2020

Technical Specification

Hot water storage vessels for Domestic Purposes for use with

Heat Pumps.

hot water association

DEVELOPING HOT WATER

HOT WATER ASSOCIATION SPECIFICATION

HWA 002:2020

Hot water storage vessels for Domestic Purposes for use with Heat Pumps.

Specification of particular requirements, test methods and labelling for hot water storage vessels designed primarily for indirect water heating using heat pumps.

Version 3: May 2020

Foreword

This publication has been prepared by industry experts as a major revision of the original HWA 002:2015 specification to cover the requirements for hot water storage vessels to be heated primarily by heat pumps.
This is a generic specification to be used alongside the constructional requirements of existing standards and specifications as listed below in Table 1 but where the typical 80^{o}C flow at 0.25 l/s primary flow conditions provided by fossil fuelled boilers are not appropriate. The specification provides several alternative test regimes.

1 Scope

This specification covers the additional design requirements test procedures and labelling requirements for hot water storage vessels designed for indirect heating by a heat pump.
The indirect heating may be by means of an internal coil, external heat exchanger or external water jacket.
In many instances an additional heat exchanger for use with a traditional boiler may also be included in which case the heat exchanger heated by the "boiler" will be assessed and labelled under the conditions stated in the relevant standards listed below.

Table 1 Reference Standards

Constructional Standard Reference	Description
BSEN 12897:2016+A1:2020	Indirectly heated unvented cylinders
BS 1566:2002+A1:2011	Vented copper cylinders
HWA 001:2012	Vented stainless steel cylinders
BS 3198:1981	Copper combination units

2 Terms and Definitions

For the purposes of this specification, the following terms and definitions apply.

2.1 cylinder
Vessel for the heating and storage of hot water, whilst the majority of vessels are cylindrical, for the purposes of this standard this definition will also apply to non-cylindrical vessels.

2.2 rated storage capacity (Gross capacity)
Total volume of water, in litres, that can be stored in the cylinder including the volume of water in the internal primary heaters, external water jacket or any external heat exchanger if supplied as part of the cylinder package.

2.3 actual storage capacity (net capacity)
Total volume of secondary water, in litres, that can be stored in the cylinder. excluding the primary water in cylinders with internal indirect heat exchangers.

2.4 hot water capacity
Maximum volume of water that can be heated by the heat sources as measured in Annex A
Where more than one heat exchanger is fitted then the hot water capacity relevant to each heat exchanger shall be required.

2.5 model range
cylinders which share the same common diameter, heat exchanger design and general overall configuration.

2.6 primary heater
heat exchanger/s for the transfer of heat from the primary water to the stored water.

2.7 primary water
water circulating through the primary heater.

2.9 reheat performance from heat exchangers
primary heater performance measured in Kilowatts.

3 Nominal storage capacity (Gross)

The nominal storage capacity of all cylinders shall be measured in accordance with A.3.1.1

4 Net storage capacity

The net storage capacity of all cylinders shall be measured in accordance with A.3.1.2

5 Heat exchanger hydraulic flow resistance test

The flow resistance of the heat exchanger shall be measured in accordance with A.7

6 Immersion Heaters

The provision of one or more immersion heaters or immersed electric elements is normally required. The purpose of these elements can be either for heating up water for normal use to a temperature above that achieved by the heat pump or to provide a temperature sufficient to sterilise the cylinder against the colonisation of legionella on a periodic basis.
All immersion heaters shall, in addition to the normal temperature control have a non self resetting cut out to comply with building regulation G3.
The position and specification of the immersion heaters shall be clearly indicated on the manufacturers technical information details are provided in Annex C.

7 Thermostat pockets

The manufacturer may supply the cylinder with one or more thermostat pockets. In many instances the design and position of these will be determined by the specifier or purchaser and in all cases their position and specification should be clearly indicated on the manufacturers technical information, details provided in Annex C

8 Testing of heat exchanger performance

For each model range heat exchangers provided for the purposes of indirect heating by means of a heat pump shall be tested by means of one or more of the following test regimes.
These tests provide a means of assessing the heat exchange performance and the amount of hot water produced by means of indirect heat exchange.

8.1 Generic HWA conditions (Class 1 Cylinders)

This provides a simple method of assessing the likely comparative heat exchanger performance of cylinders that are non-specific to a particular heat pump or control regime.
The test regime is detailed in Annex A.

For testing under HWA generic conditions the following parameters apply in Annex A.

