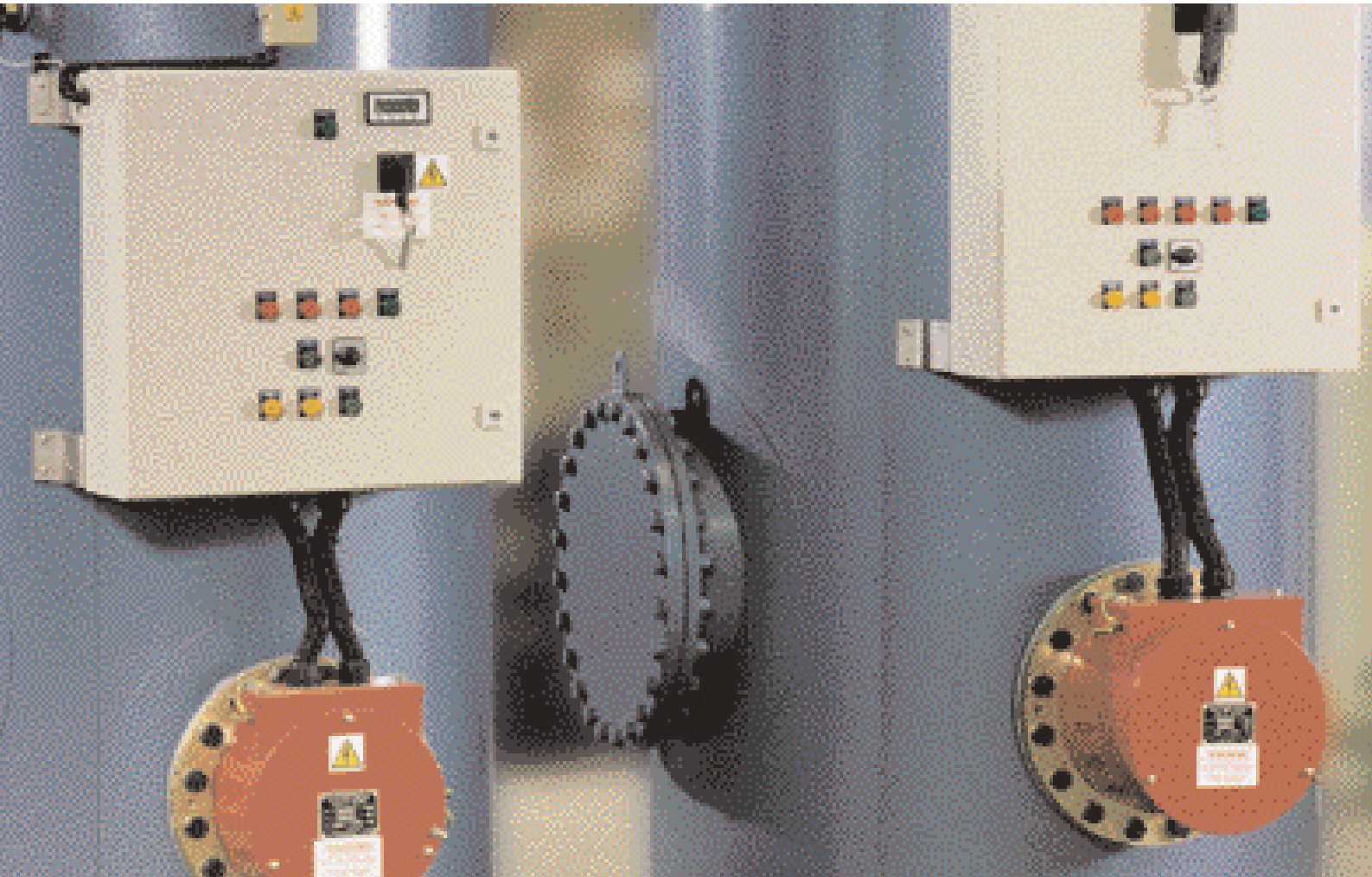


# Electric Water Heaters



# Contents

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## Electric Water Heaters

• SHELL MATERIALS	2
• IMMERSION HEATERS	4
• CONTROL PANELS	5
• INTERCONNECTING CABLES AND POWER CONSUMPTION	6
• CONTROL METHODS	7
• SELECTION AND SIZING	8
• INSTALLATION	9
• ELECTRIC STORAGE CALORIFIERS	
– SIZES AND DIMENSIONS	10
– SPECIFICATION SHEET	11
• ELECTRIC FLOW HEATERS	
– SIZES AND DIMENSIONS	12
– SPECIFICATION SHEET	13
• TYPICAL PIPEWORK SCHEMATICS	14
• ACCESSORIES	16
• EXPANSION VESSELS	18
• THERMAL STORAGE VESSELS	20
• SPARE PARTS	22

## Useful Information

• WATER QUALITY – WATER TREATMENT	23
• IMMERSION HEATERS AND EARTH LEAKAGE	24
• POWER CONSUMPTION – LINE CURRENT	25
• TYPICAL CONTROL PANEL OPERATION AND WIRING DIAGRAMS	26
• HANDLING, STORAGE AND COMMISSIONING	30
• INSTALLATION AND MAINTENANCE	31
• TROUBLE SHOOTING	32
• USEFUL FORMULAE	33

# Electric Water Heaters

ELECTRIC CALORIFIERS HAVE BECOME ONE OF THE PREFERRED MEANS OF GENERATING HOT WATER FOR BOTH DOMESTIC AND SPACE HEATING APPLICATIONS. CLEAN AND EFFICIENT IN OPERATION ELECTRIC CALORIFIERS ARE FOUND IN HOSPITALS, HOTELS, SPORTS CENTRES AND GENERAL RESIDENTIAL BLOCKS. THE VERSATILITY OF ELECTRIC HEATING ENABLES THESE UNITS TO MEET SPECIAL SITE CONDITIONS WHERE THE USE OF OTHER PRIMARY SOURCES OF ENERGY WOULD BE EXTREMELY DIFFICULT OR EXPENSIVE. BULKY PRIMARY PIPEWORK SYSTEMS, PRIMARY CONTROL VALVES OR EXHAUST FLUES ARE NOT REQUIRED.

## Storage Calorifiers

Storage calorifiers are sized to meet the peak demand period. Generally recovery periods vary between a half to four hours. Thermal storage units are also available utilising off-peak electricity tariffs. Before considering a thermal storage unit the electricity supply company should be consulted in order to ascertain the availability of off-peak tariffs.

## Flow Heaters

Flow heaters have no storage capacity and rely upon forced circulation of water through the system to dissipate the heat. Units are available for domestic water and pure heating applications.

## Benefits

- All the power supplied to the calorifier is converted into heat. There are no extraneous heat losses normally associated with a separate boiler or steam supply.
- Efficiency is maintained throughout the range of load. Even at part load all the energy is converted into heat.
- Space requirements are a minimum. There is no separate boiler plant and no fuel store.
- Installation is simplified and reduced with no primary hot water or steam equipment involved, only the calorifier has to be installed together with the power supply.

- Maintenance is kept to a minimum. Staff are not required to service external boiler plant or condensate equipment.
- Electric calorifiers are clean, produce no waste products and there are no flue gasses.
- Fuel costs are reduced with 'off-peak' tariffs (where available).
- Electric calorifiers are extremely quiet.

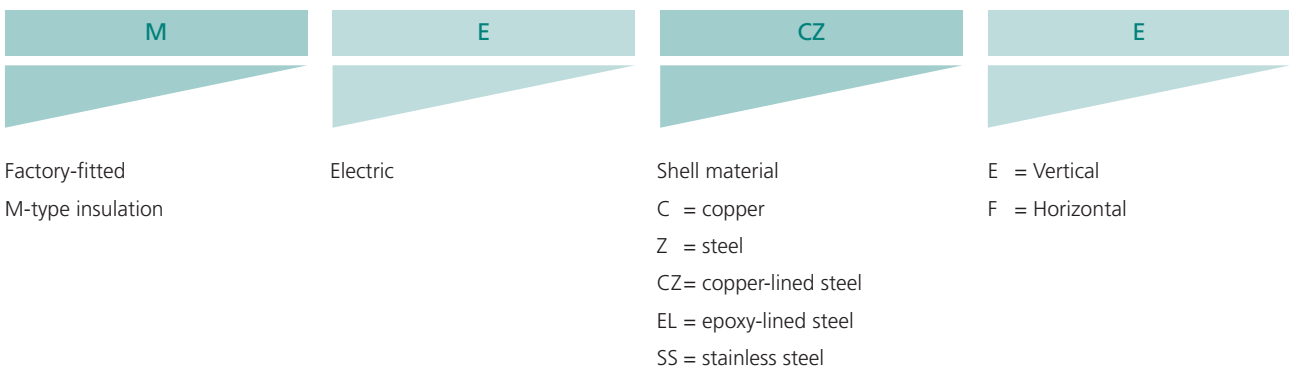
## Standards

The British Standard for electric calorifiers is BS 853:1996. For shell pressures beyond the range of this standard BS 5500:1997 is preferred. Rycroft also have a commercial range of electric calorifiers incorporating the Company's personal experience and know-how for highly competitive units.

Rycroft will design and manufacture to any of the above standards or to other codes, such as ASME VIII, where local regulations or strong preference make it necessary. Qualified welders are employed and full certification with documentation can be provided for special contracts demanding quality control assurance.

Electrical installations comply with the latest IEE regulations.

## Type references



### Example:

- MECZE = Insulated electric copper-lined steel vertical calorifier  
ZF = Uninsulated steel horizontal calorifier

# Shell Materials

## Copper Shells

Solid copper has proved to be a reliable and economical non ferrous metal for the construction of hot water storage vessels. It is used extensively throughout the world due to its long life and an ability to withstand most concentrations of corrosive elements found in domestic hot water. Modern fabricating techniques have further improved the quality of welded joints and copper alloy fittings can be selected to avoid dezincification.

The mechanism which protects copper from corrosion is the formation of a copper oxide on the metal surface. There are very few sources of fresh water which are sufficiently aggressive to prevent the formation of this oxide film. However, where such conditions do exist they are generally known locally and preventive action can be taken when the unit is first installed. The correct procedure is to fit an aluminium anode in the base of the cylinder. This sacrificial anode deposits an aluminium compound on the copper surface, which gives permanent protection and does not require further anodes to be fitted.

For open circuit applications the shell material of a flow heater must resist oxidation and be compatible with other components in the system. Copper is recommended for most swimming pool heaters and for use in conjunction with domestic hot water services. If the flow heater is incorporated into a galvanised system the shell should also be galvanised.

## Steel Copper Lined

The fabrication of large high pressure cylinders from solid copper is normally considered uneconomical and has generally been superseded by the alternative construction of steel shells lined with copper. This arrangement combines the strength of a steel vessel with the superior corrosion resistance of copper. It is essential that the copper lining is absolutely waterproof and the 'Rycolyna' technique developed by Rycroft has proved most reliable for many years. The recommended thickness of lining for the shell is 1.6mm (3lb/sq.ft.) and this increases with shell diameter. The lining is attached to the steel shell at points around the circumference and is pulled back by vacuum during manufacture to produce a good fit. Joint construction is such that longitudinal and lateral movement due to temperature and pressure changes can be accommodated without additional compensation.

An anti-vacuum valve is fitted to all copper lined shells. This valve prevents partial vacuum from forming in the shell during drain down or unusual operating conditions.

