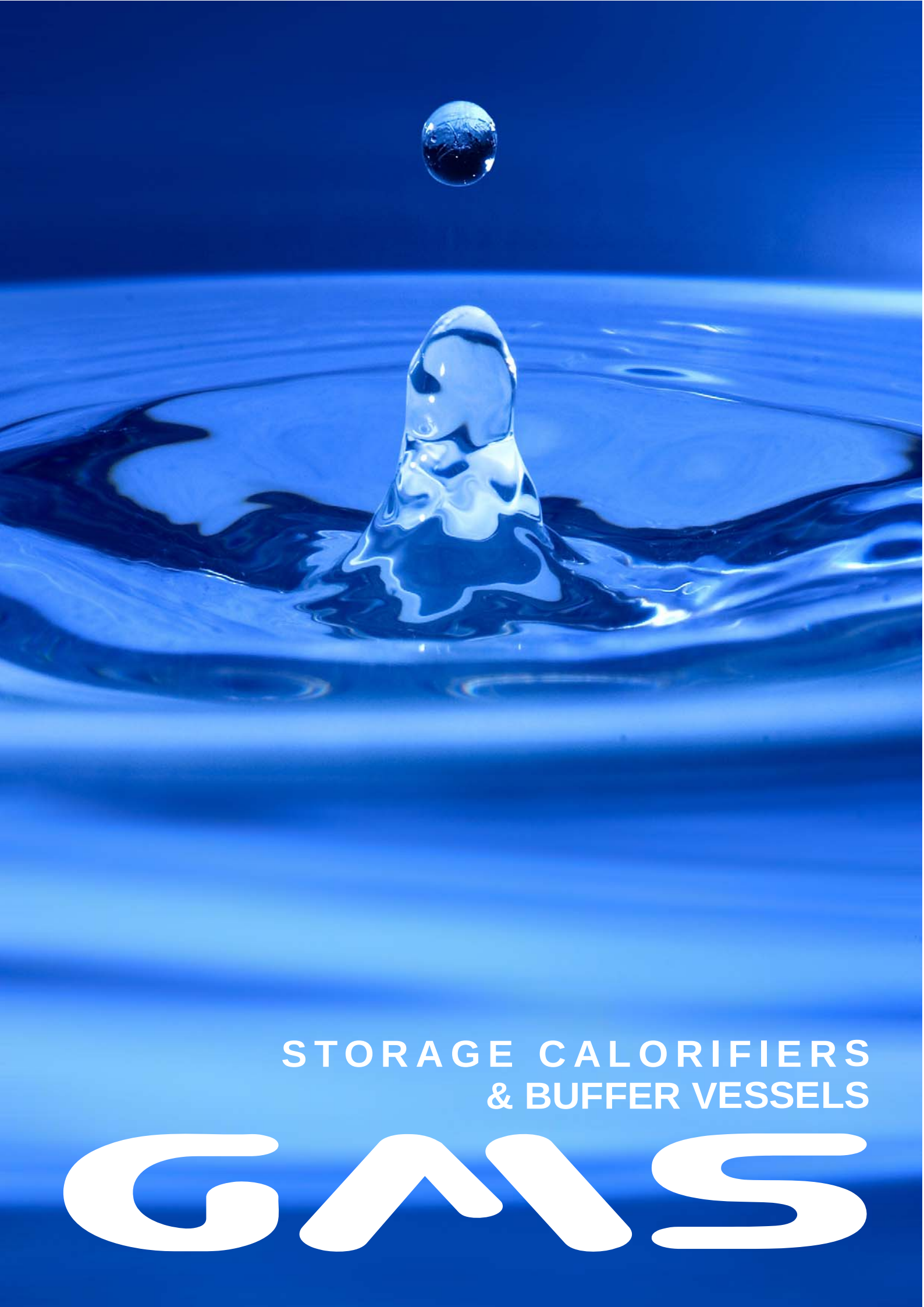

STORAGE CALORIFIERS & BUFFER VESSELS

GAS

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Background Information

When domestic hot water is required in volume, the GMS range of storage calorifiers offer an ideal solution. Stored water is heated indirectly by a primary medium (via an internal u-tube battery or a coil). Alternatively, electric immersion heaters offer a clean and efficient primary heat source.

Most of this leaflet we refer to storage calorifiers with tube bundles. Most of this is also applicable to indirect cylinders with tubular coils. The essential differences are explained in the section “Indirect Storage Cylinders”

Factors affecting the choice of storage calorifiers are:

Cost - Storage calorifiers are often the most economical water heating solution.
Low Primary Power Requirement - The stored hot water meets high peak demands with relatively low primary power, keeping the primary supply capital costs lower than in instantaneous or semi-storage systems.
Economical Temperature Control - Simple on/off temperature control is often all that is required.
Reliability - Storage calorifiers are robust and uncomplicated, giving excellent reliability and availability.
Space - An instantaneous water heater may be more compact than a storage calorifier, but requires a larger primary heat source, negating some of the space saving.
Heat Loss - Correct insulation of the calorifier results in low heat loss. Compared to instantaneous heaters, the low, steady primary heat requirement reduces inefficient boiler cycling. Primary pipework is smaller and loses less heat. Electrically heated storage calorifiers, using off-peak electricity, give savings in running costs.
Legionella Safe: Storage calorifiers and cylinders, correctly installed and operated, prevent the growth of legionella bacteria.
Environmental Benefits - Hot water storage is invaluable for storing solar thermal energy and waste heat.

Storage Volume and Recovery Time

Type of Building	Category	Storage Litres / Person	Heatup Period (Hours)
Hotel	5*	45	2
	3*	35	2
School/College	Boarding	25	2
	Day	5	3
Student Residence		35	3
Houses/Flats		45	2
Factories/Offices		5	3
Hospital Wards	In-Patient	30	1

Table 1: Typical Hot Water Storage Requirements

Storage calorifier volume and recovery time determine output. “Recovery time” is the time the calorifier takes to heat up from cold under zero demand. Long recovery times require low primary power and vice versa.

The tube battery (or coil or immersion heater) is mounted low down in the calorifier. The contents are heated almost uniformly by natural convection. During draw-off, the calorifier design minimises mixing of incoming cold water with the hot water above. If draw-off is too high, the hot water layer becomes exhausted and the water drawn will be too cool. It is important to select an adequate storage volume to meet anticipated demand.