Primary flow rate	F_{pri} = 0.42 l/s (25 l/minute)
Primary flow temperature	T_{pri} = 55°C
Cylinder maximum target temperature	T_{cyl} = 50 °C
Cylinder starting temperature	T_{start} = 10°C

8.2 Other specified but constant primary flow conditions (Class 2A Cylinders)

This allows for testing with constant primary flow conditions different from those specified in 8.1.
For testing to this regime the values of F_{pri} and T_{pri} must be clearly labelled on the cylinder and stated in the manufacturers technical documentation T_{start} shall remain at 10°C

8.3 Other specified but two constant primary flow, primary flow conditions with step change. (Class 2B Cylinders)

In some instances, the control regime chosen by the specifier/purchaser may require a step change in primary flow conditions once certain temperatures are reached. In these instances, an intermediate value of T2 may be changed and the cylinder is heated to this intermediate temperature by means of procedure 8.2. The test can then continue with the new primary flow and temperature conditions with T_{start} now taking the value of the new starting temperature and heating to a new T2 target temperature.
For testing to this regime the values of F_{pri} and Tpri must be clearly labelled for both phases of the reheat test together with the value of T2 at the change of conditions and stated in the manufacturers technical documentation

8.4 Cylinders supplied to a Heat Pump manufacturers specific specification and heated by means of the associated heat pump. (Class 3 Cylinders)

This test regime may be preferred by manufacturers where the cylinder is supplied or specified as part of the installed heat pump system. It should be noted that this is not the appropriate test procedure for dedicated heat pump water heaters.

The test procedure is similar to that specified by Annex A but the heat source is replaced by the actual heat pump. The starting temperature at T2 is 10°C but the values of primary flow temperature and primary flow are dictated by control system and may be modulated automatically during the test. If the control system requires the use of an electrical element this should be deactivated and the target cylinder temperature for the reheat test labelling is that reached at the normal activation point.

9 Testing of electrical top up time and volume heated

In some situations, an immersion heater or immersed electrical element is used to add the last few degrees of temperature to the stored water.
Where such provision is required the additional reheat time and electrical energy used to provide this top up should be measured in accordance with Annex B.
In addition, the volume of hot water shall also be measured as specified in Annex B.

10 Marking

10.1 Additional Data Label Information

In addition to the label information required by the relevant construction standards all cylinders shall have the following additional indelibly marked labelling clearly referring to its performance under this test specification. If the cylinder has an additional heat exchanger intended for auxiliary, or top up use by a separate boiler then this is tested using the appropriate procedure from the relevant standard in Table 1

a) The Class of cylinder (e.g. Class 2B)
b) The reheat performance in kilowatts for each primary heater as determined in accordance with Annex A.5
c) The volume of water heated by each heat pump primary heat exchanger as determined in accordance with Annex A.4
d) The volume of mixed water at above 40°C (V_{40}) in accordance with A.6
e) For cylinders with additional primary heaters intended for solar use then the dedicated solar volume should be stated.
f) The electrical energy and reheat time associated with each immersion heater or immersed electrical element.

10.2 Additional Technical Information

This information may be in the manufacturers technical literature and/or in any instruction or data sheet provided with the cylinder. See Example in Annex C

a) In addition to the label information, the manufacturer shall make available to the purchaser, the hot water draw off profile characteristics following heating by the heat pump primary as described by Annex A.4.

b) In addition to the label information, the manufacturer shall make available to the purchaser, the hot water draw off profile characteristics following additional heating by the immersion heaters as described by Annex A.4

c) In addition to the label information, the manufacturer shall make available to the purchaser, the hydraulic flow resistance of the heat exchanger at the four flow rates as specified by A.7.

Annex A

Testing of cylinders for indirect hot water performance under heat pump primary flow conditions

A.1 General

This annex specifies the test requirements necessary to determine:

a) the volume of hot water heated indirectly.

b) the heating power of the primary heater in kW under the specific test conditions.

A.2 Apparatus for performance of heat exchangers , Figs F1.1 ,F1.2 and F1.3 are examples of the apparatus for unvented cylinders , Fig F2 is for vented cylinders and F3 for copper combination units

Note, for this section any immersion heaters are not shown for clarity

1a ***Inlet control and expansion set*** for pressure mains connection connected to a cold water supply with a temperature not exceeding 10º C to ensure that an adequate flow (at least 0.25 l/s) is available from the cylinder.

1b ***Cold feed cistern*** connected to a cold water supply with a temperature not exceeding 10º C to ensure that an adequate flow (at least 0.25 l/s) is available from the cylinder.

2 ***Circulator*** , capable of maintaining a primary flow of ($F_{pri} \pm 0.01$) l/s to the primary heater.

3 ***Primary Heat source***, comprising a thermostatically controlled heat source capable of providing a primary flow temperature of ($T_{pri} \pm 2$) º C at F_{pri} l/s to the inlet of the primary heater. When testing to the conditions specified in 8.3 it may be necessary to have two heat sources operating at different temperatures with a quick changeover valve arrangement. When testing to the conditions specified in 8.4 the heat source is replaced by the actual heat pump to be used in combination with the cylinder.