## Galvanised Steel Shells

The coating of steel with zinc by hot dipped galvanising or by metal spray has proved good protection for hot water storage cylinders over many years providing the water is hard. It is essential that a deposit of lime forms rapidly on the surface with the galvanised parts before the zinc is dissolved or deposited in other parts of the system by electrolytic action. Local knowledge will generally decide whether a galvanised cylinder is suitable for the water conditions on site, but guidance from the water supply authority should be sought if there is any doubt.

To extend the life of the zinc coating and allow further time for the scale deposit to form cylinders are supplied with magnesium anodes. This disposable element is mounted inside the shell to be sacrificed by electrolytic action in preference to the galvanised surface. Once a satisfactory scale has formed the electrolytic action ceases and this can be checked by the continued presence of the wasted magnesium anode.



Hot dipped galvanised cylinders are coated by immersing the steel shell in a molten bath of zinc. When the vessel is too large for this dipping process the zinc can be applied by hot metal spray. The technique is well proved and conforms to BS 2569. The life of a steel calorifier sprayed with zinc is comparable to a galvanised unit. The use of copper pipework in association with a galvanised cylinder is to be avoided, particularly on the hot water side if there is a secondary return to the shell. Apart from electrolytic action between copper and galvanised steel connections there is a serious risk of damaging the zinc surface. This is caused by minute particles of dissolved copper settling on the galvanised surface and producing local cells which dissolve the zinc coating and expose the steel shell beneath.

### Warning

Galvanised steel cylinders rely upon hardness salts in the water to form a protective scale. Galvanised cylinders are therefore not suitable for use with soft water. Water supplies which have traditionally been hard and satisfactory may now prove unsuitable due to changes in source.

It is therefore wrong to assume a replacement cylinder will necessarily have the same life as the original unit. With all new galvanised cylinders secondary temperatures should not exceed 60°C until a protective scale has formed and combination with copper pipework should be avoided.

Other shell materials such as austenitic and duplex stainless steels, copper-nickel alloys and epoxy coatings are also available for special applications.

The following materials are normally incorporated into Rycroft electric calorifiers:

Standard shells are manufactured from

Copper	BS 2870-C106
Steel	BS 1501-151 / 161-430A
Galvanising	BS 2569

Standard element plates are manufactured from:

Brass	BS 2875-CZ123 BS 2875-CZ112
Steel	BS 1501-151 / 161-430A



# Immersion Heaters

THE NUMBER OF IMMERSION HEATERS FITTED IN A SINGLE SHELL DEPENDS ON AVAILABLE SPACE, THE CHOICE OF STAGE HEATING AND FLEXIBILITY OF MAINTENANCE. SMALL HEATERS NORMALLY SCREW INTO THE SHELL. ABOVE 12KW THE TUBEPLATE IS USUALLY FLANGED AND BOLTED TO A NECK RING.

THE CHOICE OF VERTICAL OR HORIZONTAL MOUNTING SHOULD BE MADE WHEN ORDERING A FLOW HEATER SO THAT THE CONTROL PANEL IS CORRECTLY ORIENTATED. AN INACTIVE OR DEAD LENGTH MUST BE ADDED TO THE HEATERS FOR VERTICAL INSTALLATION.

THE MAJORITY OF ELECTRIC DESIGN CALLS FOR 3-PHASE, 415 VOLT, 50 HZ SUPPLY BUT ANY VOLTAGE OR FREQUENCY CAN BE ACCOMMODATED. DETAILS ARE REQUIRED AT THE ENQUIRY STAGE TO SIZE THE HEATERS CORRECTLY.

Immersion heaters are classified by the manner in which the heating elements are attached to the element tubesheet. Three types are commonly used namely fixed element, replaceable element and removable core element.

## Fixed Element

This is the most economical design of immersion heater. Generally it is restricted to small immersion heaters. An element failure requires the entire immersion heater to be replaced.

## Replaceable Element

The elements on this type of immersion heater can be changed (Fig. A). The calorifier contents must be drained down and the immersion heater removed from the shell before a defective element can be changed.

## Removable Core Element

This immersion heater is the most serviceable type. Failed elements can be changed without draining the calorifier or removing the immersion heater from the shell (Fig. B). The mechanical design of these immersion heaters results in a larger diameter unit however the service life benefits are significant. Removable core elements have the built in advantage of low Watts density element cores.

## Materials

Element sheaths are available in copper, incoloy or titanium. Incoloy 825 is a titanium-stabilised nickel-chromium-iron-molybdenum-copper alloy, and is the preferred choice of material for element sheaths.

## Watts Density

The Watts Density of an immersion heater element is arguably the most significant issue for water heating. Generally the maximum Watts Density used for fresh water calorifiers is 7.8 W/sq.cm. (50 W/sq.in.). Providing a water softening plant is used 7.8 W/sq.cm. should be satisfactory, however, for raw water applications we consider this figure to be too high.

### Some of the basic rules concerning Watts Density are:

The lower the Watts Density the longer the service life.

The lower the Watts Density the larger the immersion heater.



Fig. A



Fig. B



# Control Panels

ENCLOSURES ARE A MINIMUM OF 1.5MM SHEET STEEL, NORMALLY TO IP 66 DIP COAT PRIMED AND POWDER COATED IN RAL 7032 GREY, WITH A TOP GLAND PLATE FOR INCOMING CABLE ENTRY.

ALL ELECTRICAL SYSTEMS CONFORM TO EUROPEAN EMC DIRECTIVE APPLICABLE STANDARDS AND CARRY THE CE MARK.

ALL THE WIRING OF PANEL AND COMPONENTS ARE TO IEE (CURRENT EDITION) STANDARD.

The following features are available:

## Front Panel Controls and Fittings

- Door Interlocked Isolator
- Test/Off/Auto Switch
- Test and Fault Reset Buttons
- Door Lock(s)
- Pump Controls
- Labels

## Typical panel illuminating indicators:

### General

- Power On
- Automatic
- Stage(s) On – were applicable.

### Safety Shutdown

- High Temperature Fault
- Low Water Fault.

### Pump status

- Duty
- Running
- Stopped
- Tripped.

## General

Suitability rated protective circuit breakers, fuses are fitted to the control circuit and each phase of each stage of heater supply to break the supply on fault condition.

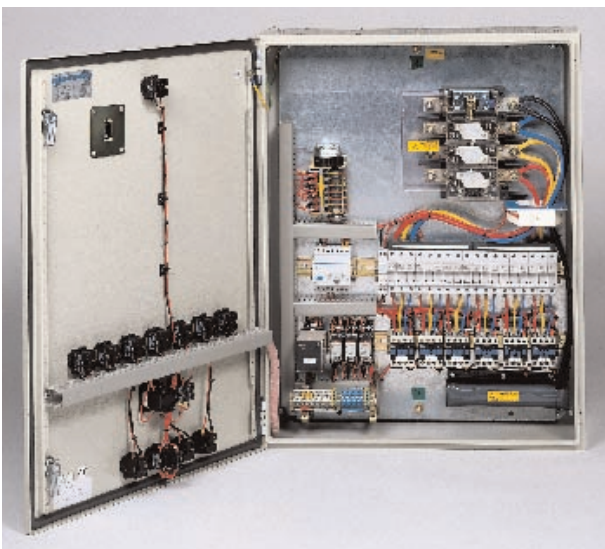
All components are of proven reliability.

Four terminals are provided to allow remote switching of the heaters.

Components are Din Rail mounted wherever possible for ease of component removal.

volt free contacts are provided for fault condition/healthy signals are supplied as standard.

On safety shut down the fault will be displayed on the front panel. The heater cannot be re-started until the fault is addressed and the reset button pressed.



Panels are built to meet specific contract requirements. Not all the features listed unless specified will be fitted.

# Interconnecting Cables and Power Consumption

## Interconnecting Cables

INTERCONNECTING CABLES ARE IN 105°C, TRI-RATED, PVC INSULATED SWITCHGEAR CABLE TO BS 6231 UL APPROVED AS FLAME RETARDING, WITH COLOUR CODED CABLE MARKERS.

### External Components

The conduits to wired shell mounted equipment are in black reinforced oil resisting flexible conduit, terminated in proprietary waterproof glands. All the components carry world wide approvals and will not support combustion.

Shell mounted thermostats, heaters, pumps (where fitted) and low water probes have totally enclosed terminal heads, and are fully earthed for safety.

### Control Wiring

All control wiring is in 0.5mm<sup>2</sup> tri-rated wire unless otherwise stated. Insulated bootlace ferrules are used as standard termination.

### Earthing

All heater head covers are earthed in 6mm<sup>2</sup> earth wire, minimum. Cables above 10mm<sup>2</sup> that are terminated in the panel shall be connected to a dedicated stud, with only two cables maximum per stud. Components to be earthed are:

Heater Head Cover	Heater Gland Plate
Heater Front Inspection Cover	Heater Head Cover
Heater Head Brass Plate	Metallic Thermostat Housing Covers

All panels mounted on back plates should be 'Spaced Off' to allow heat dissipation.

## Power Consumption

A SUITABLY-SIZED FEEDER CABLE WITH ADEQUATE MECHANICAL PROTECTION MUST BE USED TO SUPPLY THE CALORIFIER PACKAGE. STEEL WIRE ARMoured, PVC COVERED. SINGLE CORE PVC COVERED CABLE IN CONDUIT OR TRUNKING BEING THE MOST COMMON.

Line currents can be read from the *Power Consumption and Line Current* table (See page 25). Once the current for each line of supply is known, the required cable size can be determined. However, de-rating factors for cable length, method of installation, ambient temperatures and type of protection must be applied.

All bends should be as gentle as possible and as a guide, the radius should be no less than 8 times the diameter of the cable.

$$R = 8 \times D \text{ (Minimum)}$$

The cable should be frequently supported along its full length, typically at half metre intervals, and must have suitably rated protection and means of isolation at the supply end.

The cable should be put into the control panel using a waterproof gland or seal. The supply cores are usually three phases, neutral and earth.

### Note

Some installers prefer to use the armourings of the cable, the metal of the conduit or the trunking as earth. If this method is used, the paint around the gland plate entry hole is normally removed back to bare metal on the inside face to ensure good electrical contact between the locking nut/washer and the panel body. It is usual to fit a sealing washer on the outside and a serrated washer with earth tag on the inside. A green/yellow earth cable must then be run from the tag to the main panel earth.

The earth cable should be the same size as the feeder cable cores, with good connections at either end, ensuring metal to metal contact. The connection of the power cores, phase 1 (red), phase 2 (yellow), phase 3 (blue), can now be made. All efforts are made to provide as much room as possible for the incoming cables to allow a gentle sweep into the panel isolator. This should be considered before drilling holes for glands, etc, and care must be taken not to damage other components.

Reference should be made to IEE or local regulations.



# Control Methods

WITH HIGH POWER MULTI-STAGE IMMERSION HEATERS IT BECOMES IMPORTANT TO SPREAD THE SWITCHING ON OF THE LOAD INTO SMALLER STEPS OR STAGES. THIS IS DESIRABLE FOR TWO MAIN REASONS:

1. TO EFFECT CONTROL OF THE POWER TO THE HEATER, FOR ECONOMY, ACCURACY AND SAFETY.
2. TO PREVENT PREMATURE FAILURE OF CABLES AND COMPONENTS.

THE FOLLOWING ARE SOME TYPICAL EXAMPLES OF MANAGING THE ELECTRICAL LOAD.

