondary circuit kit. Please ensure this kit has been requested if the system is to by hydraulically separated in this way.



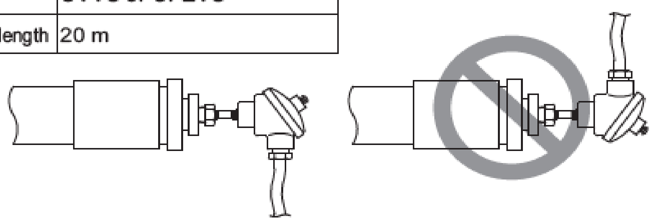
External water temperature sensor TW-TH16-E

Shape	Specification
 * The size and length noted are approximate.	A: 157 mm B: 42 mm C: 54 mm D: 48 mm



Wiring specifications

Size	2-core cable (Min.1.25 mm²)
Type	CVVS or CPEVS
Maximum length	20 m



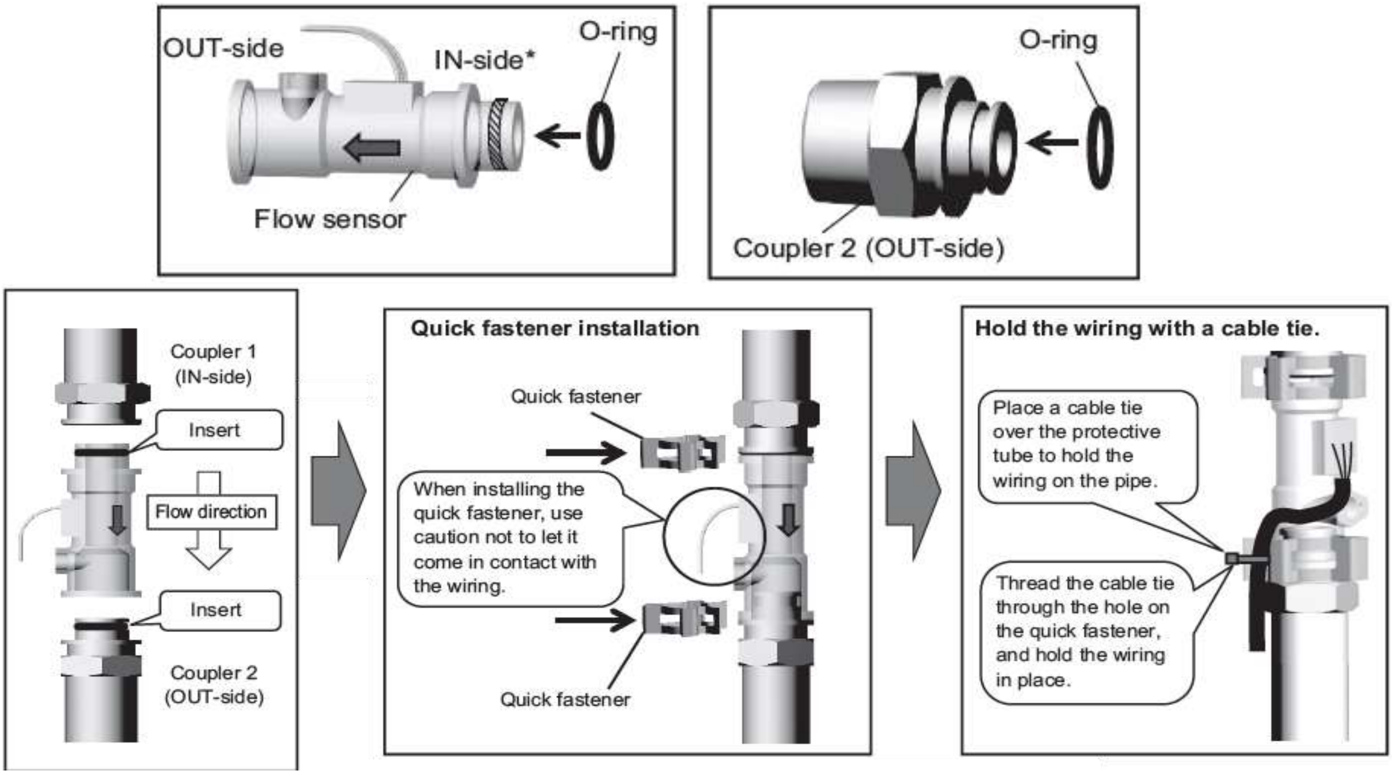
Vertical installation

Horizontal installation

The thread for the temperature sensor connection is 1/2 inch BSP.