4 ***Weighing machine*** , fitted with a suitable container (with draining mechanism), capable of indicating the mass of hot water drawn off to an accuracy of ±1 %. If desired, an automatic system such as a data logger may be used to record the temperature/draw off data. It is essential that any such equipment has an accuracy at least equal to that specified for the weighing machine and temperature sensor.

5 ***The Cylinder under test,*** *for clarity the cylinders are shown unlagged in the various schematic diagrams, the test will normally be carried out on factory insulated cylinders.*

FL1 , FL2 ***Flow meters***, comprising a flow meter (FL1) calibrated for water at T_{pri}º C and accurate to ±0.01 l/s at a flow rate of 0.42 l/s. An optional second flow meter (FL2), calibrated for water at T_{cyl} C at a flow rate of 0.25 l/s is used to speed up calibration of the test rig.

V1, V2 *Primary By-Pass Arrangement*, employing two full flow lever operated, quarter turn spherical valves.

V3, V4 *Flow control valves*, comprising two needle valves or similar devices for regulating the primary and secondary flows respectively.

V5 *Outlet valve*, a full flow lever operated, quarter turn spherical valve.

P1, P2 *Pressure gauges* , two pressure gauges or equivalent device/s such as a differential manometer capable of measuring the pressure drop across the primary heater to an accuracy of ±2 %.

T1, T2, T3 *Temperature sensors* , comprising three thermometers or thermocouple type devices capable of measuring the temperature of water to an accuracy of ±1º C. The temperature sensors shall be positioned as follows:

> **(T1)** in the primary flow pipe from the circulator to sense the primary water temperature immediately prior to the tee off to the by-pass arrangement;
>
> **(T2)** inside the cylinder either utilising the thermostat pocket intended for heat pump control use or, if no pocket fitted then at a position corresponding to its recommended position. If no recommendations are available, then the position shall be 25 mm above the highest point of the heat exchanger coil.
>
> **(T3)** in the outlet pipe, no more than 150 mm downstream from the cylinder outlet, to sense the temperature of hot water leaving the cylinder;

Figure F1.1 Apparatus example for unvented cylinder (EN12897) with internal coil type heat exchanger

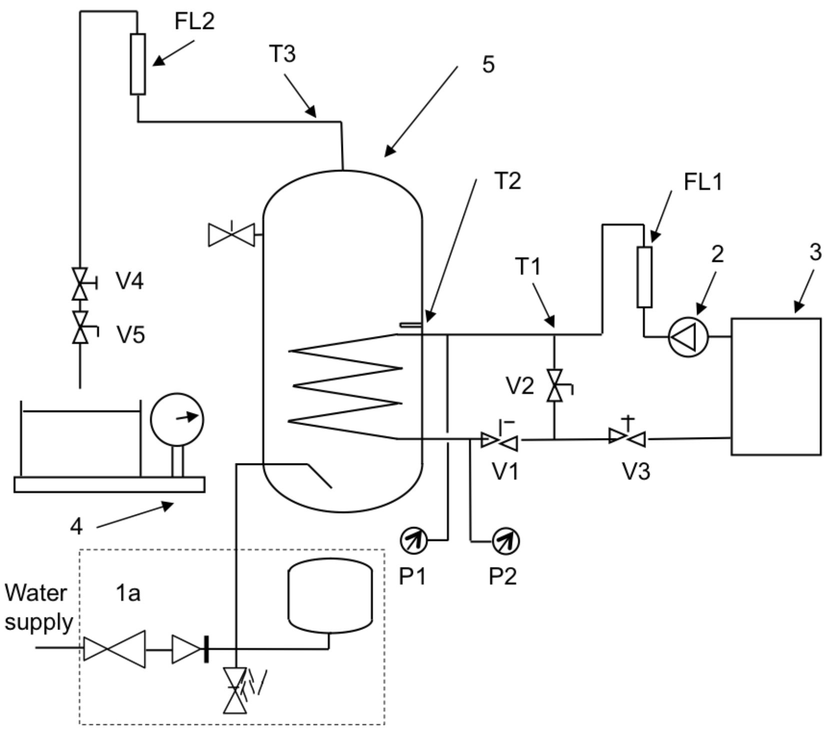


Figure F1.2 Apparatus example for unvented cylinder (EN12897) with external plate to plate