The “CIBSE Guide” gives design curves for storage calorifiers for various duties with worked examples. Also, as a quick guide, the figures given in the table to the left will, in our experience, give good results. Any sizing table should be used with a common sense estimate of the likely demand pattern. For example, a business hotel may have a sharper morning peak demand than a tourist hotel.

Available space or boiler power may also limit choice.

Primary Heat Source

Water, Steam and other fluids

Low Temperature Hot Water (LTHW) - Typically 82°C/71°C (Up to a maximum of 110°C). A common source of primary heat.

Medium/High Temperature Hot Water (MTHW or HTHW) - Primary temperatures above 110°C up to a maximum working pressure of 17.5 BarG

Steam - Steam condenses in a tube bundle and the latent heat transfers to the stored water. The resultant condensate is at the same temperature and pressure as the steam. This can cause noise in the condensate main, as steam "flashes" off the hot condensate after a steam trap. To cure this problem, a "flash bundle" to condense the flash steam can be included in the calorifier if required.

Thermal Oils - These allow high temperatures at low pressure. Primary connections should be flanged and have oil resistant gaskets. Copper degrades some oils so the tube bundle may have cupro-nickel or stainless steel heater tubes.

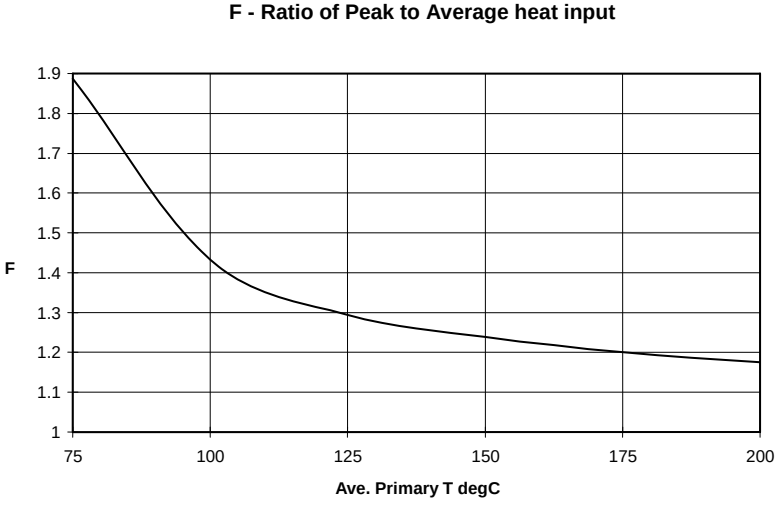
Refrigerant - Superheated refrigerant can be cooled (and condensed if required) to heat a calorifier between compressor and condenser. A back-up system should be provided for times when the refrigerant is unavailable.

Waste Heat - If waste heat is only available at low temperatures, a separate top-up heat supply will be required. We can advise the best match of calorifier to waste heat availability and hot water demand.

Solar Heat - Usually, a separate heat source is required, and the heat from the solar water is fed through a second heater battery or coil to pre-heat the stored water.

Calculating the primary power requirement - fluid primaries

At the start of the heat-up period, when the calorifier contents are cold, heat transfer is higher than at the end. To achieve design performance, primary power must match this. When the primary fluid is water or thermal oil, flowrate and flow temperature remain constant while return temperature starts low then rises during heat-up. For steam, temperature remains constant but flowrate starts high then decreases during heat-up.



Calculating Average Primary Power

Assuming a well insulated calorifier and ignoring any heat losses from primary pipe-work,

Average Primary Power Required,

$$Q = \frac{V \times 4.18 \times (T1-T2)}{t \times 3600} \text{ kW}$$

where: V=Storage Volume (litres)
t=Recovery Time (hours)
T1 = Required Temperature (usually 65ºC)
T2 = Cold Feed Temperature (usually 10ºC)

Example: Calculate average primary power for a 2000 litre storage calorifier, with a 2 hour recovery time, heating water from 10ºC to 65ºC

Average Primary Power Required,

$$Q = \frac{2000 \times 4.18 \times (65-10)}{2 \times 3600} = 64 \text{ kW}$$

Calculating Peak Primary Power

Multiply Q by the correction factor F obtained from the chart below.

EG for LTHW primary
82ºC flow / 71ºC return
Secondary cold feed 10ºC, 65ºC flow
Average primary temperature =(82/71)/2 = 76.5ºC
From the chart, F=1.8
From the example above, average power Q=64 kW
Peak primary power required = 64 x 1.8 = 115 kW

EG for steam primary
Steam at 3 BarG (143.75ºC) after control valve
Secondary cold feed 10ºC, 65ºC flow
Average primary temperature = 143.75ºC
From the chart, F=1.25
From the example above, average power Q=64 kW
Peak primary power required = 64 x 1.25 = 80 kW

NOTE:
Standard U-tube bundles are externally finned for high performance. If requested, or for steam primary fluid, or if told that the water is hard, plain U -tubes may be offered.

Space must be allowed for withdrawal of the tube bundle for inspection. If withdrawal distance is not known, assume full length. We will be pleased to advise withdrawal distances for specific units.

Materials of Construction

Solid Copper, Type CS - Copper is virtually impervious to attack by aggressive water. In the few areas where water is know to attack copper, the calorifier can be protected by a sacrificial aluminium anode. This leaves a protective coating on the copper and does not need replacing. The copper thickness required for a calorifier increases with pressure and diameter. Above a certain size, copper-lined steel is more economical.

Copper-Lined Steel, Type CL - Carbon steel lined internally with copper. None of the steel is in contact with the water. The steel gives great strength, the copper prevents corrosion. Special techniques have been developed to ensure a close fit of copper to steel, to allow thermal expansion and contraction of the lining and to test the lining. Fitted as standard with an anti-vacuum valve to prevent partial vacuum damaging the lining. Even so care should be taken during drain-down to ensure adequate venting of the calorifier. The cold feed must never be restricted during draw-off.

Galvanised Steel, Type GS - Hot dip galvanising deposits a zinc layer which provides excellent protection against corrosion if the water is hard. Galvanised calorifiers should not be used with copper pipe-work or soft water. The copper causes electrolytic action and releases particles of copper which deposit in the calorifier, causing localised electrolytic action and corrosion. Soft water prevents formation of a protective scale. The copper tube bundle rapidly gets a film of scale because of its higher temperature. This prevents electrolytic action and corrosion. For added protection a magnesium sacrificial anode can be fitted. This must be replaced when exhausted. Also the copper tube bundle can be electrotinned which reduces the electrochemical potential.