Install the flow sensor vertically with flow going from top to bottom.

(1) Install an O-ring on the flow sensor and coupler 2 (OUT-side).



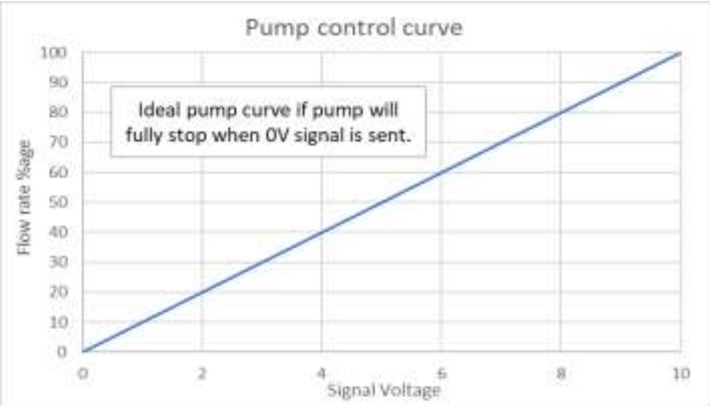
The coupler thread size is 3/4 inch BSP.

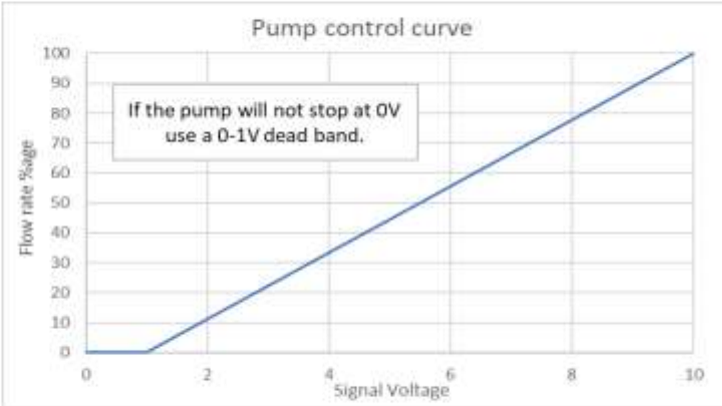
The secondary side pump (field supplied) is controlled by the QAHV 0-10V output to match flow rates across the primary and secondary side. Adjusting the pump output on the secondary side maintains the target outlet hot water temperature and prevents acute rising of water inlet temperature to the QAHV.

For the secondary side pump to operate, +10V must be supplied to Terminal 10 of TB6. A 0-10V control signal is sent from the QAHV to the pump via terminal 11 of TB6. Refer to wiring page for wiring examples.

External pipe work must be trace heated.

The secondary side pump curve should be set-up to control in the following manner.*



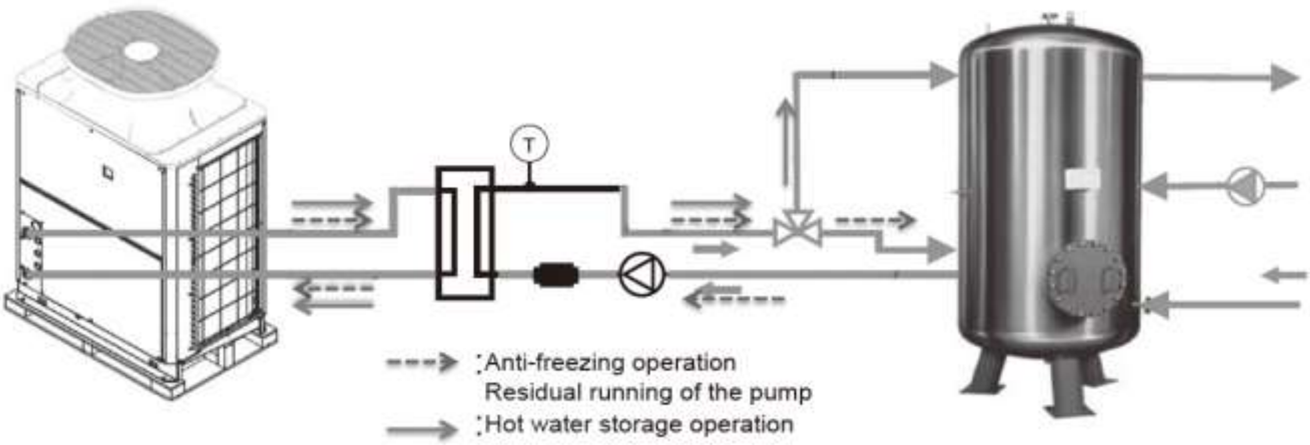


*Most pumps will have a 0-2V deadband 'out of the box.' This will require changing as per the curve above.