## Timers

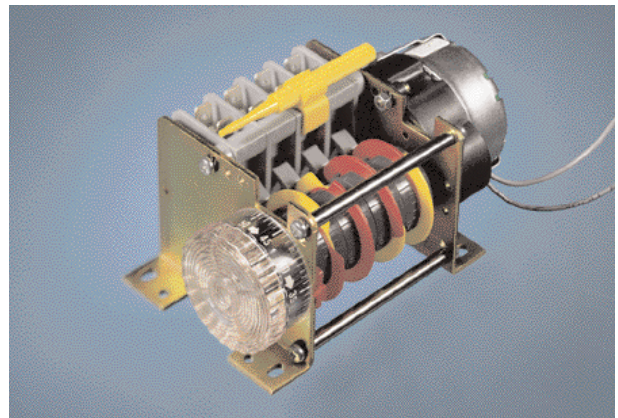
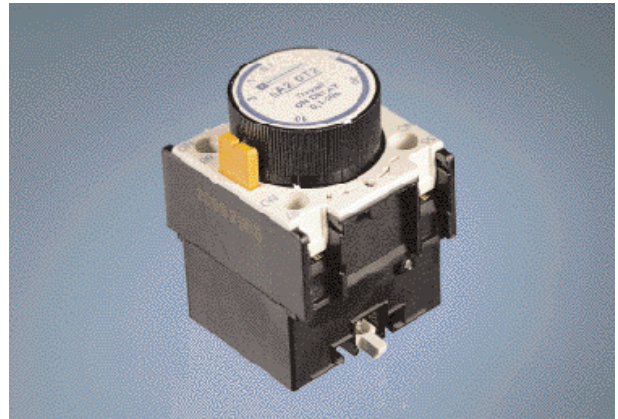
Timers prevent the simultaneous switching of immersion heater stages. The time interval between switching can be increased from the minimum factory setting of 10 seconds.

## Random Cam

For larger immersion heaters the use of cam driven micro switches is recommended. Intervals between stage switching can be changed by adjusting the cams or speed of the driving unit. The unit powers stages as the cam drive rotates. At the control set point all the stages are de-energised simultaneously. On subsequent energising, the first stage activated will be determined by the position of the cam. In this manner the controller will power a different initial stage on each heating cycle.

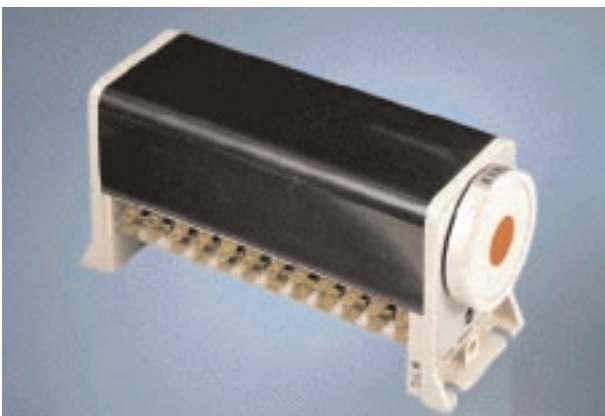
## Digital Step Controllers

Thyristor control, digital step controllers and temperature indicator controllers can be used where very accurate temperature control is required. Domestic hot water systems in general do not need this level of control.



## Controlled Cam (Modulating)

These are used when the volume of system water is small or reduced (eg in flow heater installations). The heater stages are switched on by motor-controlled adjustable cams. The motor may be driven in either direction or stopped in a fixed position so that the number of stages switched on exactly matches the heating demand and reduces the risk of overheating the water.



# Selection and Sizing

## Storage Calorifiers

The consumption of domestic hot water in public buildings fluctuates throughout the day and where possible data should be collected to establish the peak demand. The table below gives typical maximum hourly demand rates for water at 65°C.

The provision of a one hour storage capacity with a one hour heat-up period is generally sufficient to cope with the peak demand. If the power supply is limited it is advisable to increase the storage volume for reducing the power input, as shown in the table below. Storage volumes less than one hour capacity need careful consideration. If there is a high demand for a short period the storage volume must be sufficient to meet that demand.

Off peak heating at reduced tariff offers considerable financial savings, particularly if the storage volume can be increased. Unless the extra volume is sufficient to meet the entire day's demand subsidiary heaters are necessary to keep the top of the cylinder hot once the overnight storage has been consumed.

Reduced Power	Increased Capacity	Recovery Hours
1	1	1
2/3	2	3
1/2	3	6

## Flow Heaters

Flow heaters for closed circuit applications have their maximum rating determined by the process or heating load calculations. This may be stated as a flow rate and temperature rise or simply as a power consumption in kW.

The power equation for water is:

$$\text{kW} = \text{flow in l/s} \times \text{temp. rise in } ^\circ\text{C} \times 4.187.$$

The flow through the heater is important and if necessary should be calculated to determine the connection sizes listed in Table 3.

Flow heaters for open circuit applications have their duty calculated in a similar manner. The hourly demand rate calculated for storage calorifiers cannot be used for a flow heater unless it is coupled to a storage system. Fluctuations in demand found with domestic hot water systems are generally too rapid for a flow heater to react satisfactorily without some storage capacity.

Maximum Demand Rates (litres/hour)										
Installation	Private Hand Basin	Public Hand Basin	Shower *	Bath	Slop Sink	Bar Sink	Kitchen Sink	Pantry Sink	Laboratory Sink	Load Factor
Hospital	10	15	70	60	50		80			0.7
Hotel and Residential Hall	10	15	50	50	50	100	80			0.5
Day School	5	20	180		40		80			0.8
Sports Centre	5	15	220		40	100	80			1.0
Restaurant	5	25			100	100	140	120		1.0
University	5	20	220		40		80		40	0.8
Offices	5	10			40		40		40	1.0
Factory	5	20	120		50		80		40	1.0

\* Where a shower and bath are combined in a single cubicle it is only necessary to use one demand rate and the total number of cubicles.

## Example

Hospital Wing (10 to 65°C)

70 private handbasins	10x70	=	700
10 public handbasins	15x10	=	150
12 showers	70x12	=	840
12 baths	60x12	=	720
8 slop sinks	50x8	=	400
6 kitchen sinks	80x6	=	480
	Total	=	3290
Factor 0.7:	Maximum Demand	=	3290 x 0.7
		=	2303 l/hr
Power Input for Maximum Demand		=	$\frac{\text{litres/hr} \times \text{temp. rise} \times 4.187}{3600}$
		=	$\frac{2303 \times (65-10) \times 4.187}{3600}$
		=	147.3 kW

A calorifier of 2300 litres capacity with a heater output of 150 kW is adequate.

If the power available is only 100 kW the storage volume should be increased to say 4500 litres in accordance with the recommendations in the table above.

For storage temperatures below 65°C the hot water demand must be increased proportionately,

# Installation

## Storage Calorifiers

Apart from electrical requirements and safeguards mentioned elsewhere in this leaflet the installation details are very similar to those of any storage calorifier.

The cold feed and secondary flow should be adequately sized to prevent disturbance of the stored water. Stratification is an important feature of a storage calorifier and a high velocity flow of cold water can cause mixing. Maximum flow rates for different connection sizes are given in Table 1 and if the peak flow rate can be estimated this should be used in preference to the hourly consumption figure.

A small secondary circulation through the distribution pipework is recommended for most domestic hot water systems. This maintains the service temperature by replacing heat losses in the pipework. Having estimated the heat loss the circulation rate should be based on a temperature drop of about 5°C. The secondary return connection to the cylinder can be obtained from Table 1 using the pump flow in place of the peak flow in litres/second.

A vent connection from the cylinder is essential for release of air from the heated water, for expansion or contraction of the water and for inlet of air when the cylinder is drained. In many instances the vent is a continuation of the secondary flow connection, but where this is not convenient a separate vent connection can be added near the top of the cylinder. Recommended vent sizes are given in Table 2.

If an open vent is not possible, other provisions must be made for the functions mentioned above.

For example an automatic vent can release air and an anti-vacuum valve will admit air for draining purposes. An expansion vessel will almost certainly be necessary for changes in volume if there is no open vent. Refer to Rycroft Expansion Vessel section.

Where two calorifiers share a common vent system it is important that the 3-way cocks are fitted correctly.

**Table 1. Maximum Secondary Flow**

Connection ins	Size mm	Hourly Demand l/hr	Peak Demand l/s
1	25	150	0.1
1½	40	400	0.3
2	50	850	0.6
2½	65	1400	1.0
3	80	2500	1.5
4	100	5500	2.5
5	125	11000	4.0
6	150	20000	6.0

**Table 2. Size of Vent Pipes**

Diameter mm	25	32	38	50	63
Max. Output kW	60	150	300	600	>600

## Flow Heaters

The layout and connections for a flow heater are different to those for a storage calorifier. Circulation through the flow heater is normally constant and changes in load are reflected in the return temperature from the system. The velocity through the connections can be much higher and the maximum flow for each nozzle size is given in Table 3.

A vent is equally important for this type of water heater and for open vented circuits the sizes given in Table 2 are recommended. Closed circuits require special attention with adequate provision for expansion and contraction of the water and for movement of air when filling and draining the system.

When a flow heater is used in conjunction with a storage vessel for domestic hot water services it should be fitted with its own recirculation pump.

This pump will maintain a constant flow across the unit and enable the heater to continue with a steady input regardless of fluctuating demand.

**Table 3. Maximum Secondary Flow**

Nozzle Dia. mm	25	40	50	80	100	125	150	200	250
Flow l/s	0.75	1.9	3.0	7.7	12	19	27	48	75

### Note

**Foundations.** Calorifiers should be mounted on prepared foundations which are level. Even a slight tilt can cause an airlock. It is also important that the vessels stand firmly on the ground to prevent movement when heaters are removed or other forms of maintenance undertaken.

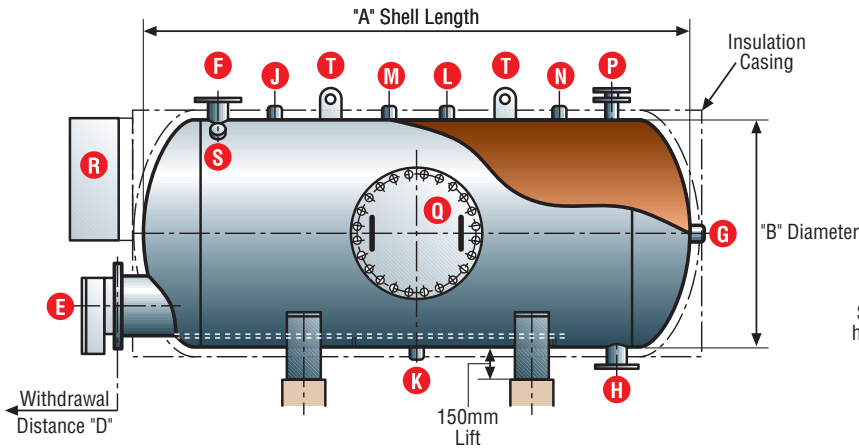
**Relief Valve.** The relief valve and any bursting disc both require a discharge pipe equal in size to the outlet port of the safety device.

**Precaution.** It is important for safety reasons that the discharge pipe is laid with a continuous downward gradient clear of the calorifier or storage vessel to a place where the discharge is visible and cannot injure any person.