Stainless Steel, Type SS - Stainless steel calorifiers can be offered as an option to copper when a high working pressure is required. The thickness required can be substantially less than copper thus making it an economical alternative. Using stainless steel can also increase the lifespan of the calorifier with some water conditions.

Glass/Polymer Lined Steel, Type PL - An alternative to copper-lined steel. The lining was developed for arduous conditions in industrial processes. It is generally more resistant to abrasion, chemical attack and impact damage than traditional glass linings. If damage occurs the surrounding coating will not be affected and the damage can be repaired. In the lining process minute glass flakes are combined with a special polymer, applied to the steel, cured and electrically tested. The lining is WRC approved for use with hot water.

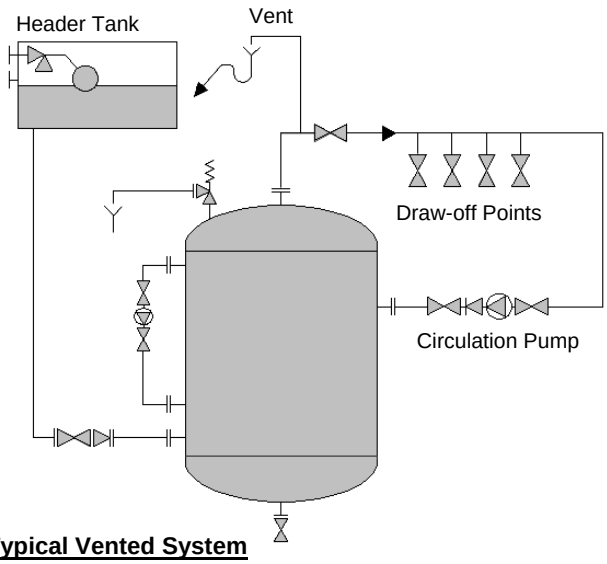
Thermal Insulation Options

Type S Insulation - Consists of 50mm mineral wool with Stucco aluminium cladding. This gives good thermal insulation and a quality finish. For some installations, there will be a high risk of damage to the factory fitted insulation. In these instances, it is preferable to insulate on site.

Type L Insulation - Consists of 50mm mineral wool wrapping the cylinder with a steel angle frame. Each side fitted with a removable panel to allow inspection or modification.
Type L is recommended for sites where damage to the casing maybe likely.

Type UF Insulation - For smaller cylinders, we can offer semi-rigid urethane foam insulation. This is sprayed on in a standard thickness of 25mm (up to 60mm on request). It's Ozone depletion potential (ODP) is zero, it does not support combustion and it resists water penetration. (Uniform thickness cannot be guaranteed)

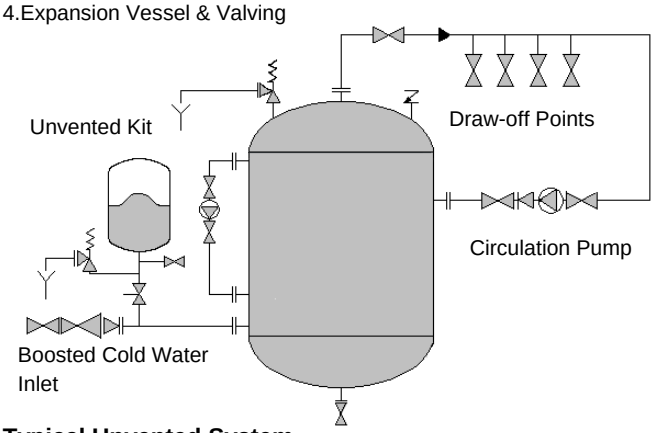
System Considerations



Typical Vented System

In open vented systems, the vent pipe allows escape of air from the calorifier, ingress of air during drain down, thermal expansion of water and (in the event of control failure) escape of steam from the calorifier. The vent pipe should never be blocked. NO valves should be fitted to it except, where more than one calorifier share a common vent, special 3-way vent/bypass valves. These ensure that the calorifier is always open to atmosphere.

Unvented Kit:
1.Temperature/Pressure Relief Valve
2.Automatic Air Vent
3.Anti-Vacuum Valve
4.Expansion Vessel & Valving



Typical Unvented System

When it is not practical to fit a vent, an unvented system will be used. Certain additional precautions and equipment are necessary to ensure that an unvented system will be safe (see above). A water booster set may be required to provide water at the required pressure and flowrates.

Calorifiers installed into sealed systems are manufactured to meet the mandatory requirements of the Building Regulations G3 Sections 3 and 4.

GMS are able to design and supply calorifiers complete with the necessary safety devices required to meet the regulations including expansion vessels, expansion relief valve and pressure regulation. The unvented kit can be supplied loose or as a fully packaged, skid

Design and Manufacturing Standards

GMS Commercial Standard - A GMS commercial standard cylinder is designed for minimum cost without loss or performance or reliability, based on many years' experience of calorifier design and construction.

BS853 - For customers who require a calorifier constructed to an internationally recognised standard. GMS Thermal Products will produce calorifiers to BS853 if required, both BS853 Part 1 & BS853 Part 2. There is scope within BS853 for 3rd party verification of design and construction. This adds to cost and delivery time, but can be arranged if required.

PD5500 - For very high working pressure, GMS Thermal Products can design and build calorifiers to PD5500. However, BS853 now includes higher pressures so it is often not necessary to resort to PD5500.

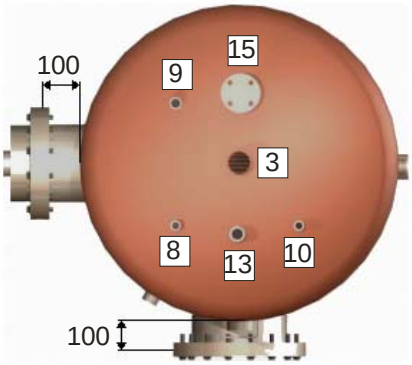
Other Standards - GMS Thermal Products will consider production of calorifiers to other standards. Please contact us with details.