During commissioning, the QAHV will send a 6% signal (1.12V) to the secondary side pump. If the flow sensor does not detect a change in flow rate, the QAHV will display a 2601 error (water supply cut-off).

100%, 10V, should be set to between 20 - 30 litres per minute flow rate.

Currently, glycol is not allowed to be used in the QAHV primary circuits. Therefore, heating of the external pipe-work in necessary. This can be achieve by trace heating, or using the QAHVs internal anti-freeze control. The QAHV's anti-freeze control is the preferred method, as it ensures that the QAHV's internal components are also protected.

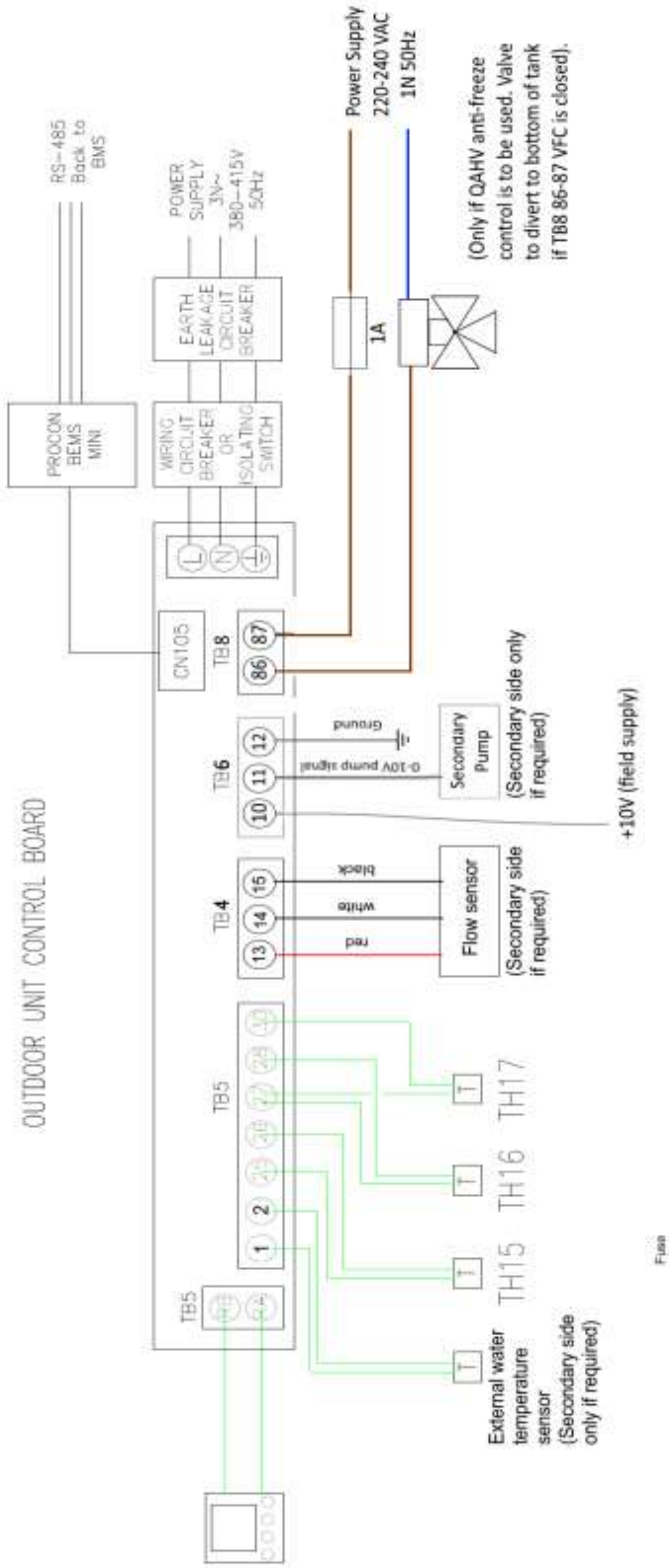


The figure above shows an indirect system, but can be used with a secondary side.