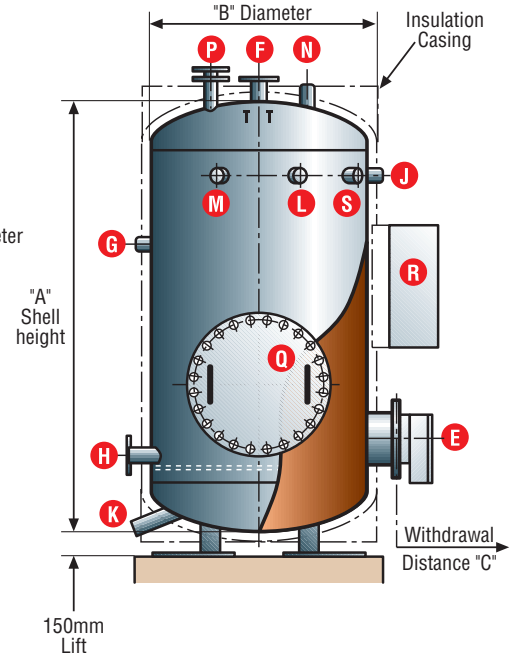
# Electric Storage Calorifiers

## Sizes and Dimensions

Horizontal Pattern



Vertical Pattern



**DESCRIPTION**

- E Immersion Heater
- F Secondary Flow
- G Secondary Return
- H Cold Feed
- J High Limit Safety Thermostat
- K Drain
- L Thermometer
- M Pressure Gauge
- N Safety Valve/Pressure Temperature Relief Valve
- P Anti Vacuum Valve (factory fitted on copper lined calorifiers)
- Q Inspection Opening
- R Control Panel
- S Low Water Cut-Out Probe (optional extra)
- T Lifting Points

Capacity	Dimensions (mm)				Dry Weights (kg)		
					Copper	Steel	Steel
Litres	A	B	C (max.)	D (max.)	4 Bar Test Pressure 2.7 Bar Design Pres.	10.5 Bar Test Pressure 7 Bar Design Pres.	15 Bar Test Pressure 10 Bar Design Pres.
440	1800	600	600	1500	140	250	250
550	1700	675	675	1500	160	260	260
700	1750	750	750	1500	190	300	300
800	1950	750	750	1500	200	330	330
900	2000	800	800	1500	225	400	500
900 Alt	1650	900	900	1500	225	400	500
1000	1950	750	750	1500	250	430	540
1000 Alt	1800	900	900	1500	250	430	540
1200	2100	900	900	1500	280	480	600
1350	2350	900	900	1500	300	530	660
1500	1950	1050	1050	1500	365	550	680
1800	2300	1050	1050	1500	405	630	780
2000	2500	1050	1050	1500	430	670	830
2000 Alt	2000	1200	1050	1050	430	670	830
2300	2400	1150	1150	1500	500	740	900
2500	2450	1200	1200	1500	510	800	1000
3000	2900	1200	1200	1500	585	910	1140
3000 Alt	2350	1350	1350	1500	383	910	1140
3500	2700	1350	1350	1500	715	1250	1470
4000	3050	1350	1350	1500	770	1370	1620
4000 Alt	2700	1450	1450	1500	770	1370	1620
4500	3400	1350	1350	1500	845	1500	1750
4500 Alt	2700	1500	1500	1500	845	1500	1750
5000	3200	1450	1450	1500	964	1500	1750
5000 Alt	2700	1600	1500	1500	964	1500	1750
6000	3800	1450	1450	1500	1130	1720	2020
6000 Alt	3200	1600	1500	1500	1130	1720	2020
7000	3300	1680	1500	1500	1355	2350	2800
8000	3700	1680	1500	1500	1510	2560	3050
9000	4200	1680	1500	1500	1590	2820	3360
9000 Alt	3700	1830	1500	1500	1590	2820	3360
10000	4600	1680	1500	1500	1820	3030	3610
12500	6000	1830	1500	1500	2760	4360	5270
15000	6000	1830	1500	1500	2760	4360	5270
15000 Alt	5300	2000	1500	1500	2760	4360	5270

Alt denotes alternative shell dimensions for a given capacity.

Weights/dimensions are approximate and for guidance only. Other pressure ratings and sizes are available on request. Leg height may vary. Calorifiers illustrated above are copper lined mild steel. For copper lining purpose on the smaller calorifiers bolted head would be fitted in lieu of inspection opening.

# Electric Storage Calorifiers

## Specification Sheet

### Order or Enquiry Specification

THE FOLLOWING CHECK LIST CONTAINS A CHOICE OF CLAUSES FOR MATERIAL AND EQUIPMENT TO ASSIST WITH THE PREPARATION OF A PERSONAL SPECIFICATION.

One Rycroft vertical (horizontal) electric water heater type ●●●● with a capacity of ●●●● litres having a maximum working pressure of ●●●● bar and hydraulically tested ●●●● bar. The calorifier shall be fitted with immersion heaters to give a maximum output of ●●kW and capable of raising the contents from ●●°C to ●●°C in ●● hour(s).

The shell shall be constructed from low carbon steel to BS 1501-151-430A and lined with copper sheet not less than 1.6mm thick (3 lb/sq.ft) (solid copper to BS 2870 C106, or low carbon steel to BS 1501-151-430A and galvanised in accordance to BS 729, or low carbon steel to BS 1501-151-430A). The shell thickness and fabrication shall comply with BS 853 1996 (BS 5500 1997, etc.).

A manhole shall be provided in accordance with the relevant BS code.

Secondary connections shall be screwed to BS 21 or flanged to BS 4504 for the following connections:

Secondary flow outlet.

Secondary return inlet.

Cold feed inlet.

The shell shall be fitted with screwed connections for the following mountings (supplied loose for site assembly).

Safety valve/pressure temperature relief valve set at ●● bar.

100mm dial pressure gauge calibrated 0-●● bar and psi c/w gauge cock.

100mm dial thermometer calibrated 0-120°C and °F.

Drain cock with hose union and removable key.

Anti-vacuum valve (factory fitted on copper lined calorifiers).

Sacrificial aluminium (magnesium) anode.

Low water cutout (factory fitted).

100mm (150mm) high fixed steel legs (150mm high cradles).

The shell to be fully lagged with Rycroft 'M' type insulation consisting of fibreglass mattresses 50mm thick encased in galvanised steel sheet painted with one coat of gloss blue paint.

The electric supply will be ●● volts, ●● phase, ●● hertz and the control circuit to be ●● volts, single phase. The heater stages are to be arranged for ●● stage control. The immersion heaters must not be rated in excess of ●● W/sq.cm. and the elements are to be replaceable Incoloy (copper, titanium, stainless steel, etc) sheathed with mechanical seals (fixed, removable core without draining the shell).

The water heater to be fitted with a factory fitted shell mounted pre-wired control panel with the following:

Thermostatic control shall comprise of a thermostatic switch for each step with facilities for adjusting the temperature differential between stages (a single thermostat with motorised sequence).

High temperature safety thermostat mounted on the shell.

Low water cutout mounted on the shell.

Circulating pump interlock.

Panel door interlock to be provided to isolate the panel from the mains when the door is opened.

Test buttons.

Indicator lamps for all stages and power ON lamp.

High temperature safety thermostat and low water cutout to be supplied with manual reset button, fault indicator lamps and volt free contacts for external alarm.

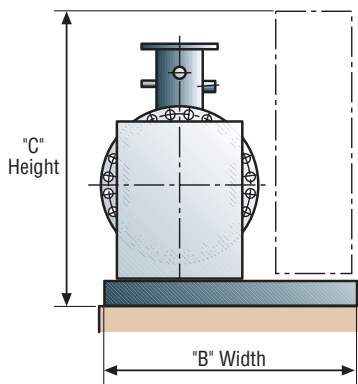
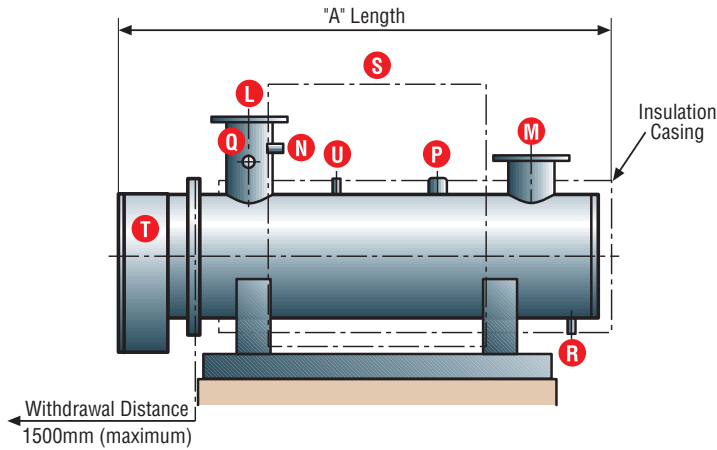
Prior to despatch all controls are to be electrically tested. Flash testing will be at twice the working voltage (or 2000 volts).

The insulation resistance of individual elements shall not be less than 1 megaohm.

# Electric Flow Heaters

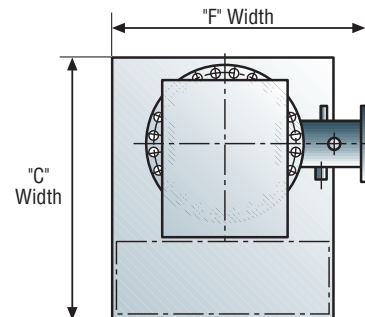
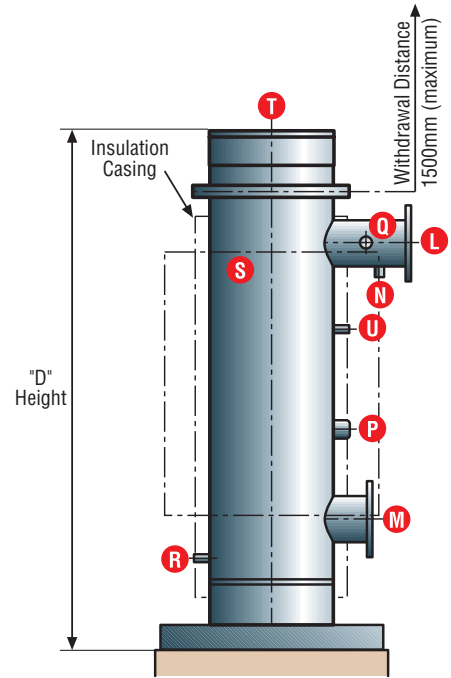
## Sizes and Dimensions

Horizontal Pattern



- DESCRIPTION**
- L Secondary Outlet
  - M Secondary Inlet
  - N Control Thermostat
  - P Safety Valve
  - Q Low Water Cut-Out
  - R Drain
  - S Control Panel
  - T Immersion Heater
  - U Pressure Gauge

Vertical Pattern



Model	Dimensions (mm)						Electrical Data			Dry Weights (kg)	
							Number of Stages	Full Load Current (Amps)		11.55 Bar Test Pressure 7 Bar Design Pressure	
	A	B	C	D	E	F		415/3/50	380/3/50	Copper	Steel
FH30	1750	550	600	1950	750	550	2	50	55	135	160
FH45	1750	600	700	1950	750	600	3	75	82	165	190
FH60	1750	600	800	1950	750	600	3	100	110	175	200
FH75	1800	800	850	2000	800	600	3	125	137	190	220
FH90	1800	800	880	2000	800	600	3	150	164	200	230
FH105	1800	800	1050	2000	850	650	4	175	192	210	240
FH120	1800	800	1100	2000	850	850	4	201	219	220	250
FH150	1850	870	1100	2050	1000	950	5	251	274	290	320
FH180	1850	870	1100	2050	1000	1000	6	301	329	310	340
FH210	1850	950	1200	2050	1100	1200	7	351	383	380	420
FH240	1850	950	1200	2050	1100	1200	8	401	438	400	440
FH270	1850	950	1250	2050	1100	1250	9	451	493	420	460
FH300	1850	1000	1250	2050	1250	1300	10	501	548	550	600
FH330	1850	1000	1300	2050	1275	1350	11	552	602	570	620
FH360	1850	1000	1500	2050	1275	1500	12	602	657	590	640
FH405	1850	1000	1500	2050	1300	1500	9	677	739	620	670
FH450	1850	1000	1800	2050	1450	2000	10	752	821	670	720

Weights/dimensions are approximate and for guidance only.  
 Flow heater illustrated above is mild steel. Other pressure ratings and sizes are available on request.  
 When considering overall length allowance must be made for interconnecting pipework.