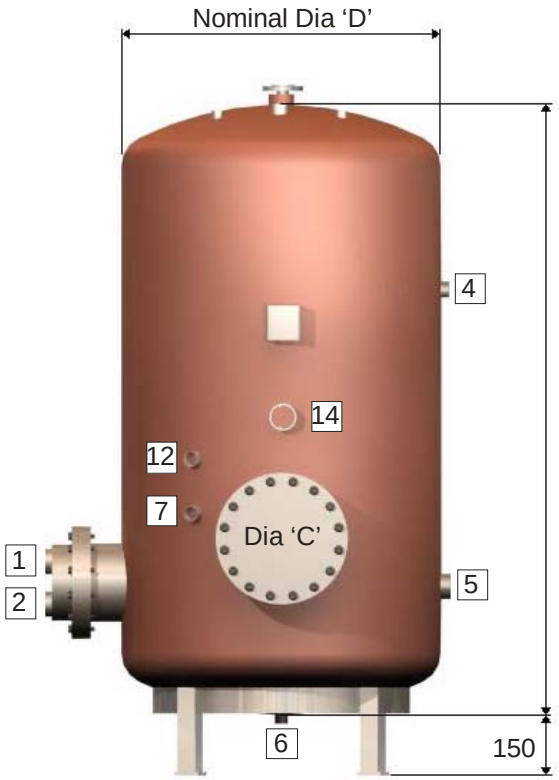
All our storage vessels comply fully with the European Pressure Equipment Directive 97/23/EC

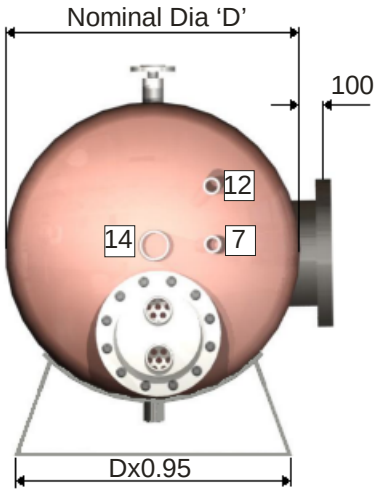
Storage Calorifiers

The standard range of GMS storage calorifiers are fitted with U-tube batteries and is the most common type of heater for storage type water heaters.

Standard U-tube batteries are manufactured using 19mm o/d copper integron tube (finned on the outside). The batteries are removable which makes inspection, cleaning or replacement a possibility.





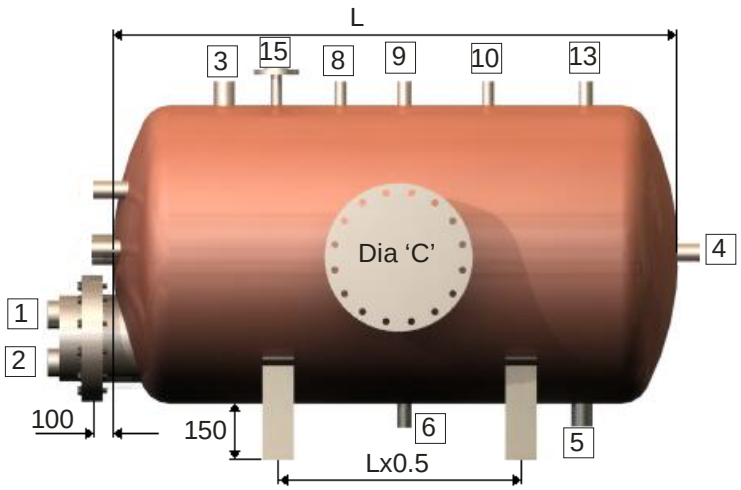


Connections

Ref	Description	Size	Ref	Description	Size
1	Primary Inlet	Varies	9	Safety Valve	Varies
2	Primary Outlet	Varies	10	Pressure Gauge	3/8"
3	Secondary Flow	Varies	11	Vent (Optional)	Varies
4	Secondary Return	Varies	12	High Limit Thermostat (Optional)	1"
5	Cold Feed	Varies	13	Anti-Vacuum Valve (Optional)	Varies
6	Drain	Varies	14	Immersion Heater (Optional)	Varies
7	Control Thermostat	1"	15	Bursting Disc (If Specified)	Varies
8	Thermometer	1/2"			

Size	D	L	C	Main Connection Sizes					
Litres	(mm)	(mm)	(mm)	3	4	5	6	11	13
230	500	1270	250	1¼"	1"	1¼"	¾"	1"	¾"
270	500	1470	250	1¼"	1"	1¼"	¾"	1"	¾"
360	600	1370	250	1¼"	1"	1¼"	¾"	1"	¾"
450	600	1740	250	1½"	1"	1½"	¾"	1"	¾"
500	675	1470	250	1½"	1"	1½"	¾"	1"	¾"
550	675	1720	250	1½"	1"	1½"	¾"	1"	¾"
600	750	1450	250	1½"	1"	1½"	¾"	1"	¾"
700	750	1680	250	1½"	1"	1½"	¾"	1"	¾"
800	750	1930	250	1½"	1"	1½"	¾"	1"	¾"
900	750	2150	300	1½"	1"	1½"	¾"	1"	¾"
1000	900	1750	300	2"	1½"	2"	1"	1¼"	1"
1200	900	2050	300	2"	1½"	2"	1"	1¼"	1"
1500	1050	1950	450	2"	1½"	2"	1"	1¼"	1"
1750	1050	2175	450	2"	1½"	2"	1"	1¼"	1"
2000	1050	2400	450	2"	1½"	2"	1"	1¼"	1"
2250	1200	2200	450	65	2"	65	1½"	1½"	1¼"
2500	1200	2400	450	65	2"	65	1½"	1½"	1¼"
3000	1200	2850	450	80	2"	80	1½"	1½"	1½"
3500	1350	2700	450	80	2"	80	1½"	1½"	1½"
4000	1350	3000	450	80	2"	80	1½"	1½"	1½"
Copper-Lined, Galvanised or Glass Lined Vessels only after 4000 Litre									
4500	1500	2770	450	80	2"	80	1½"	1½"	1½"
5000	1500	3050	450	80	2"	80	2"	2"	1½"
5500	1500	3350	450	100	65	100	2"	2"	2"
6000	1600	3250	450	100	65	100	2"	65	2"
7000	1600	3750	450	100	65	100	2"	65	2"
8000	1800	3450	450	125	65	125	2"	65	2x2"
9000	2000	3200	450	125	65	125	2"	65	2x2"
10,000	2000	3500	450	125	65	125	2"	65	2x2"

For alternative sizes please contact the sales office on 01457 835700



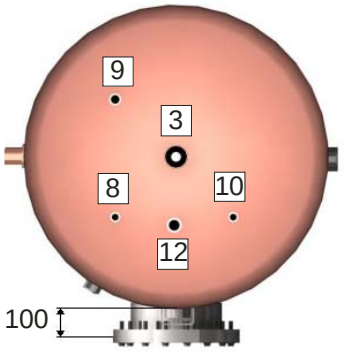
Indirect Cylinders

The standard range of GMS indirect cylinders are fitted with fixed copper heaters. These are not replaceable unless a bolted head is fitted to the cylinder.