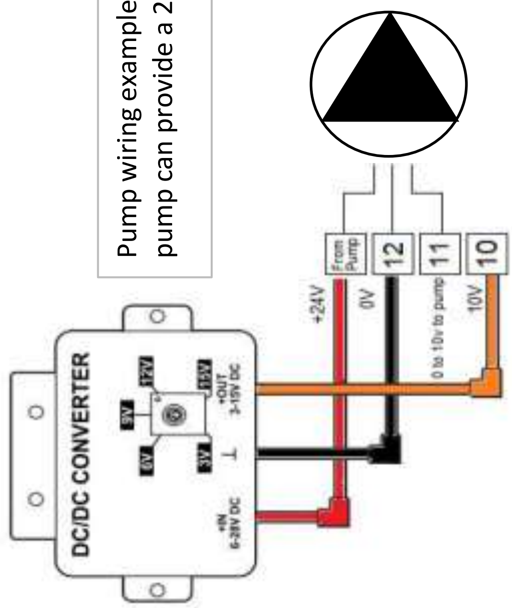
<u>Anti-freeze control operates when the following conditions occur:</u>
Pump runs when: Outdoor temp. 1°C and Inlet water temp. 3°C
(The pump will run for at least 3 minutes.)
Pump turns OFF when: Outdoor temp. 3°C or Inlet water temp. 5°C.

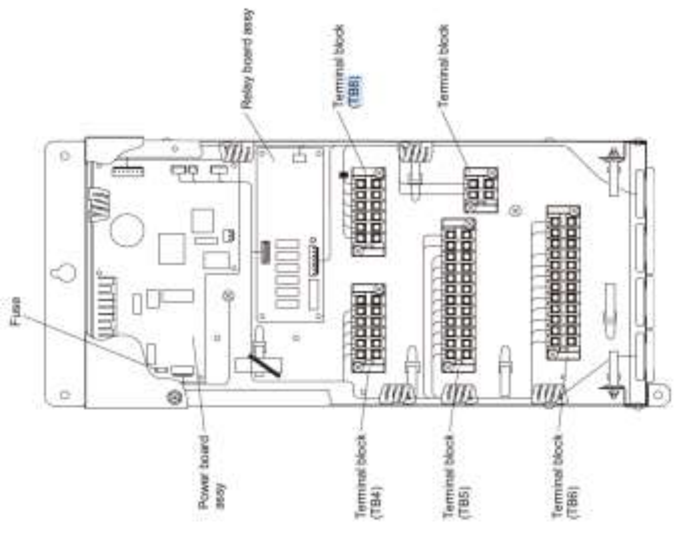
When anti-freeze control operates, a volt free contact from TB8 terminals 86 and 87 of the QAHV closes. This volt free contact is to be used to operate the 3-way valve and direct the cooled water residual in the pipe-work back to the bottom of the cylinder.

Use a three way valve operating at 220-240VAC, greater than 10mA and less than 1A operating current. Refer to 'Wiring' page for wiring information.