# Electric Flow Heaters

## Specification Sheet

### Order or Enquiry Specification

THE FOLLOWING CHECK LIST CONTAINS A CHOICE OF CLAUSES FOR MATERIAL AND EQUIPMENT TO ASSIST WITH THE PREPARATION OF A PERSONAL SPECIFICATION.

One Rycroft vertical (horizontal) electric flow heater type •• having a maximum working pressure of •• bar and hydraulically tested •• bar. The calorifier shall be fitted with immersion heaters to give a maximum output of •• kW and capable of raising the contents from ••°C to ••°C in •• hour(s).

The shell shall be constructed from low carbon steel to BS 1501-151-430A (or solid copper to BS 2870 C106, or galvanised in accordance to BS 729). The shell thickness and fabrication shall comply with BS 853 1996 (BS 5550 1997, etc).

Secondary connections shall be flanged to BS 4504 for the following connections:

Secondary flow outlet.

Secondary return inlet.

The shell shall be fitted with screwed connections for the following mountings (supplied loose for site assembly).

Safety valve/pressure temperature relief valve set at •• bar.

100mm dial pressure gauge calibrated 0-•• bar and psi c/w gauge cock.

Drain cock with hose union and removable key.

Low water cutout (factory fitted).

Control thermostat (factory fitted).

100mm dial thermometer calibrated 0-120°C and °F (for fitting into secondary flow pipework).

150mm high steel legs (150mm high steel cradles) to be fitted to the shell with steel skid base frame.

The shell to be fully lagged with Rycroft 'M' type insulation consisting of fibreglass mattresses 50mm thick encased in galvanised steel sheet painted with one coat of gloss blue paint.

The electric supply will be •• volts, •• phase, •• hertz and the control circuit to be •• volts, single phase. The heater stages are to be arranged for •• stage control. The immersion heaters must not be rated in excess of •• W/sq.cm. and the elements are to be replaceable Incoloy (copper, titanium, stainless steel, etc) sheathed with mechanical seals (fixed, removable core without draining the shell). The water heater to be fitted with a factory fitted shell mounted pre-wired control panel with the following:

Thermostatic control shall comprise of a thermostatic switch for each step with facilities for adjusting the temperature differential between stages (a single thermostat with motorised sequence and a single thermostat with modulating control).

High temperature safety thermostat mounted on the shell.

Low water cutout mounted on the shell.

Circulating pump interlock.

Panel door interlock to be provided to isolate the panel from the mains when the door is opened.

Test buttons.

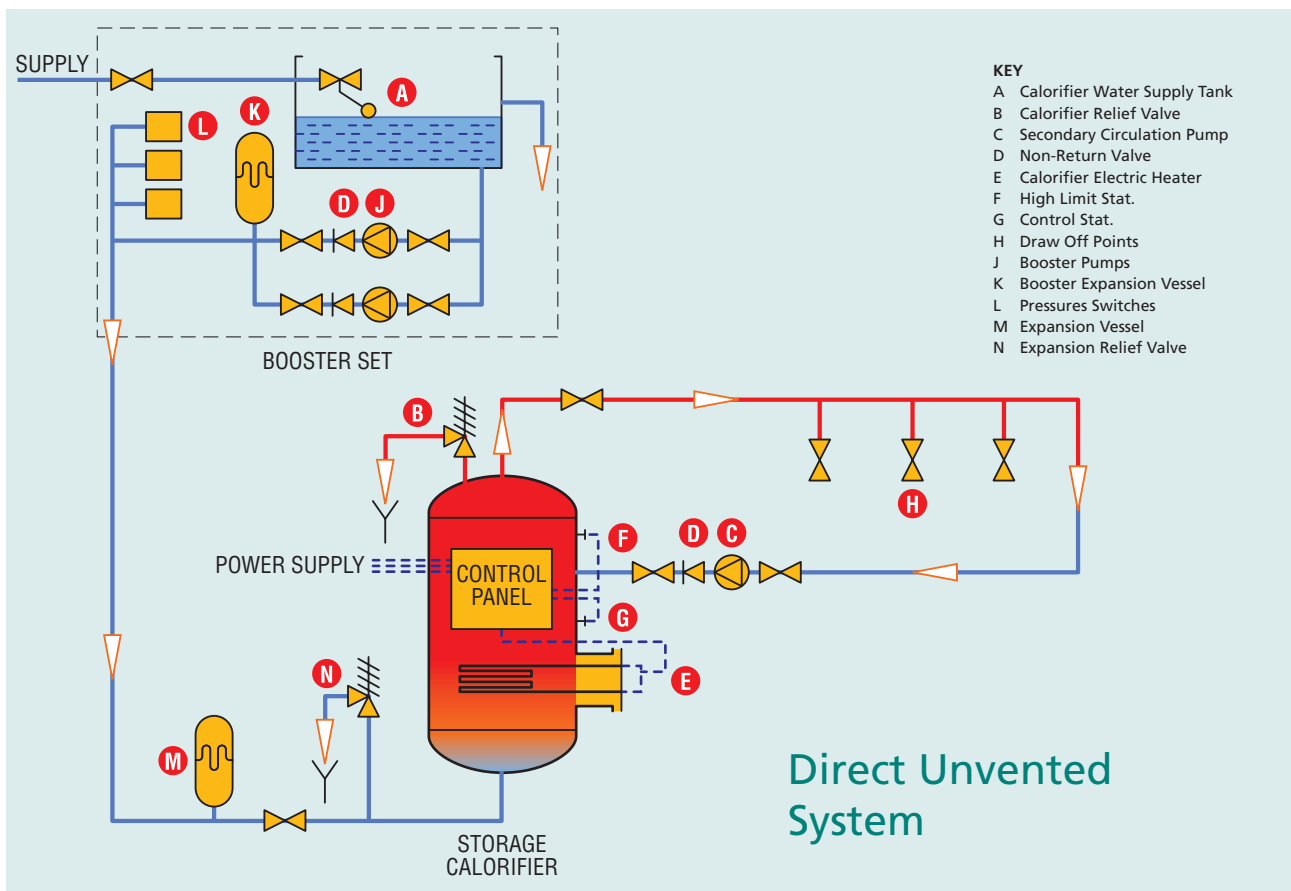
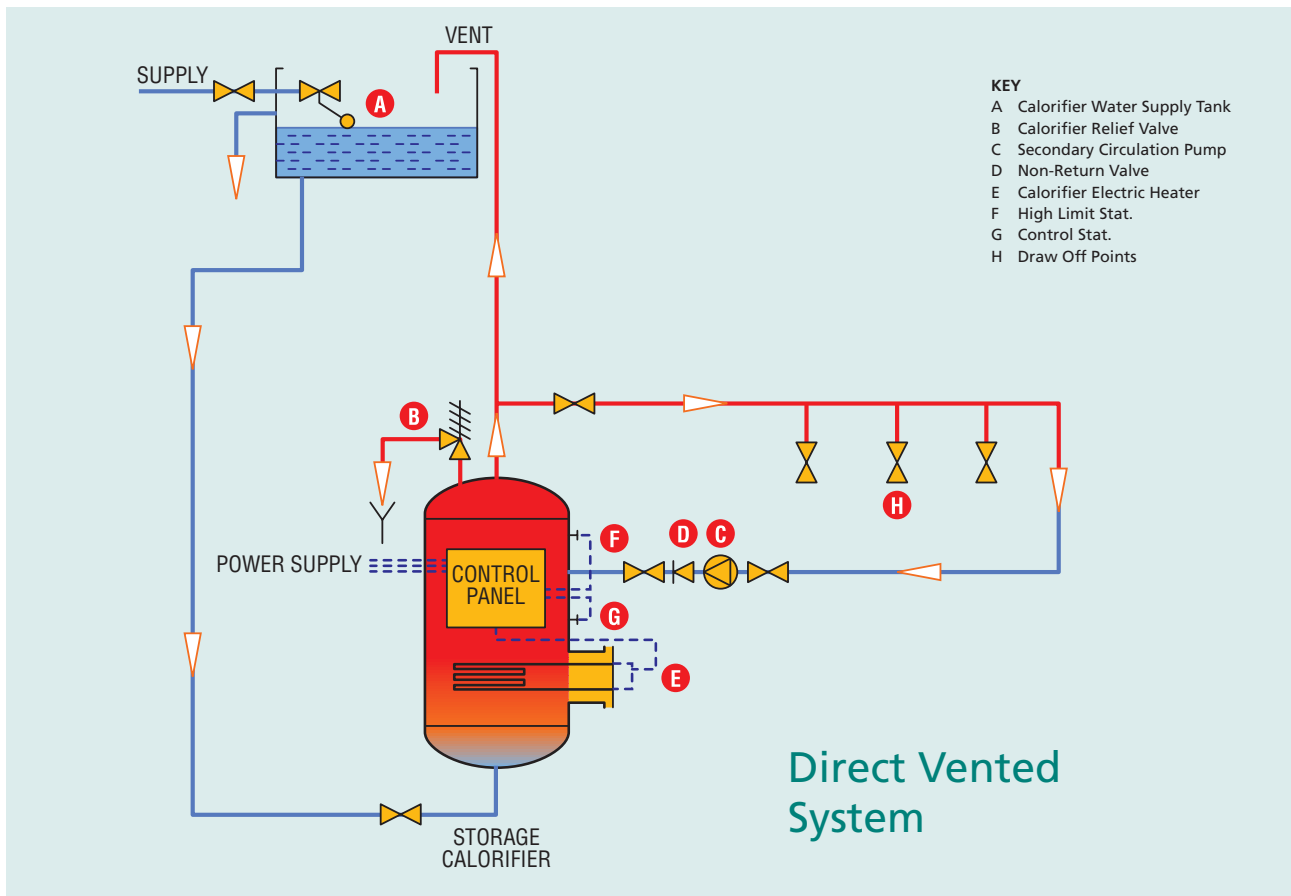
Indicator lamps for all stages and power ON lamp.

High temperature safety thermostat and low water cutout to be supplied with manual reset button, fault indicator lamps and volt free contacts for external alarm.

Prior to despatch all controls are to be electrically tested. Flash testing will be at twice the working voltage (or 2000 volts).