The heater is either in the form of a helical coil or as straight heater tubes fitted between headers

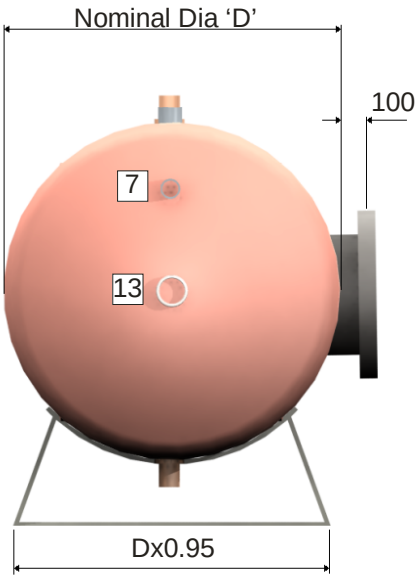
Connections

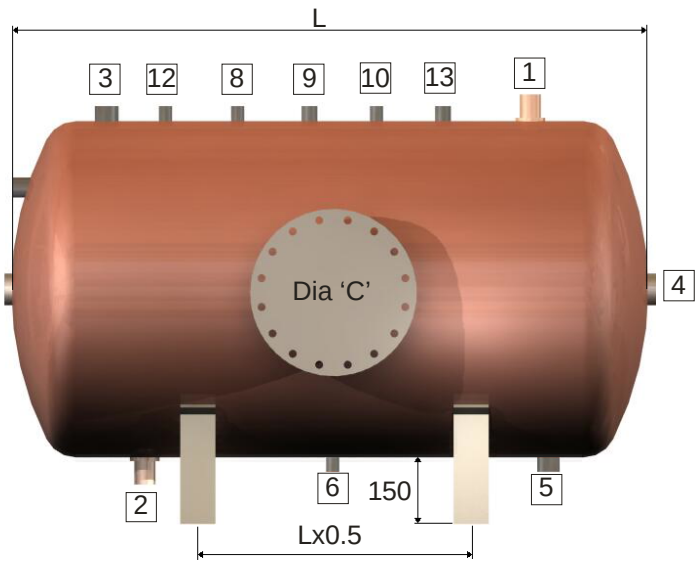
Ref	Description	Size	Ref	Description	Size
1	Primary Inlet	Varies	8	Thermometer	1/2"
2	Primary Outlet	Varies	9	Safety Valve	Varies
3	Secondary Flow	Varies	10	Pressure Gauge	3/8"
4	Secondary Return	Varies	11	Vent (Optional)	Varies
5	Cold Feed	Varies	12	Anti-Vacuum Valve (Optional)	Varies
6	Drain	Varies	13	Immersion Heater (Optional)	Varies
7	Control Thermostat	1"	14	High Limit Thermostat (Optional)	1"



Size Litres	D (mm)	L (mm)	C (mm)	Main Connection Sizes 3	4	5	6	11	12
230	500	1270	250	1¼"	1"	1¼"	¾"	1"	¾"
270	500	1470	250	1¼"	1"	1¼"	¾"	1"	¾"
360	600	1370	250	1¼"	1"	1¼"	¾"	1"	¾"
450	600	1740	250	1½"	1"	1½"	¾"	1"	¾"
500	675	1470	250	1½"	1"	1½"	¾"	1"	¾"
550	675	1720	250	1½"	1"	1½"	¾"	1"	¾"
600	750	1450	250	1½"	1"	1½"	¾"	1"	¾"
700	750	1680	250	1½"	1"	1½"	¾"	1"	¾"
800	750	1930	250	1½"	1"	1½"	¾"	1"	¾"
900	750	2150	300	1½"	1"	1½"	¾"	1"	¾"
1000	900	1750	300	2"	1½"	2"	1"	1¼"	1"
1200	900	2050	300	2"	1½"	2"	1"	1¼"	1"
1500	1050	1950	450	2"	1½"	2"	1"	1¼"	1"
1750	1050	2175	450	2"	1½"	2"	1"	1¼"	1"
2000	1050	2400	450	2"	1½"	2"	1"	1½"	1½"

For alternative sizes please contact the sales office on 01457 835700





Electric Storage Calorifiers

Low installation, maintenance and off-peak costs can make electricity attractive. It can also be a cost effective back-up for other heat sources during periods of low demand and shut-down of the main primary heating source.

CALCULATING THE PRIMARY POWER REQUIREMENT
For electrically heated calorifiers, the power output is constant irrespective of the water temperature. Therefore the primary power requirement is equal to the average primary power as calculated on page 3.
Space must be allowed for withdrawal of the immersion heater for inspection. If withdrawal distance is not known, assume full length. We will be pleased to advise withdrawal distances for specific units.

Fixed Elements
Lowest cost option but if one element fails, the entire heater must be replaced.

Replaceable Elements
These are fixed to the element plate using special nuts and glands. A failed element can be replaced (after draining down the calorifier to remove the heater) without wasting the remaining good elements.

Removable Core Elements
The highest cost type. Each heater element can be withdrawn from the immersion heater and replaced without draining down the calorifier.