Pump wiring example where pump can provide a 24C DC

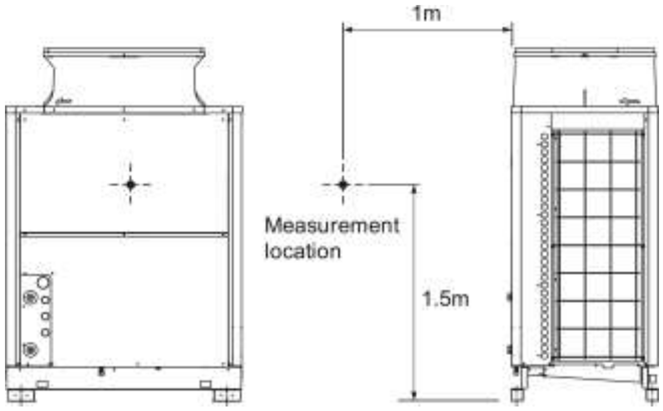


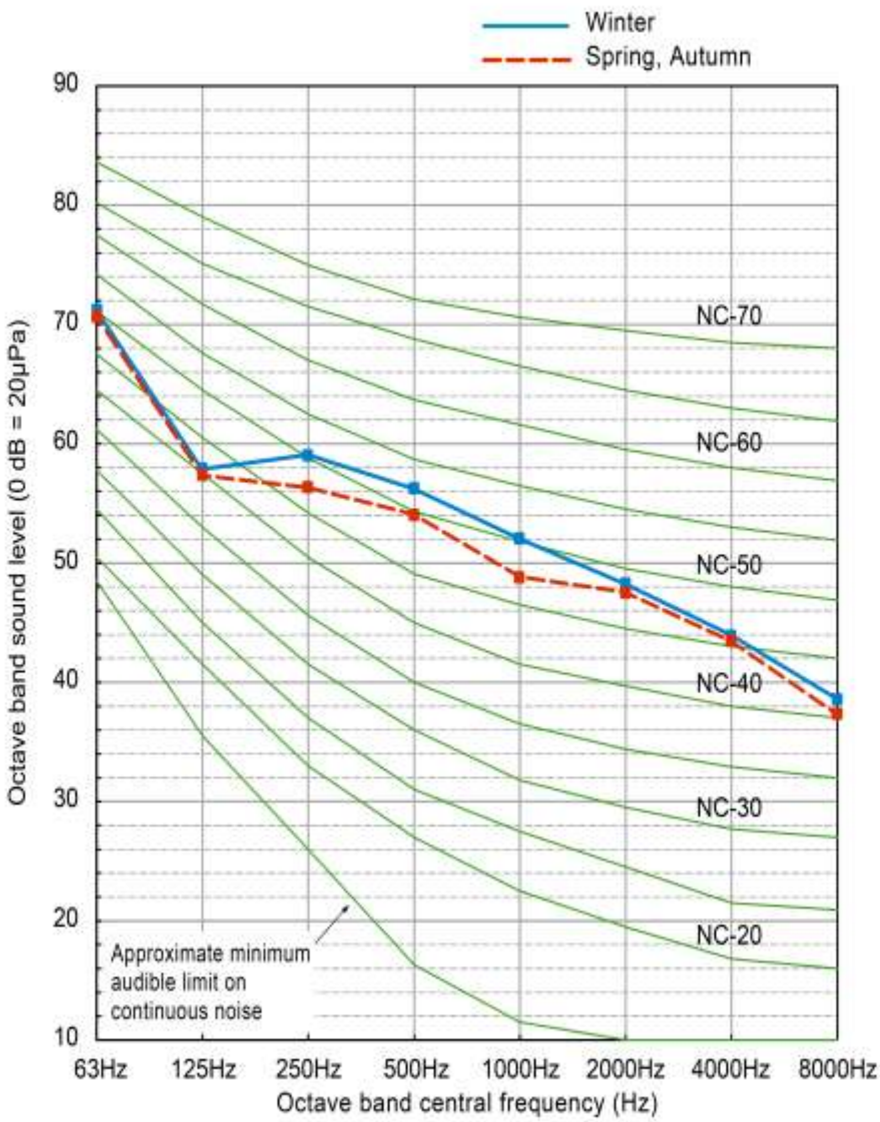


In order to ensure the normal operation, use water that conforms to the quality standards shown in the table below for water supply into the QAHV. When the circulating water quality is poor, the water side HEX can develop scale and corrosion can occur. Consider water treatment if necessary.