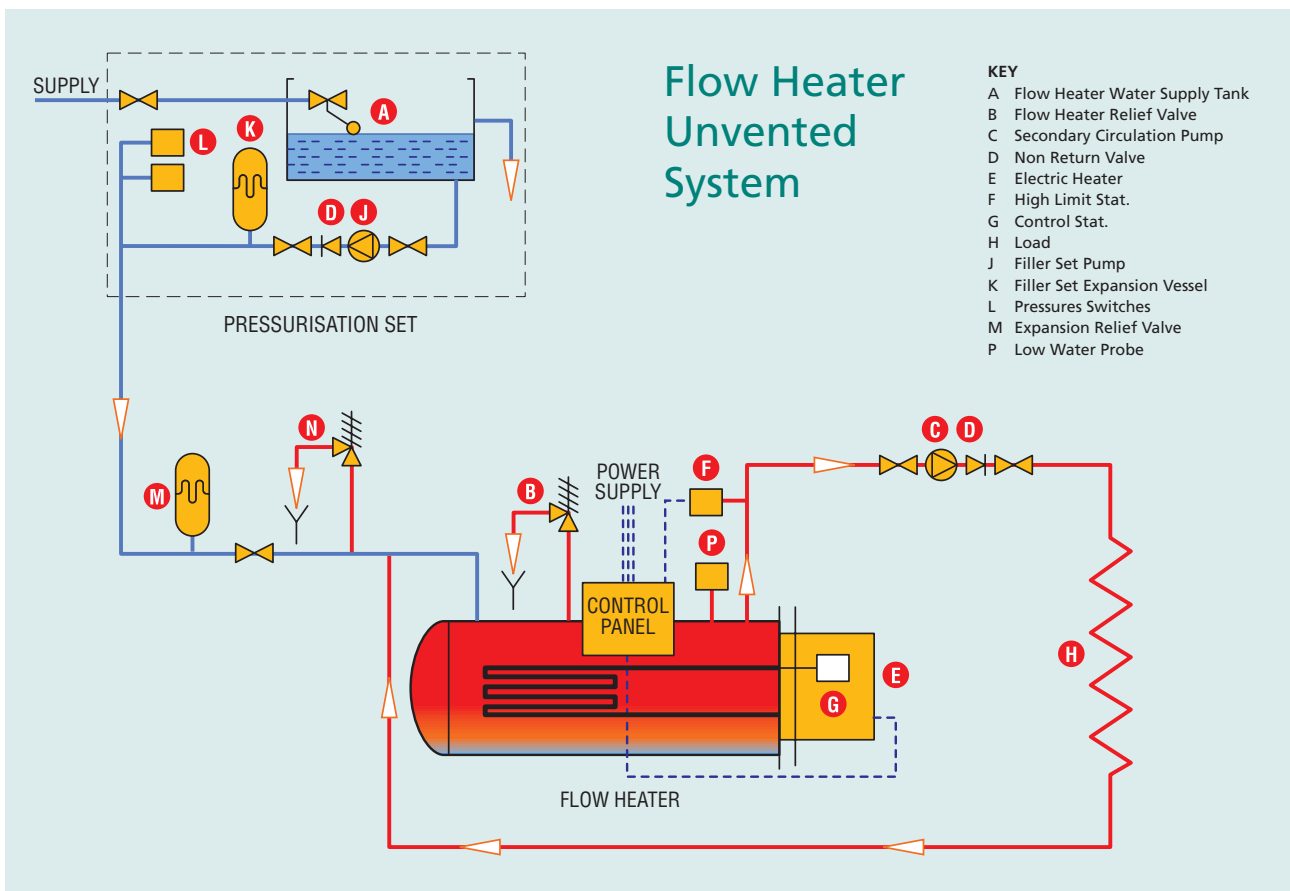
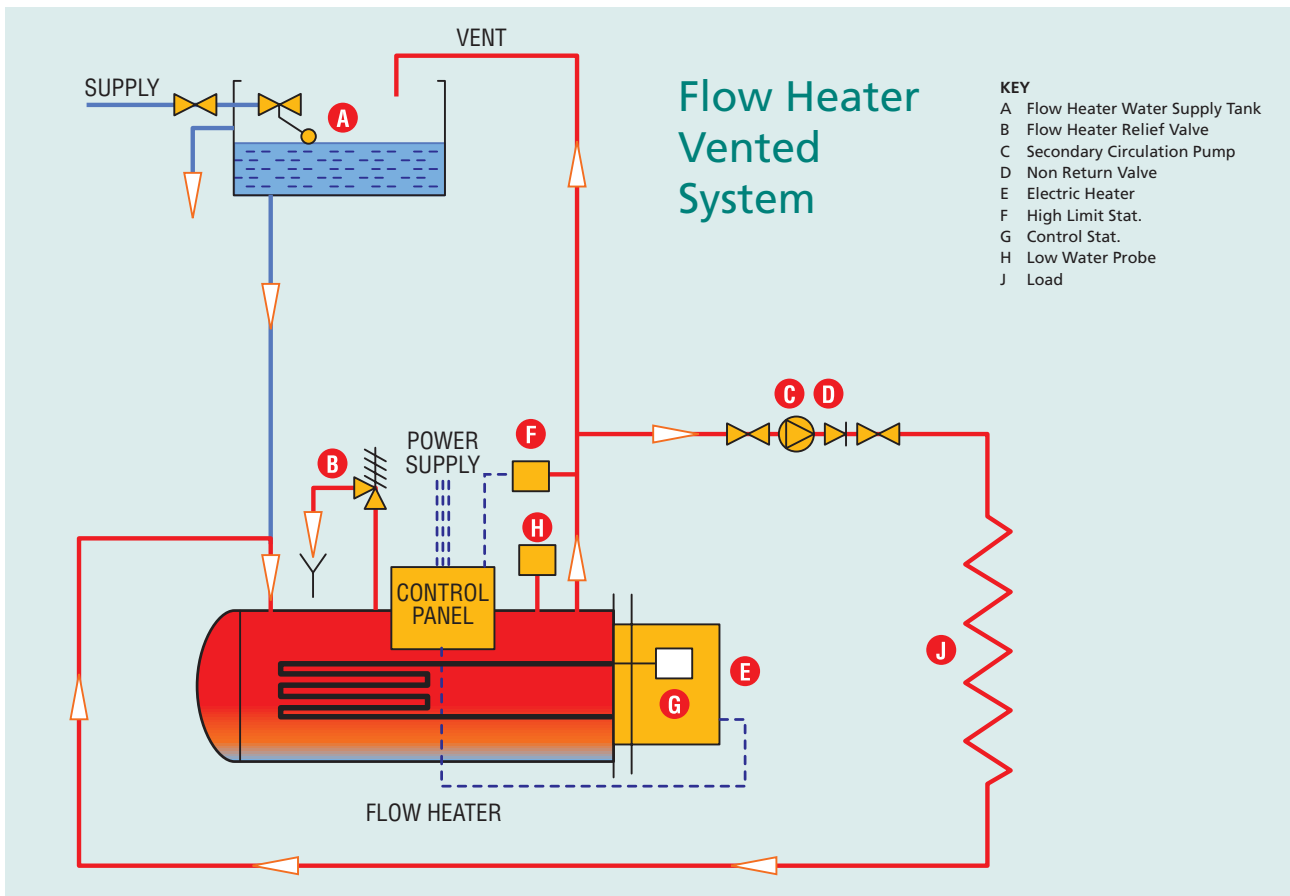
The insulation resistance of individual elements shall not be less than 1 megaohm.

# Typical Pipework Schematics





# Typical Pipework Schematics



# Accessories

## Thermometer

The thermometer is located near the top of a storage calorifier to measure the temperature of water reaching the outlet. The control thermostat is normally lower down to activate the heater before all the hot water has been drawn off.

A thermometer fitted to a non-storage calorifier can only act as a guide to the heater performance. It may also prove difficult to insert a thermometer pocket in the shell. The true temperature rise across a flow heater is measured by locating a thermometer on the inlet pipe and another on the outlet.

## Safety Valve

All electric calorifiers should be fitted with a safety valve to protect the cylinder against over-pressure due to malfunction of controls or incorrect operation.

Combined pressure/temperature relief valves are fitted on unvented installations.

## Anti-vacuum Value

Copper lined vessels must be protected against partial vacuum and all Rycroft copper lined calorifiers have an anti-vacuum valve fitted as standard. This must not be removed except for periodic inspection.

## Supports

Practically all electric calorifiers have their legs or cradles permanently fixed to the shell before despatch. This is to assist handling and to offer greater protection against damage, particularly when the control panel is attached. Loose cradles can only be supplied if the shell is unlagged and the control panel is wall mounted.

## Manhole

The heater and shell internals can be inspected by withdrawing the heater. Alternatively a manhole can be incorporated so that inspection does not disturb the heater or its connections.

The majority of manholes take the form of a flanged neck piece extended away from the shell body designated RMH (raised manhole). However, low pressure copper cylinders can be fitted with a semi-raised manhole, designated SRMH which is less expensive and formed from the shell material without a separate neckpiece.

## Anodes

Sacrificial anodes can be supplied to counteract certain adverse water properties

Magnesium anodes help to protect galvanised cylinders whilst the initial deposit of scale forms on the shell. The combination of copper pipework and galvanised cylinders should be avoided if at all possible. The life of magnesium anodes depends on the quality of water and regular checks should be made to establish a service period.

Aluminium anodes can be fitted to copper cylinders to give lasting protection against pitting corrosion. This is only necessary for fresh water supplies which are known to prevent the formation of the natural protective oxide film.

## Insulation

Adequate thermal insulation is essential to prevent unnecessary heat losses from storage calorifiers which may be standing for many hours at working temperature. Flow heaters will also dissipate considerable heat unless properly lagged.

Rycroft standard factory-fitted type M insulation consists of 80mm thick fibreglass mattresses compressed to 50mm thick, closely fitted to the shell and encased in rigid galvanised mild steel sheets 1.6mm thick.

Nominal density: 95kg/m<sup>3</sup>

Thermal conductivity: 0.040 W/mk

Limiting temperature: 230°C

Fire protection: Non-combustible to BS 476:Part 4: 1970, class 1. (Surface of very low flame spread to BS 476:Part 7:1971).

Alternative insulating materials and aluminium or stainless steel cladding are available on request.

### Control Thermostat

The accuracy of temperature control depends on the choice of thermostat and the switching arrangement for the heaters. There may be a series of temperature switches located at different levels in the cylinder or set at different temperatures to operate various stages of heating.

Alternatively a single temperature switch may actuate a relay circuit containing a timer or cam mechanism with progressive step control. In its simplest form each stage is brought in sequentially and when the desired temperature is reached the stages are all switched off simultaneously. With modulating control the temperature is monitored after each step and the system held at the optimum number of stages.

When the thermostat is 'integral' with the heater it is mounted on the tubeplate under the terminals cover. A 'remote' thermostat has its own pocket and cover. The correct position for a remote thermostat on a flow heater is in the secondary flow immediately above the calorifier.

### Low Water Level Switch

We strongly recommend the fitting of a low level cut out. The risk of switching on the heaters when they are not covered by water is greatest during commissioning or maintenance. The water in a flow heater only just covers the elements and the level switch should be mounted above the shell.

### Pump Interlock/Flow Switch

It is strongly recommended that an electric link is made between the immersion heater controls of any flow heater and the circulating pump. This is to prevent the heater being switched on before the pump is started. Additional protection is gained by fitting a flow switch to cut out the heater if the pump fails in service.

### High Limit Cut Out

With an electric calorifier it is considered essential to fit a high temperature cut out. This acts as an immediate monitor of overheating. It should be fitted with a manual reset button so that the heater will not continue to operate from the high limit switch if the control thermostat is malfunctioning.



# Expansion Vessels

## Application

When water is heated it expands. For example the change in volume from 5°C to 65°C is 2%. This may appear small but since water is almost incompressible it is essential that provision is made for expansion to avoid extremely high pressures. Correctly installed hot water systems are fitted with a relief valve to limit the maximum pressure. However, this is a safety device which is not intended to operate frequently as a pressure controller. apart from the loss of water which would appear with each expansion cycle the valve may wear and begin to leak continuously.