Element Sheath Options (The sheath is the part in contact with the water)
- **Copper -** Most commonly used
- **Nickel Alloys -** (EG Incolloy) - Recommended for use with hard water
- **Stainless Steel**
- **Titanium**

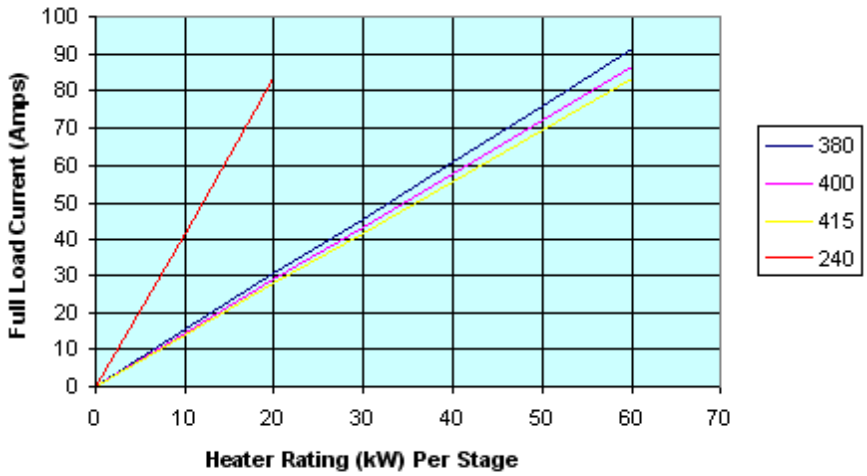


Fig 2. Typical Full Load Current of Immersion Heaters (240v 1ph & 380-415v 3ph)
Please note that when specifying a heaters' kW rating, you must also specify the working voltage to ensure full heating capacity

Standard Controls Consist of:
- Control Thermostat
- High Limit Thermostat
- Timed Stage Operation
- Low Water Cut-Out
- Volt Free Contacts for site BMS
- IP54 Steel Enclosure with Door Interlocked Isolator

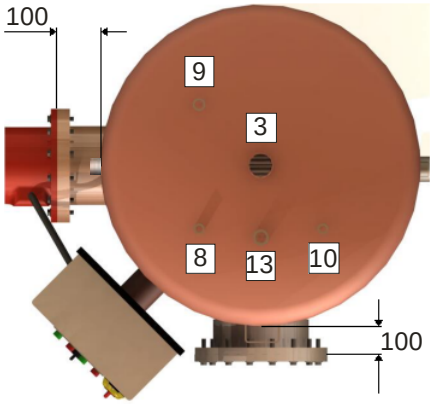
Please contact our sales office to discuss any other requirements.

Electric Storage Calorifiers

The standard range of GMS electric storage calorifiers are fitted with various types of immersion heaters and can be supplied with or without control panels.

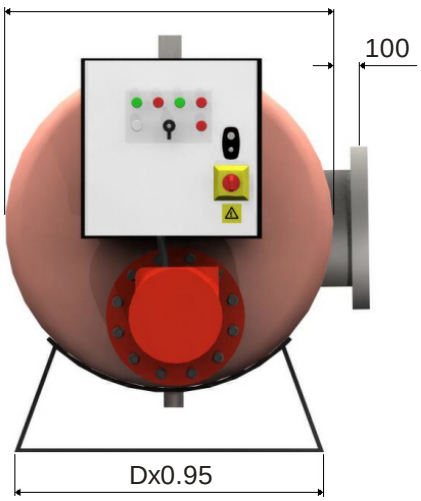
Connections

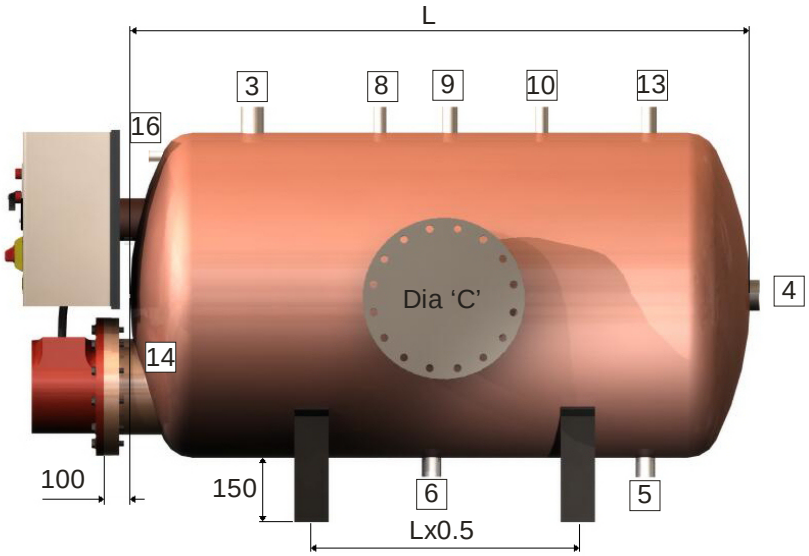
Ref	Description	Size	Ref	Description
3	Secondary Flow	Varies	10	Pressure Gauge
4	Secondary Return	Varies	11	Vent (Optional)
5	Cold Feed	Varies	12	Low Water Cut-Out (Optional)
6	Drain	Varies	13	Anti-Vacuum Valve (Optional)
7	Control Thermostat	1”	14	Immersion Heater
8	Thermometer	1/2"		
9	Safety Valve	Varies		



Size	D	L	C	Main Connection Sizes					
Litres	(mm)	(mm)	(mm)	3	4	5	6	11	13
230	500	1270	250	1¼”	1”	1¼”	¾”	1”	¾”
270	500	1470	250	1¼”	1”	1¼”	¾”	1”	¾”
360	600	1370	250	1¼”	1”	1¼”	¾”	1”	¾”
450	600	1740	250	1½”	1”	1½”	¾”	1”	¾”
500	675	1470	250	1½”	1”	1½”	¾”	1”	¾”
550	675	1720	250	1½”	1”	1½”	¾”	1”	¾”
600	750	1450	250	1½”	1”	1½”	¾”	1”	¾”
700	750	1680	250	1½”	1”	1½”	¾”	1”	¾”
800	750	1930	250	1½”	1”	1½”	¾”	1”	¾”
900	750	2150	300	1½”	1”	1½”	¾”	1”	¾”
1000	900	1750	300	2”	1½”	2”	1”	1¼”	1”
1200	900	2050	300	2”	1½”	2”	1”	1¼”	1”
1500	1050	1950	450	2”	1½”	2”	1”	1¼”	1”
1750	1050	2175	450	2”	1½”	2”	1”	1¼”	1”
2000	1050	2400	450	2”	1½”	2”	1”	1¼”	1”
2250	1200	2200	450	65	2”	65	1½”	1½”	1¼”
2500	1200	2400	450	65	2”	65	1½”	1½”	1¼”
3000	1200	2850	450	80	2”	80	1½”	1½”	1½”
3500	1350	2700	450	80	2”	80	1½”	1½”	1½”
4000	1350	3000	450	80	2”	80	1½”	1½”	1½”
Copper-Lined, Galvanised or Glass Lined Vessels only after 4000 Litre									
4500	1500	2770	450	80	2”	80	1½”	1½”	1½”
5000	1500	3050	450	80	2”	80	2”	2”	1½”
5500	1500	3350	450	100	65	100	2”	2”	2”
6000	1600	3250	450	100	65	100	2”	65	2”
7000	1600	3750	450	100	65	100	2”	65	2”
8000	1800	3450	450	125	65	125	2”	65	2x2”
9000	2000	3200	450	125	65	125	2”	65	2x2”
10,000	2000	3500	450	125	65	125	2”	65	2x2”