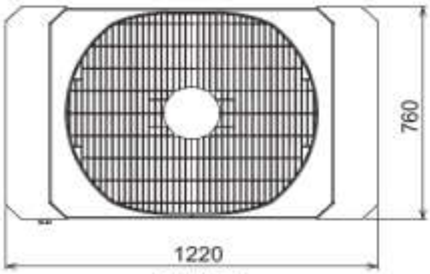
Items			Higher mid-range temperature water system Water Temp. > 60°C	Make-up water criteria (with secondary side control enabled) Water Temp. > 60°C	Tendency	
			Recirculating water	Recirculating water	Corrosive	Scale-forming
Standard items	pH (25°C)		6.5 ~ 8.0	6.5 ~ 8.0	○	○
	Electric conductivity	(mS/m) (25°C) (μs/cm) (25°C)	30 or less [300 or less]	30 or less [300 or less]	○	○
	Chloride ion	(mg Cl⁻/ℓ)	30 or less	30 or less	○	
	Sulfate ion	(mg SO_4^{2-}/ℓ)	30 or less	30 or less	○	
	Acid consumption (pH4.8)	(mg $CaCO_3$/ℓ)	50 or less	50 or less		○
	Calcium hardness	(mg $CaCO_3$/ℓ)	6.5 ≤ pH ≤ 7.5: 90 or less 7.5 ≤ pH ≤ 8.0: 50 or less	250 or less		○
	Ionic silica	(mg SiO_2/ℓ)	30 or less	30 or less		○
Reference items	Iron	(mg Fe/ℓ)	0.3 or less	0.3 or less	○	○
	Copper	(mg Cu/ℓ)	0.1 or less	0.1 or less	○	
	Sulfide ion	(mg S^{2-}/ℓ)	Not to be detected	Not to be detected	○	
	Ammonium ion	(mg NH_4^+/ℓ)	0.1 or less	0.1 or less	○	
	Residual chlorine	(mg Cl/ℓ)	0.1 or less	0.1 or less	○	
	Free carbon dioxide	(mg CO_2/ℓ)	10.0 or less	10.0 or less	○	

Reference: Guideline of Water Quality for Refrigeration and Air Conditioning Equipment. (JRA GL02E-1994)

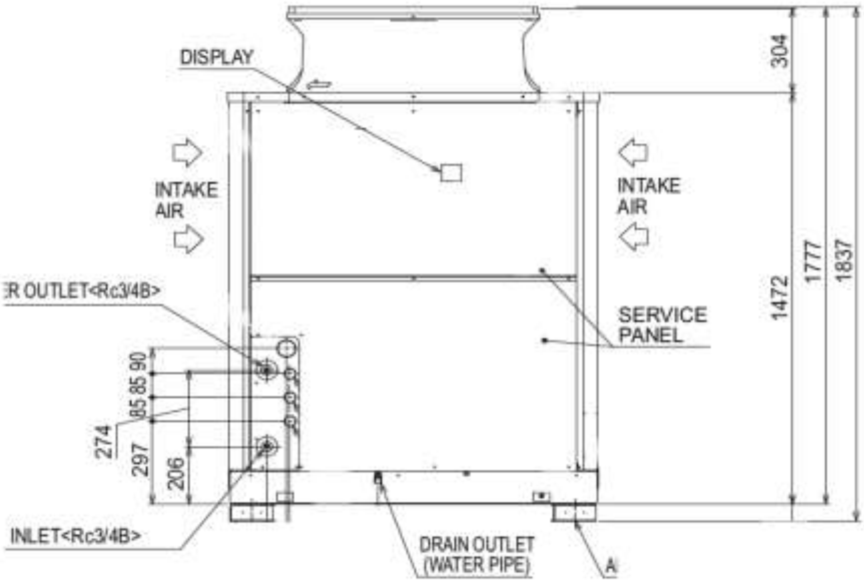

1m
Measurement location
1.5m


Winter
Spring, Autumn
90
80
70
60
50
40
30
20
10
Octave band sound level (0 dB = 20µPa)
NC-70
NC-60
NC-50
NC-40
NC-30
NC-20
Approximate minimum audible limit on continuous noise
63Hz
125Hz
250Hz
500Hz
1000Hz
2000Hz
4000Hz
8000Hz
Octave band central frequency (Hz)