Hot water circuits which have an open vent normally discharge the expansion volume back into the make up tank. When the pressure is too high for an open vent or the water is above 85°C the circuit is sealed and an enclosed space is necessary to accommodate the expansion.

Sometimes an air pocket is provided in the top of a vessel for this purpose but unless the air is replenished regularly it can be absorbed by the water and the buffer volume will disappear.

The Rycroft expansion vessel uses an air pocket but there is a rubber bag which separates the air from the water and so avoids absorption. The rubber bag also acts as a barrier between the water and the interior surface of the expansion vessel. This prevents corrosion and contamination of the water.

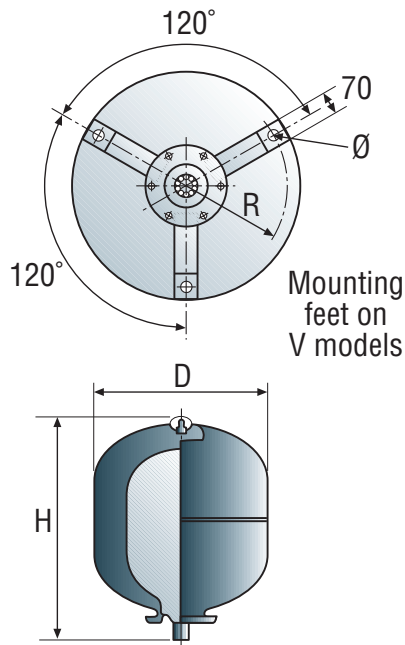
## Designation

EXP	150	V
Model	Capacity	H = Horizontal V = Vertical P = Pipeline mounted

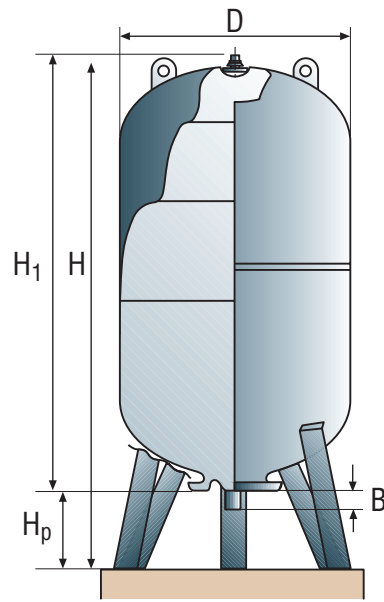
## Technical Specification

- Temperature range to 100°C
- Interchangeable EPDM membrane
- Maximum of 8 or 10 bar system pressure
- Suitable for hot and cold water, glycol mixtures, de-mineralised and de-ionised water
- Vertical, horizontal and pipeline mounted models
- WRC approved
- Water totally isolated from tank avoiding dangerous corrosion.

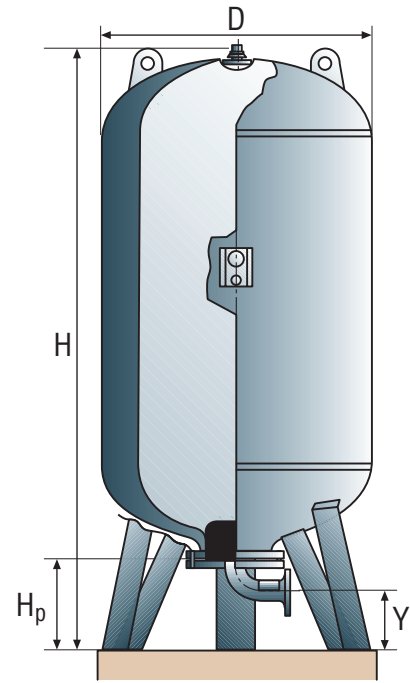




EXP 3P to EXP 35P



EXP 50V to EXP 1500V



EXP 2000V to EXP 3000V

### Dimensions for Vertical and Pipeline Mounted Models

Model	Capacity (litres)	Diameter D (mm)	Height H (mm)	H1 (mm)	Y (mm)	HP (mm)	R (mm)	Dia (mm)	Connection (BSPM)	Maximum Working Pressure	Weight (kg)
EXP 3 P	3	170	240						3/4"	8 BAR	1.3
EXP 5 P	5	170	280						3/4"	8 BAR	1.4
EXP 8 P	8	220	310						3/4"	8 BAR	1.8
EXP 12 P	12	265	315						3/4"	8 BAR	2.4
EXP 16 P	16	265	340						3/4"	8 BAR	3.0
EXP 18 P	18	265	375						3/4"	8 BAR	3.2
EXP 24 P	24	265	490						3/4"	10 BAR	3.6
EXP 35 P	35	380	590						1"	10 BAR	7.0
EXP 50 V	50	380	740	555		140	153	12.5	1"	10 BAR	10.3
EXP 60 V	60	380	830	635		140	153	12.5	1"	10 BAR	11.3
EXP 80 V	80	460	760	600		140	195	12.5	1"	10 BAR	14.0
EXP 100 V	100	460	880	720		140	195	12.5	1"	10 BAR	17.6
EXP 150 V	150	510	1030	870		140	220	12.5	1.1/4"	10 BAR	24.7
EXP 200 V	200	590	1070	885		140	220	12.5	1.1/4"	10 BAR	27.4
EXP 300 V	300	650	1250	1085		140	220	12.5	1.1/4"	10 BAR	43.8
EXP 500 V	500	750	1600	1360		240	325	14	1.1/2"	10 BAR	81.1
EXP 750 V	750	800	1785	1520		265	350	14	2"	10 BAR	157.0
EXP 1000 V	1000	800	2100	1820		280	350	14	2.1/2"	10 BAR	187.0
EXP 1500 V	1500	1000	2100	1850		250	450	14	2.1/2"	10 BAR	241.0
EXP 2000 V	2000	1100	1550	2170	200	335	940	14	DN65 PN10	10 BAR	301.0
EXP 3000 V	3000	1200	2950	2615	200	335	500	14	DN65 PN10	10 BAR	*

\* Information available upon request.

### Checklist

Rycroft will be pleased to select the correct size and pressure rating for all applications of their expansion vessels. The following information is required for an accurate assessment to be made.

- Cold feed pressure of a domestic hot water service or the static head of a primary hot water system.
- Maximum working temperature – design pressure of the system.
- Circulating pump head – Volume of the system.
- Any additive to the water such as glycol and the percentage mixture.

Much of this information will already be available if Rycroft are supplying the calorifiers or water heaters.

# Thermal Storage Vessels

THERMAL STORAGE APPLICATIONS CAN BE FOUND IN BOTH THE DOMESTIC HOT WATER AND PROCESS SECTORS. GENERALLY THERMAL STORAGE VESSELS ARE CHARGED OVERNIGHT WITH SUFFICIENT HOT WATER TO SUPPLY THE ENTIRE NEEDS OF THE FOLLOWING DAY. THEY INHERENTLY REQUIRE LARGE STORAGE CAPACITIES ALTHOUGH, BY RAISING THE STORAGE TEMPERATURE ABOVE THE REQUIRED WORKING TEMPERATURE OF THE SYSTEM THE REQUIRED STORAGE VOLUME CAN BE CONSIDERABLY REDUCED. FOR DOMESTIC HOT WATER SYSTEMS PREVENTION AGAINST SCALDING MUST BE INCORPORATED INTO THE DESIGN. PLEASE CONTACT OUR ENGINEERING OFFICE FOR FURTHER INFORMATION.

The following requirements should be addressed for any thermal storage system:

- When rating the heaters a 10% allowance should be added for standing losses over a 24 hour period.
- It is essential that the cold incoming water does not mix with hot water on its entry to the vessel. We therefore recommend the use of sparge pipes to reduce disturbance and assist stratification.
- Adequate allowance must be made for the considerable changes in water volume which occurs during the heating and cooling cycles. A large open header tank may prove sufficient but for high pressure systems a pressurisation tank will be necessary. There is generally sufficient volume below the heaters in the vessel to prevent hot water passing up the expansion pipe.
- Linear expansion of the cylinder must also be considered since movement will be approximately 1mm per metre length for every 80°C temperature rise. The supports for thermal vessels are normally welded to the shell for ease of transportation and facilities should therefore be made for one set of cradles to slide over the foundations.
- If the storage temperature exceeds 90°C the system pressure must be kept above the vapour pressure of the stored water. Table 3 shows the recommended minimum working pressures.

Storage temperature °C	90	100	110	120	130	140	150	160
Working pressure bar g	0.3	0.5	1.0	1.7	2.6	3.7	5.2	6.9
Design pressure bar g	0.7	0.9	1.4	2.1	3.0	4.1	5.2	7.6

## Storage Volume and Input

Once the duty is established and the operating temperatures chosen the following formula provides a simple estimation of the vessel capacity:

$$\text{Volume in m}^3 = \frac{1.2 \times \text{daily kWh}}{\text{total temp. drop } ^\circ\text{C}}$$

### Example

140 kW for 16 hours with a storage temperature of 130°C and a final temperature of 60°C.

$$\begin{aligned} \text{Volume} &= \frac{1.2 \times 140 \times 16}{130 - 60} \\ &= 38.4\text{m}^3 \end{aligned}$$

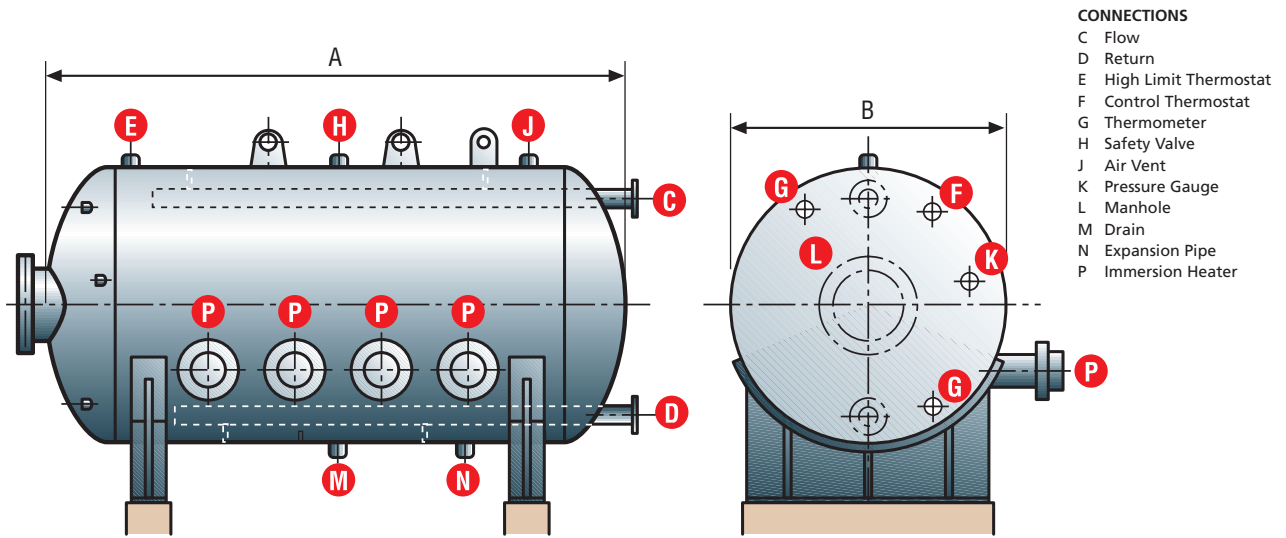
When rating the heaters a 10% allowance should be added for standing losses over the 24 hours.