For alternative sizes please contact the sales office on 01457 835700





Direct Storage Calorifiers

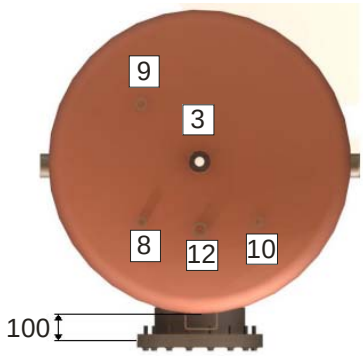
The standard range of GMS direct cylinders are specially designed to work with external heat sources such as plate heat exchangers and solar systems etc and are fitted with special internal baffles and sparges to ensure correct operation of the unit.

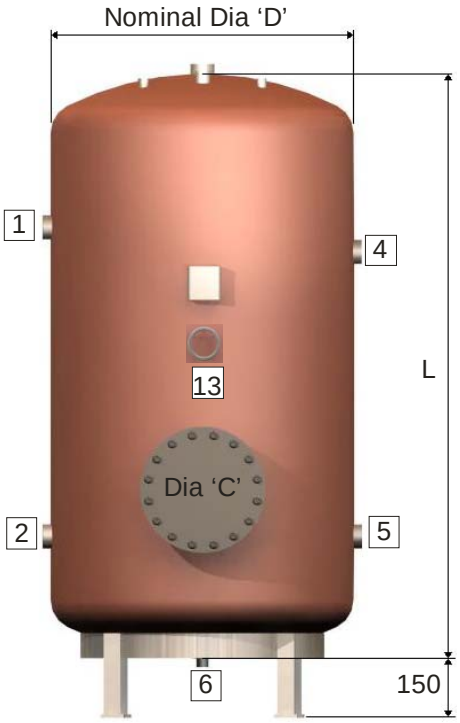
Each unit can individually designed to suit site conditions and customer requirements.

Connections

Ref	Description	Size	Ref	Description	Size
1	Primary Return	Varies	8	Thermometer	1/2"
2	Primary Flow	Varies	9	Safety Valve	Varies
3	Secondary Flow	Varies	10	Pressure Gauge	3/8"
4	Secondary Return	Varies	11	Vent (Optional)	Varies
5	Cold Feed	Varies	12	Anti-Vacuum Valve (Optional)	Varies
6	Drain	Varies	13	Immersion Heater (Optional)	Varies

Size	D	L	C	Main Connection Sizes					
Litres	(mm)	(mm)	(mm)	3	4	5	6	11	12
230	500	1270	250	1¼"	1"	1¼"	¾"	1"	¾"
270	500	1470	250	1¼"	1"	1¼"	¾"	1"	¾"
360	600	1370	250	1¼"	1"	1¼"	¾"	1"	¾"
450	600	1740	250	1½"	1"	1½"	¾"	1"	¾"
500	675	1470	250	1½"	1"	1½"	¾"	1"	¾"
550	675	1720	250	1½"	1"	1½"	¾"	1"	¾"
600	750	1450	250	1½"	1"	1½"	¾"	1"	¾"
700	750	1680	250	1½"	1"	1½"	¾"	1"	¾"
800	750	1930	250	1½"	1"	1½"	¾"	1"	¾"
900	750	2150	300	1½"	1"	1½"	¾"	1"	¾"
1000	900	1750	300	2"	1½"	2"	1"	1¼"	1"
1200	900	2050	300	2"	1½"	2"	1"	1¼"	1"
1500	1050	1950	450	2"	1½"	2"	1"	1¼"	1"
1750	1050	2175	450	2"	1½"	2"	1"	1¼"	1"
2000	1050	2400	450	2"	1½"	2"	1"	1¼"	1"
2250	1200	2200	450	65	2"	65	1½"	1½"	1¼"
2500	1200	2400	450	65	2"	65	1½"	1½"	1¼"
3000	1200	2850	450	80	2"	80	1½"	1½"	1½"
3500	1350	2700	450	80	2"	80	1½"	1½"	1½"
4000	1350	3000	450	80	2"	80	1½"	1½"	1½"
Copper-Lined, Galvanised or Glass Lined Vessels only after 4000 Litre									
4500	1500	2770	450	80	2"	80	1½"	1½"	1½"
5000	1500	3050	450	80	2"	80	2"	2"	1½"
5500	1500	3350	450	100	65	100	2"	2"	2"
6000	1600	3250	450	100	65	100	2"	65	2"
7000	1600	3750	450	100	65	100	2"	65	2"
8000	1800	3450	450	125	65	125	2"	65	2x2"
9000	2000	3200	450	125	65	125	2"	65	2x2"
10,000	2000	3500	450	125	65	125	2"	65	2x2"





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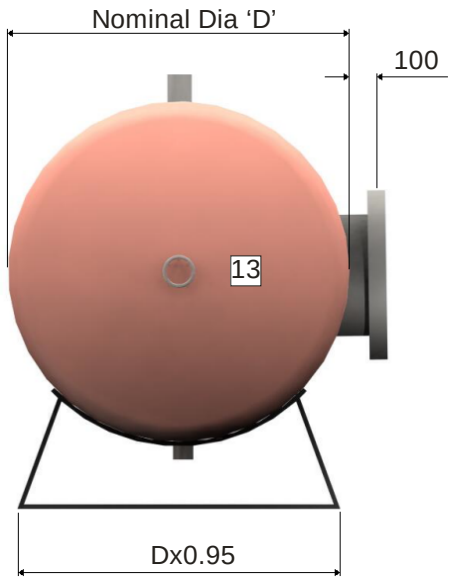