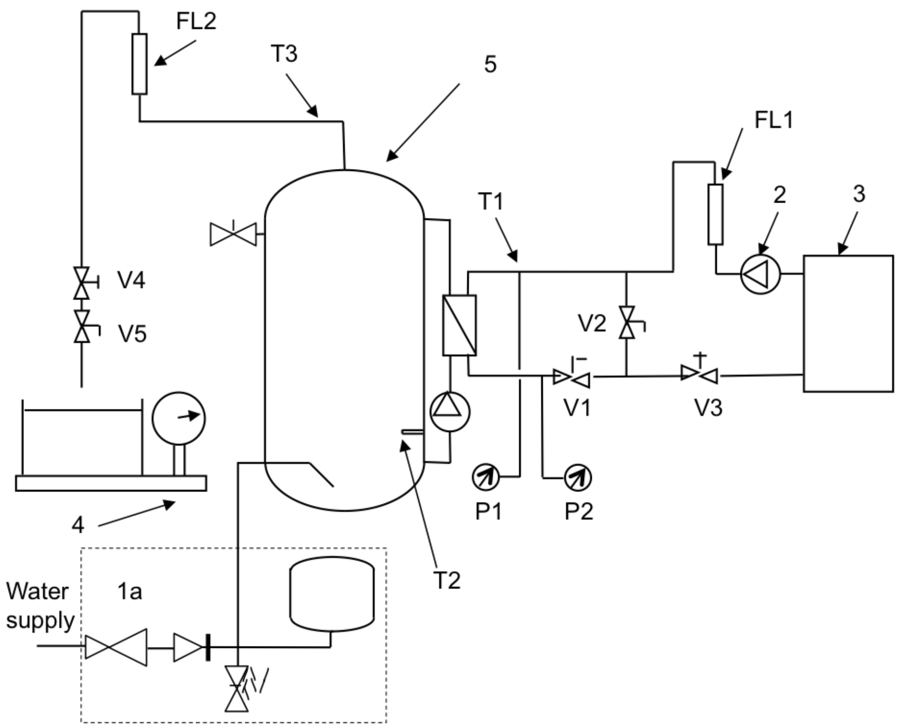


Figure F1.3 **Apparatus example for unvented cylinder (EN12897) with tank in tank water jacket heat exchanger**

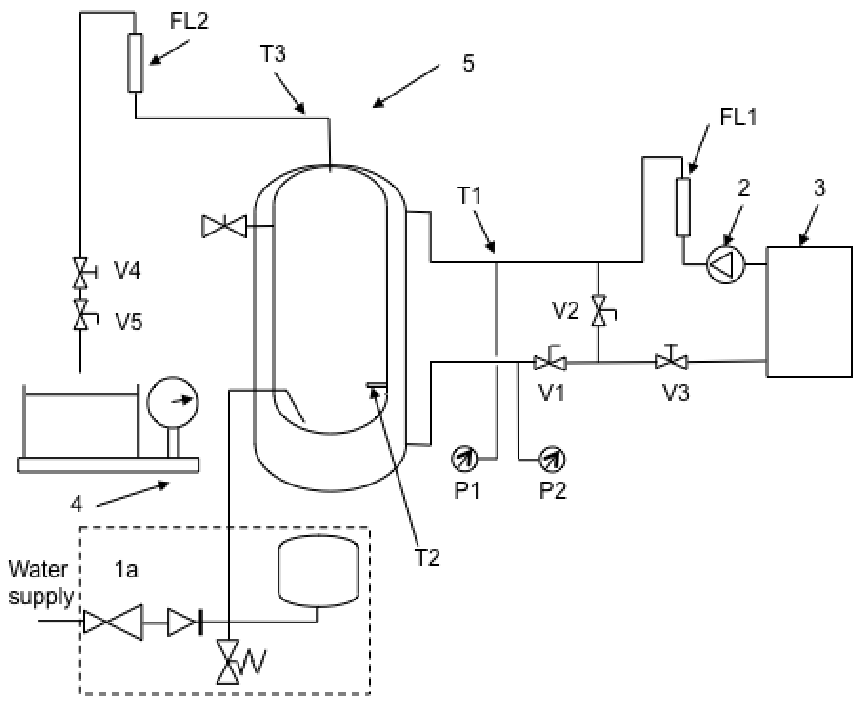


Figure F2 **Apparatus example for copper or stainless steel vented cylinder (BS1566 or HWA 001)**