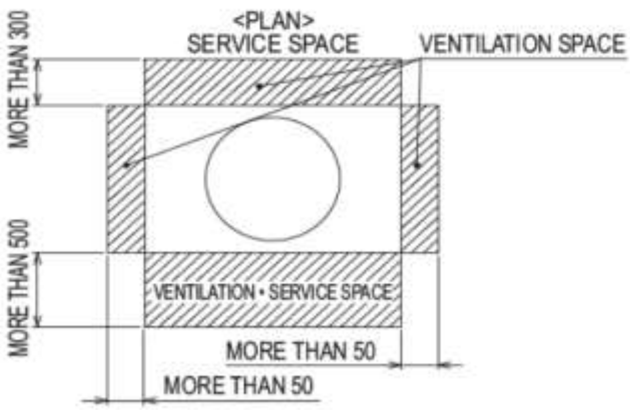
OUTDOOR UNIT		QAHV-N560YA-HPB
WATER HEATING 65ºC [*1]	CAPACITY (kW)	40
	POWER INPUT (kW)	10.31
	CURRENT INPUT (A)	16.3
	COP	3.88
WATER HEATING 65ºC [*2]	CAPACITY (kW)	40
	POWER INPUT (kW)	10.97
	CURRENT INPUT (A)	18.3
	COP	3.65
WATER HEATING 65ºC [*3]	CAPACITY (kW)	40
	POWER INPUT (kW)	11.6
	CURRENT INPUT (A)	18.7
	COP	3.44
WATER HEATING ENERGY EFFICIENCY CLASS	FOR MEDIUM TEMPERATURE APPLICATION	A
TEMPERATURE RANGE	INLET WATER TEMPERATURE (ºC)	5 ~ 63
	OUTLET WATER TEMPERATURE (ºC)	55 ~ 90
	OUTDOOR TEMPERATURE (ºC)	-25~43
ELECTRICAL	MAX CURRENT INPUT (A)	33.8
	ELECTRICAL SUPPLY (V / Hz)	380-415v, 50Hz
	PHASE	3
	FUSE RATING - MCB SIZES (A)[*5]	40
WATER DETAIL	INLET / OUTLET (mm (in.))	19.05 (Rc 3/4"), screw pipe / 19.05 (Rc 3/4"), screw pipe
	ALLOWABLE EXTERNAL PUMP HEAD (kPa)	77
DIMENSIONS (mm)	WIDTH	1220
	DEPTH	760
	HEIGHT	1837 (1777 without legs)
WEIGHT (kg)		400
NOISE LEVEL	SOUND PRESSURE [*4] (dB(A))	56
REFRIGERANT	TYPE	R744 (GWP 1)
	REFRIGERANT CHARGE (kg) / CO_2 EQUIVALENT (t)	6.5 / 0.0065



TOP VIEW



FRONT VIEW



Refer to data-book for ventilation/service space requirements for multiple units.

Hot water services shall be provided by the Mitsubishi Electric QAHV CO_2 air source heat pump.

The outdoor unit will be constructed from steel plate and painted with acrylic paint Munsell 5Y 8/1 and is a packaged type inverter driven air to water heat pump capable of delivering an integrated (with defrost) capacity of 40kW at 3°CDB ambient temperature.

The single unit heat pump is made up of a single invertor scroll compressor and hermetically sealed refrigerant circuit utilising CO_2 (R744). The exchange of heat from refrigerant to water is made through a twisted and spiral gas cooler, the gas cooler uses 3 refrigerant pipes that are wound around the twisted water pipe which maximises heat transfer.

Water outlet temperatures shall be between 55°C and 90°C and the unit is capable of working between ambient temperatures of -25°CDB and +43°CDB. Water inlet temperatures should be maintained below 29°C to ensure the required capacity is achieved.

The unit should use a flash injection circuit technology to improve low ambient compressor performance and ensure stable and efficient outlet water temperatures.

The unit should be supplied with an integrated primary side water pump which is capable of achieving an external head of 77kPa at 17l/m. Where a plate heat exchanger is used to hydraulically separate the primary and secondary circuits, the unit should be able to control the secondary circuit pump via a 0-10V control signal, thereby controlling the secondary pump flow rate by 0 – 30 l/m.

The unit should not exceed a sound pressure level of 56 dB(A) when measured at a distance of 1 metre from the front of the unit in an anechoic chamber.

The unit should be capable of controlling flow temperature based on a non-voltage input from an external source (BEMS) or by monitoring the temperature in the tank at up to 6 locations using wet pocket temperature sensors. The unit is able to be turned on or off by any of the sensor positions depending on commissioning set up.

Multiple units can be connected together by a shielded 2 core cable and controlled using the inbuilt supplied control logic. Up to 16 units can be piped together delivering up to 640kW at 3°CDB.

A minimum circuit volume of 40 litres per unit is required and all pipe work should be installed in accordance with related BS regulations. The units' control logic should be able to perform an anti-freezing function to ensure external pipework does not freeze, the control logic should circulate the primary circuit water flow when outdoor temperature is less than 1°CDB and water temperature is less than 3°C.

Each outdoor unit module will require a 415V AC 3 phase & neutral mains supply.

The contractor should notify Mitsubishi Electric (Site visits coordinator) at least 14 days prior to the installation being completed so that a Mitsubishi Electric engineer can be scheduled for commissioning.