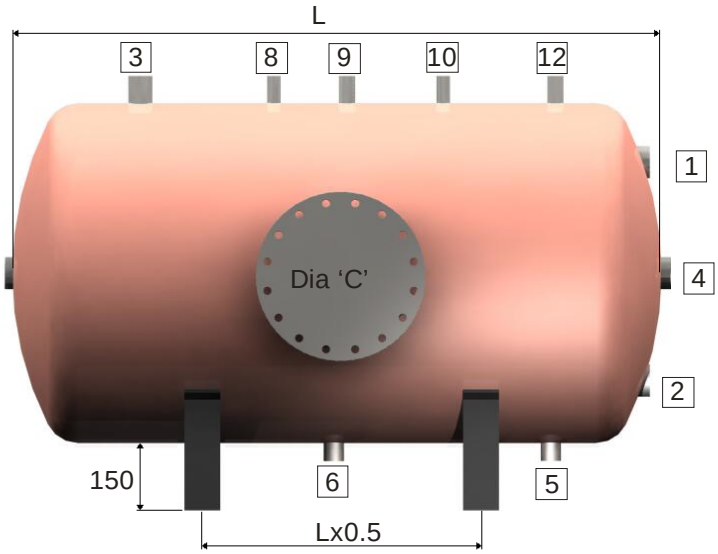

Mild Steel Buffer Vessels

The standard range of steel Buffer Vessels are suitable for both chilled water systems and heating systems.

Each unit can individually designed to suit site conditions and customer requirements.

Connections

Ref	Description	Size	Ref	Description	Size
1	System Connection	Varies	5	Pressure Gauge	3/8"
2	System Connection	Varies	6	Thermometer	1/2"
3	Drain	Varies	7	Vent	1/2"
4	Safety Valve	3/4"			

Capacity	D	L	C	Main Connection Sizes		
Litres	mm	mm	mm	1	2	3
230	500	1270	250	2”	2”	¾”
270	600	1100	250	2”	2”	¾”
300	600	1200	250	2”	2”	¾”
360	600	1370	250	2”	2”	¾”
400	600	1540	250	2”	2”	¾”
450	600	1740	250	2”	2”	¾”
500	700	1470	250	2”	2”	¾”
550	700	1580	250	2”	2”	¾”
600	700	1700	250	2”	2”	¾”
700	700	2000	250	2”	2”	¾”
800	800	1750	250	65	65	¾”
900	800	1950	300	100	100	¾”
1000	900	1750	300	100	100	1”
1200	900	2050	300	100	100	1”
1500	1000	2060	450	100	100	1”
1750	1000	2380	450	100	100	1”
2000	1100	2280	450	100	100	1½”
2250	1200	2200	450	150	150	1½”
2500	1200	2400	450	150	150	1½”
3000	1200	2850	450	150	150	1½”
3500	1400	2500	450	150	150	1½”
4000	1400	2850	450	150	150	1½”
4500	1500	2770	450	150	150	1½”
5000	1500	3050	450	150	150	2”
5500	1500	3350	450	150	150	2”
6000	1600	3250	450	200	200	2”
7000	1600	3750	450	200	200	2”
8000	1800	3450	450	200	200	2”
9000	2000	3200	450	200	200	2”
10,000	2000	3500	450	200	200	2”

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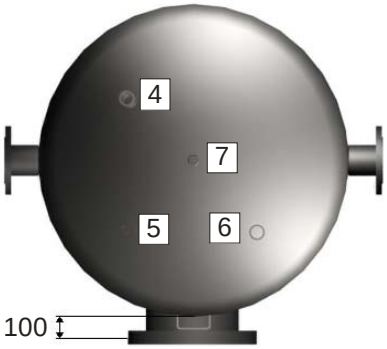

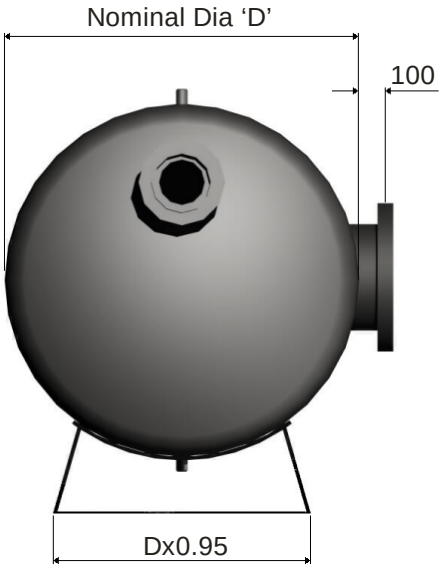

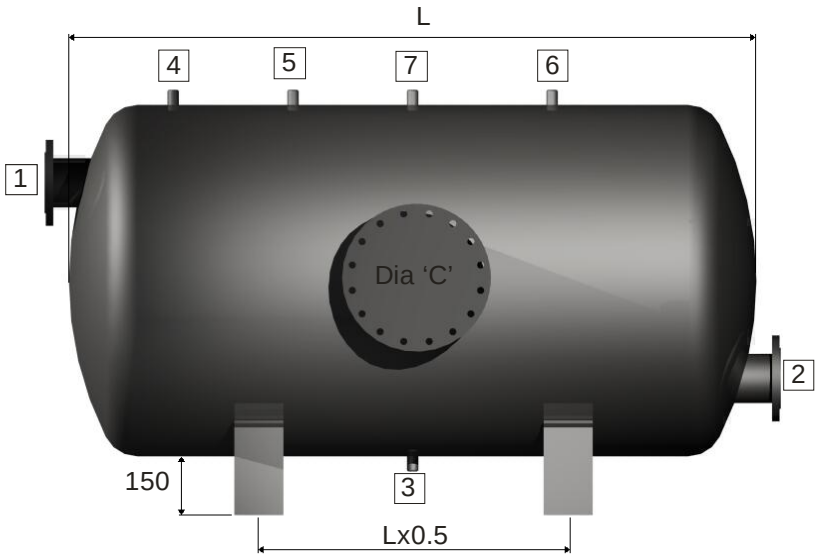

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