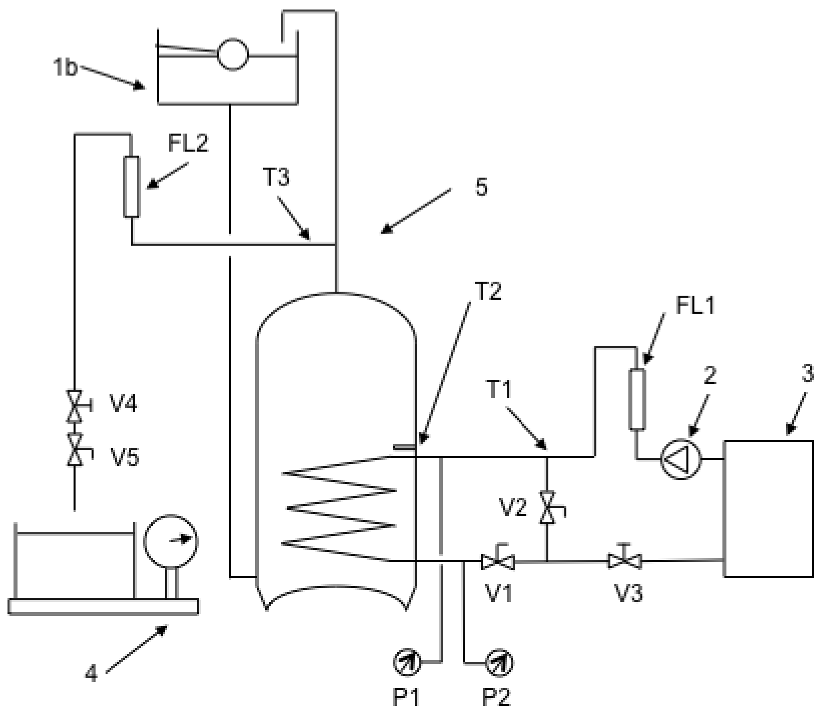
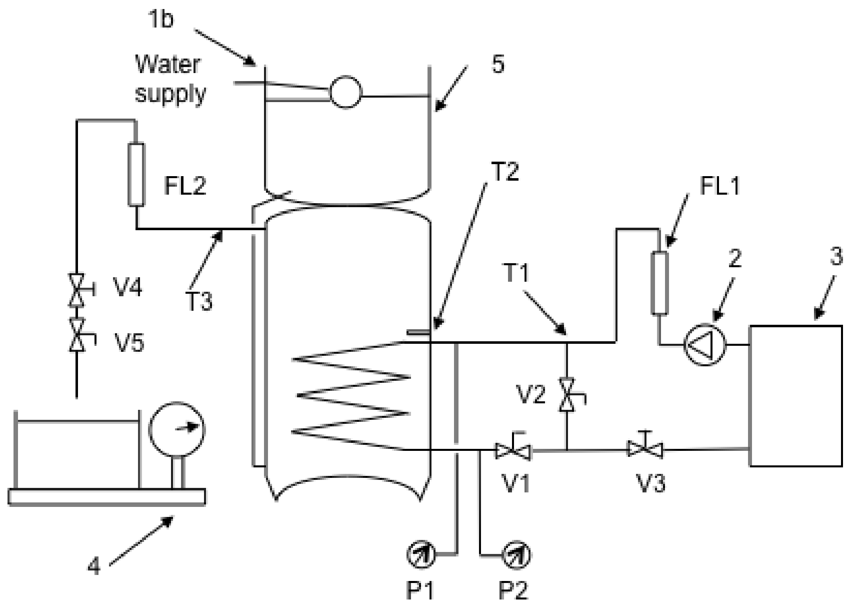


Figure F3 Apparatus example for copper combination unit (BS3198)



A.3 Procedure

A.3.1.1 Nominal (gross) storage capacity
Weigh a cylinder without a primary heater (i.e. equivalent direct) cylinder empty, using a weighing machine capable of indicating the mass to an accuracy of ±1 % and record the mass. Fill the cylinder with cold water until it emerges from the hot water draw off pipe and weigh the cylinder again, recording the mass. The difference in mass between the full cylinder and the empty cylinder in kilograms is deemed to be the nominal storage capacity in litres.

A.3.1.2 Net storage capacity
Weigh the empty cylinder complete with primary heater/s (if indirect) using a weighing machine capable of indicating the mass to an accuracy of ±1 % and record the mass. Fill the cylinder with cold water until it emerges from the hot water draw off pipe and weigh the cylinder again, recording the mass. The difference in mass between the full cylinder and the empty cylinder in kilograms is deemed to be the nominal storage capacity in litres.

A.3.2 Hot water performance

Set up the apparatus for testing as shown in Figure A.1

Fill the primary heater and associated primary circuit and expel all excess air.

Switch on the primary heater and allow the primary water to heat up to a flow temperature of T_{pri}º C, as measured at T1, with valves V1, V2 and V3 open and any excess air allowed to escape.

Close valve V2, leave valve V1 open and adjust valve V3 to give a primary flow rate of F_{pri} l/s through the primary heater as measured by flow meter FL1. Once this is achieved, open valve V2 and close valve V1.

Turn on the water supply to the cylinder, open valves V4 and V5 and expel any excess air from the system until water flows freely from the cylinder outlet.

With valve V5 fully open, adjust valve V4 to give a discharge flow rate of 0.25 l/s as measured either by flow meter FL2 or by timing the rate of increase in discharged water mass using a timer in conjunction with weighing machine. Once a flow rate of 0.25 l/s is achieved, close valve V5.

With valves V5 and V1 closed and V2 open, allow the primary heater to heat the primary water up to a flow temperature of T_{pri}º C.

Once stable primary conditions are established at T_{pri} °C and F_{pri} l/s, open valve V1 and then immediately close valve V2. Once the temperature of water at the thermostat position, as measured using temperature sensor T2, reaches Tstartº C start a timer for the reheat period. If necessary, adjust valve V3 to maintain a primary flow rate, as measured at FL1 of F_{pri} l/s.

A.3.2.1 Once the temperature of water measured using temperature sensor T2 reaches T_cº C disconnect the heat source by opening valve V2 and immediately closing valve V1. Note the time taken for the temperature to reach T_c °C and record this as the reheat time *t*. Allow the system to stabilize for three minutes.

Three minutes after closing valve V1 commence the draw off by opening valve V5. Measure the flow rate either by means of flow meter FL2 or by starting a timer as V5 is opened and using weighing machine W to record the mass. If necessary, adjust valve V4 in order to maintain the 0.25 l/s flow rate.
Record the temperature of the water drawn off in 5 l increments at T3. Once the water temperature at T3 drops to below 40º C then at the end of the 5 l increment when this occurs, immediately close valve V5.

A.4 Hot water capacity of Indirect Cylinders

The hot water capacity is derived from the hot water draw off profile as determined by the volume of water drawn off at above 40ºC, this is determined as follows.

The hot water draw off shall be plotted graphically with draw off in litres plotted in 5 l increments on the horizontal axis, and temperature at T3 on the vertical axis.
If automatic recording equipment was used, a continuous plot can be substituted for the manual 5 l incremental plot.
For the cylinder to be deemed as satisfying the requirements of this specification then at least 70 % of the net storage capacity (as measured in accordance with A.3.1.2) shall be drawn off as hot water at 40º C or above. The Hot Water capacity *Vh* is the volume drawn off before closing V5 as determined by reference to the graph of the draw off profile.

See Example in Annex C

A. 5 Reheat performance of Indirect Cylinders

The reheat performance P, expressed in kilowatts, is given by the equation:

$$P = \frac{(T_{av}-10) \times V_h}{14.3 \times M}$$

Where

T_{av} is the average temperature of the water at T3 drawn off at 40º C or above, established at the from the readings at the 5L increments and/or the graph of the draw off profile

Vh is the volume of water (in litres) drawn off at 40º C or above (Hot Water Capacity)

M is the reheat time in minutes

A 6 Calculation of V_{40} Equivalent volume of mixed water available at 40ºC

Following measurement of hot water draw off according to A.4 the normalized value of the average temperature is calculated according to the following formula:

$$T_{norm} = (T_{cyl} -10) \times \frac{(T_{av} -10)}{(T_{cyl} -10)} +10$$

Where T_{norm} in ^{o}C is the normalized average temperature of outlet water.

The quantity of hot water V_{40} in litres delivered with a temperature of at least 40^{o}C will be calculated by the following formula.

$$V_{40}\,(\text{litres}) = V_h \times \frac{(T_{norm} - 10)}{30}$$

A.7 Hydraulic flow resistance of the heat exchanger

This test can be done using cold water at any temperature between 10^{o}C and 20^{o}C. Cold water shall be passed through the coil at various flow rates starting at 0.15 l/s then in increments of 0.15 l/s up to 0.75 l/m. At each flow rate the pressure drop as determined by the difference between P1 and P2 shall be noted and the results recorded for each step in tabular format.

Annex B

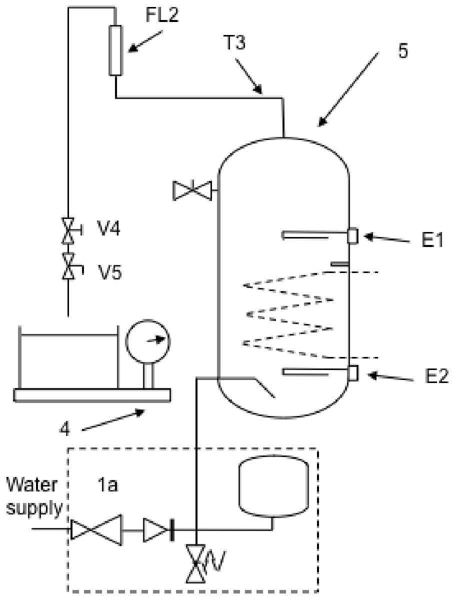
Performance testing of immersion heaters (or immersed electrical elements)

Apparatus

Figure F4 below shows the apparatus, for legend see A.2 with addition of immersion heaters. Primary circuit not shown in F4 for clarity

Heater E1 is the immersion heater used on a daily basis (see test B.1)
Heater E2 is used to heat the whole cylinder when required (see test B.2) including for regular sterilisation. In some products E1 may not be present so proceed to B.2.

Figure F4



For tests B.1 and B.2 it will be necessary to connect the immersion heater via an electricity meter or equivalent device capable of measuring the electrical power consumption to an accuracy of ± 0.01 kWh.

B.1 Testing of immersion heaters used to elevate some of the cylinder contents to a temperature above the cut off point of the heat pump Tc.

For this test the cylinder is brought up to temperature T_{cyl} by means of the primary circuit. At this point the primary circuit flow is terminated, the immersion heater E1 is energised a timer started and a meter reading taken. When the cylinder reaches 65^{o}C as measured at the immersion heater thermostat position then the immersion heater is de-energised the time in minutes noted together with the new meter reading.

At this point a draw off is commenced following the procedure in A.3.2.1 and procedure A4 followed to establish the hot water volume.

The V40 hot water volume should also be calculated following procedure A.6 but with the initial value of T_{cyl} being replaced by a value of 65^{o}C.

B.2 Testing of immersion heaters used to elevate the temperature of the whole contents.

For this test the cylinder is again brought up to temperature T_{cyl} by means of the primary circuit. At this point the primary circuit flow is terminated, the immersion heater E2 is energised a timer started and a meter reading taken. When the cylinder reaches 65^{o}C as measured at the immersion heater thermostat position then the immersion heater is de-energised the time in minutes noted together with the new meter reading.

At this point a draw off is commenced following the procedure in A.3.2.1 and procedure A4 followed to establish the hot water volume.

The V40 hot water volume should also be calculated following procedure A.6 but with the value of T_{cyl} being replaced by a value of 65^{o}C.

Annex C Examples of technical information format

C.1 Cylinder label Example

The label must be firmly attached to the cylinder in accordance with clause 10.1 of this specification. This label is additional to any label required for compliance with the reference standards in Table 1

Label No 1 is an example of the cylinder label for a cylinder with one heat pump heat primary heat exchanger and two immersion heaters with no solar coil.

Label 1

Kenilworth Cylinder Co 150 L		
Class 2 Heat Pump Cylinder Constructional Standard EN 12897		
Heat exchanger 1	Reheat power kW	11Kw
	Volume heated	120 L
	V_{40} volume	140 L
	Time to heat	36 mins
	Primary Flow Rate F_{pri}	0.5 l/s
	Primary Flow temperature T_{pri}	60 °C
Upper Immersion heater	Time to heat	20 mins
	Energy used	1.2 kWh
	V_{40} volume	160 L
Lower Immersion heater	Time to heat	39 mins
	Energy used	2.5 kWh
	V_{40} volume	180 L
Dedicated solar volume	Vol in L	N/A

Label No 2 is an example of the cylinder label for a cylinder with two heat pump heat primary heat exchangers and one immersion heater with no solar coil.
The two sets of primary conditions are shown for the second step of the reheat (see asterisk)

Label 2

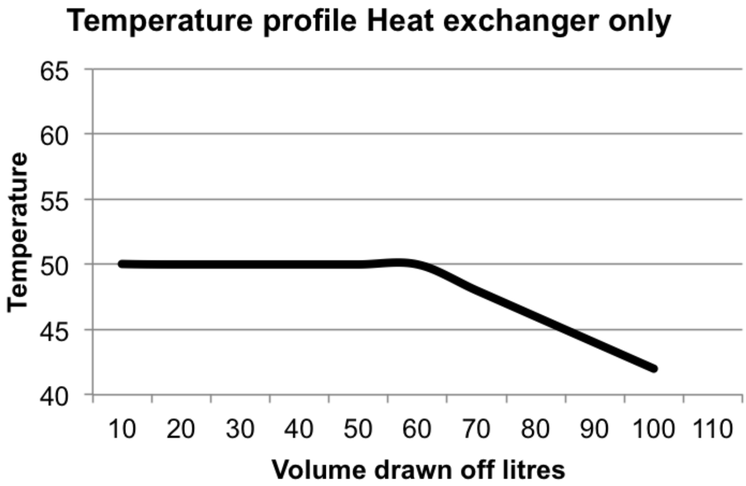
Kenilworth Cylinder Co 150 L		
Class 2B Heat Pump Cylinder Constructional Standard EN 12897		
Heat exchanger 1	Reheat power kW	11Kw
	Volume heated	120 L
	V_{40} volume	140 L
	Time to Heat	20 mins
	Primary Flow Rate F_{pri}	0.5 l/s 0.5 l/s *
	Primary Flow temperature T_{pri}	60 °C 65°C*
Heat exchanger 2	Reheat power kW	6Kw
	Volume heated	100 L
	V_{40} volume	105 L
	Time to heat	26 mins
	Primary Flow Rate F_{pri}	0.4 l/s
	Primary Flow temperature T_{pri}	70 °C
Immersion heater	Time to heat	20 mins
	Energy used	1.2 kWh
	V40 volume	150 L
Dedicated solar volume	Vol in L	N/A

C.2 Other technical information to be provided see clause 10.2

Draw off profile from each heat exchanger coil (or external heat exchanger) heated by the heat pump primary, separate information shall be required for each coil heated by the heat pump see A.4

See examples C.2.1 and C.2.2 below which show suitable alternative methods of presentation.

Example C.2.1 Information may be provided in graphical format; (multiple curves may be used to show additional heat exchangers or models in the same range) this example shows one coil only.



Example C.2.2 Information may be provided in tabular format as shown below, this example could cover a range of cylinder sizes the 120 litre has two coils and the 150 litre has one coil.

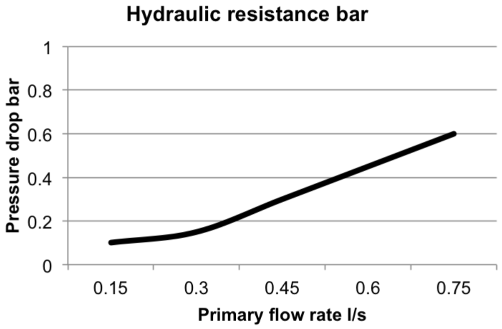
	120 Litre Cylinder		150 Litre Cylinder	
Volume in Litres	Upper Coil	Lower Coil	Upper Coil	Lower Coil
10	50	50	50	-
20	50	50	50	-
30	50	50	50	-
40	50	50	50	-
50	49	50	50	-
60	48	50	50	-
70	47	48	50	-
80	45	47	50	-
90	42	45	48	-
100	40	42	47	-
120		40	45	-
130			42	-
140			40	-
150				-

In addition, temperature profile information is required to show the hot water profile after “topping up” by each immersion heater.

The information shall be provided in a similar format to those indicated in the alternatives C.2.1 or C.2.2

C.2.3 A chart of primary hydraulic flow resistance is required in accordance with A.7

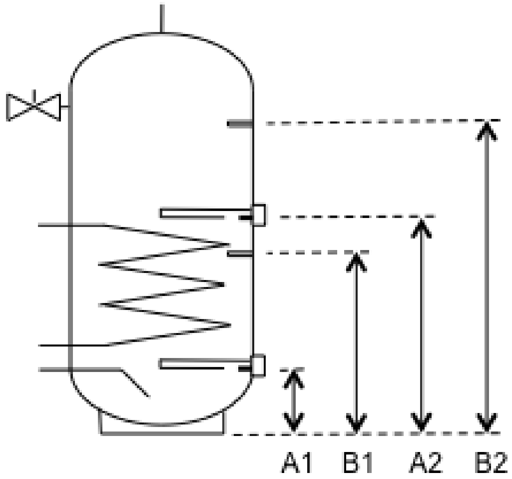
See example below using a graphical format, this may also be replaced by tabular information covering several models of cylinder: -



C.3 Other technical information to be provided.

a) Position and specification of immersion heaters
b) Position and specification of thermostats or thermostat pockets

The above information may at the discretion of the manufacturer be provided by means of dimensioned engineering drawings or schematics. A typical diagram is shown below where the dimensions for several models can be used in tabular format.



Note :- The above dimensions are to the thermostat positions which are not necessarily at the centre line of the immersion heater connections

The Hot Water Association exists to promote the concept and use of stored hot water in domestic and commercial circumstances in the United Kingdom and Republic of Ireland. HWA is a trade organisation whose membership accounts for nearly 100% of hot water storage devices sold in the UK.

Our role is to provide:

- Information: From an explanation on how hot water storage systems work to the latest industry developments.
- Advice: From technical queries to advice on the Building Regulations/Byelaws.
- Expertise: With the combined knowledge of member companies, HWA offers unrivalled expertise within the sector.
- Promote the highest standards of efficiency & manufacturing through the HWA charter.

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