$$\text{Heaters kW} = \frac{1.1 \times \text{daily kWh}}{\text{heat up time hours}}$$

Using the above example with a 7 hour input

$$\begin{aligned} \text{kW} &= \frac{1.1 \times 140 \times 16}{7} \\ &= 352 \text{ say } 360 \text{ kW minimum} \end{aligned}$$

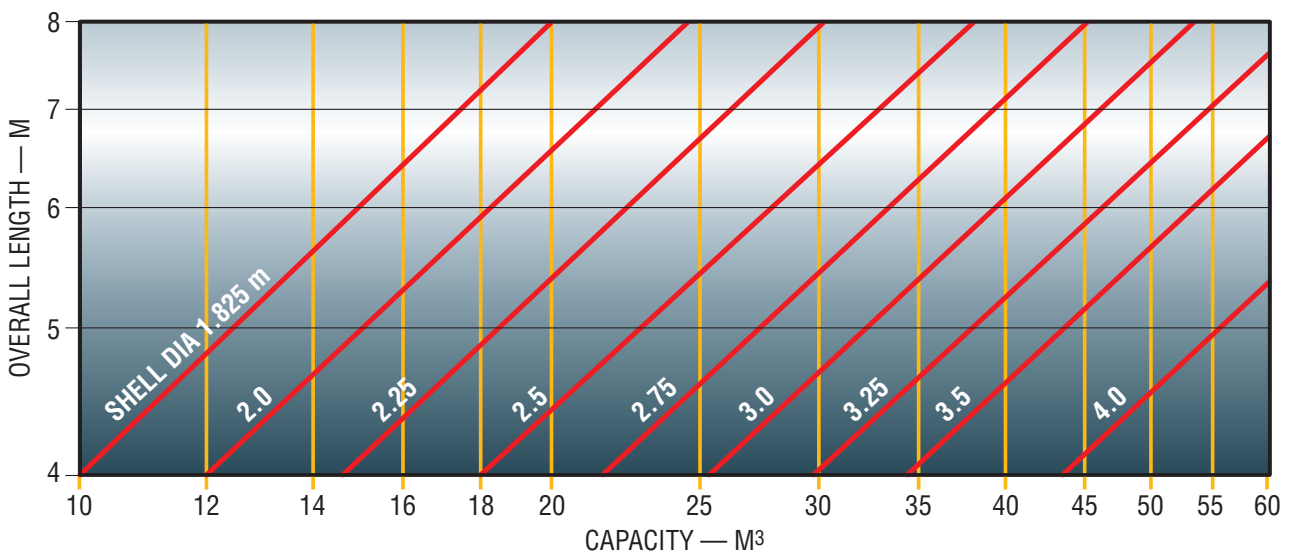
# Dimensions and Weights



Type Ref	Capacity	Dimensions (mm)		* Dry Weight kg
	Litres (nominal)	A	B	Test 4.0 Bar Design 2.7 Bar
TS10	10 000	4100	1825	1430
		3500	2000	1675
TS15	15 000	5100	2000	2300
		3450	2500	2300
TS20	20 000	4450	2500	2790
		3750	2750	2750
TS25	25 000	4600	2750	3200
		3950	3000	3150
TS30	30 000	5450	2750	3650
		4650	3000	3560
TS35	35 000	5350	3000	3975
		4650	3250	3910
TS40	40 000	6050	3000	4400
		5300	3250	4350
TS45	45 000	6750	3000	4800
		5950	3250	4750
TS50	50 000	6600	3250	5150
		5700	3500	6125

\* Excludes Cradles and Immersion Heaters

Chart of Diameter x Length Profiles



# Spare Parts

IT IS IMPORTANT WITH ELECTRIC WATER HEATERS AND BOILERS TO CARRY A MINIMUM AMOUNT OF SPARE PARTS AS EMERGENCY STOCK TO ENSURE AN UNINTERRUPTED SERVICE.

THE FOLLOWING LIST OF SPARES WILL COVER THE MAJORITY OF LIKELY REQUIREMENTS AND RYCROFT WILL ADVISE ON THE QUANTITIES FOR 2 YEARS' OPERATION AT TIME OF ENQUIRY.

## Description

- 1. Stage circuit breaker
- 2. Test/off/auto switch
- 3. Control fuse holder
- 4. Relay
- 5. Pump overload
- 6. Low water switch
- 7. Transformer
- 8. Indicators
- 9. Contactor
- Thermometer
- Pressure gauge
- Safety valve
- Anti-vacuum valve
- Immersion heater joint ring
- Manhole joint ring
- Immersion heater element
- Control thermostat
- High limit thermostat
- Control fuse
- Push to test button
- Low water probe
- Timer



1. Stage circuit breaker



2. Test/off/auto switch



3. Control fuse holder



4. Relay



5. Pump overload



6. Low water switch



7. Transformer



8. Indicator lamp



9. Contactor



# Useful Information

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## Water Quality and Electric Water Heating

### Water Hardness

All waters contain dissolved substances. A large proportion of these dissolved substances are generally calcium and magnesium carbonates and sulphates. The concentration of these salts in the water define how hard water is: the greater their concentration then the harder the water, the smaller their concentration then the softer the water.

Generally, water which can be considered as slightly hard to moderately hard, in itself does not necessarily require the use of softening water plant. However, where water is heated electrically we must consider the effects on the immersion heaters and other components within the calorifier shell.

## Water Treatment

### Softening

Remove or replace Calcium and Magnesium salts with Sodium. This process employs beds of small resin beads which are chemically prepared and contain Sodium Ions such that when water containing Calcium and Magnesium passes through the bed, the beads allow an exchange between them and the Sodium. Sodium Ions do not give rise to scale formation. This chemical exchange continues until the supply of Sodium Ions runs out and the bed is described as being exhausted.

The unit is then taken off line backwashed to remove any suspended matter collected in the preceding run, then regenerated with 10% brine (Sodium chloride solution). This brine treatment replenishes the resin with Sodium and drives off the previously accumulated Calcium and Magnesium Ions to drain. Brine solutions are made by dissolving salt in predetermined volumes of water between regenerations. Typical periods for plant to be on line would be 10-12 hours, with regenerations taking about 1.5 hours. Base exchange softening is the most widely used process to soften water – it is not considered to constitute an environmental risk.

Softening is used within such industries as Laundries, Hotels and the Home, where a relatively cheap supply of soft water is required.

### Chemical Conditioning

Instead of replacing or removing Calcium it is possible to make the Calcium less available for formation of deposits. This can be achieved by adding to the water Polyphosphates in a liquid or solid form. The effect of this is to cause the water to behave in some ways as if it has been softened, although the water is not softened in the true sense of the word. (Removal or replacement of Calcium.)

### Warning

Some people have skin which is sensitive to Polyphosphates.

### Physical Conditioning

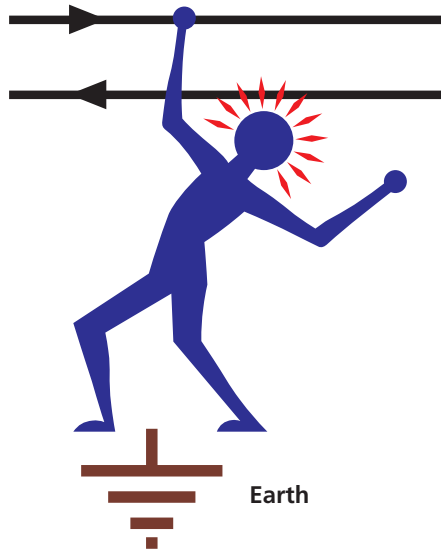
There are a number of devices on the market which generate a magnetic or electrical field for the water to pass through. Some of these devices must be plumbed in the pipework. It is important to know that the chemical composition is not changed, salts may precipitate when the water is heated.

# Immersion Heaters and Earth Leakage

Electric Shock is categorised into two groups by the IEE Wiring Regulations, namely:

## 1. Direct Contact with the electrical supply

Direct contact is prevented by insulation of live parts, use of suitable enclosures, use of protective barriers, use of obstacles or by placing live parts out of reach.



## 2. Indirect Contact with the supply via exposed accessible conductive parts or metal work becoming live

Indirect contact is a result of a fault condition, ie earthed metalwork becoming live. Protective measures include:

Earthed equipotential bonding and automatic disconnection of supply.

Use of Class II all insulated equipment.

Non conductive location.

Protective by earth-free local equipotential bonding.

Protection by electrical separation, eg ELV isolating transformers.



## Residual Current Devices

When specified Residual Current Devices can be incorporated into the control panel. Earth fault protection requirements can be classified into three groups:

Protection against injury to personnel.

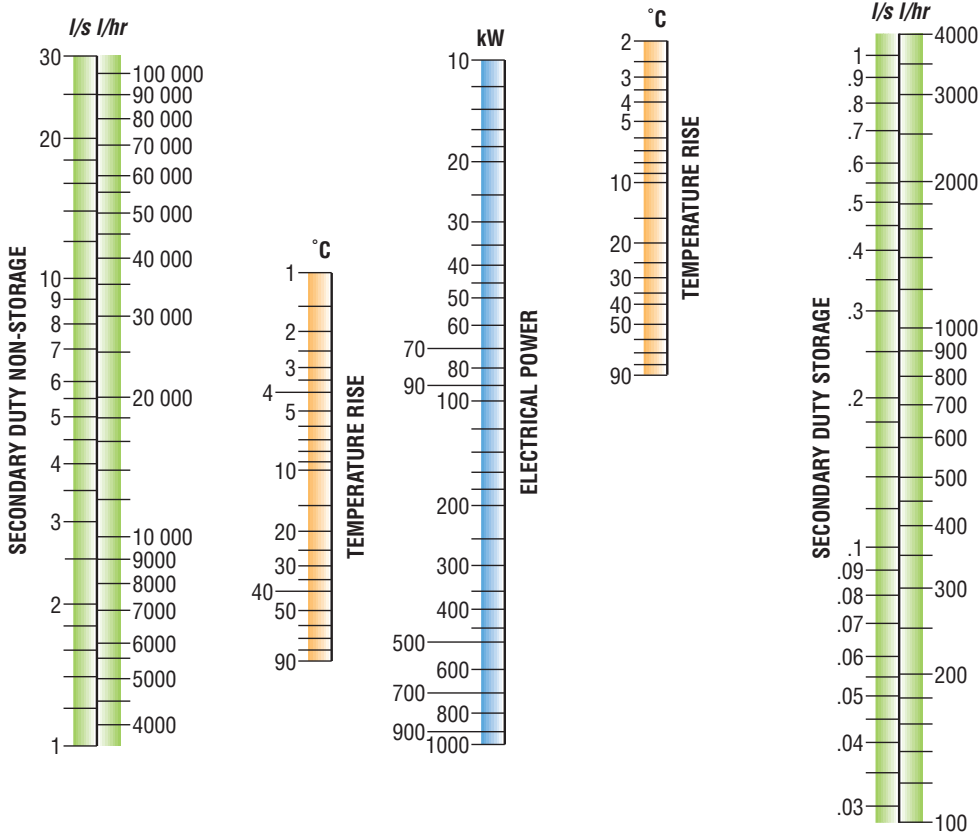
Protection against damage to equipment and buildings.

Protection of the system.

When required RCD classification for industrial/commercial immersion heaters is generally specified as Protection of the system. This is primarily due to the inherent natural earth leakage associated with immersion heater design. For example, a single 30 kW immersion heater would have an allowable earth leakage of 30 mA.

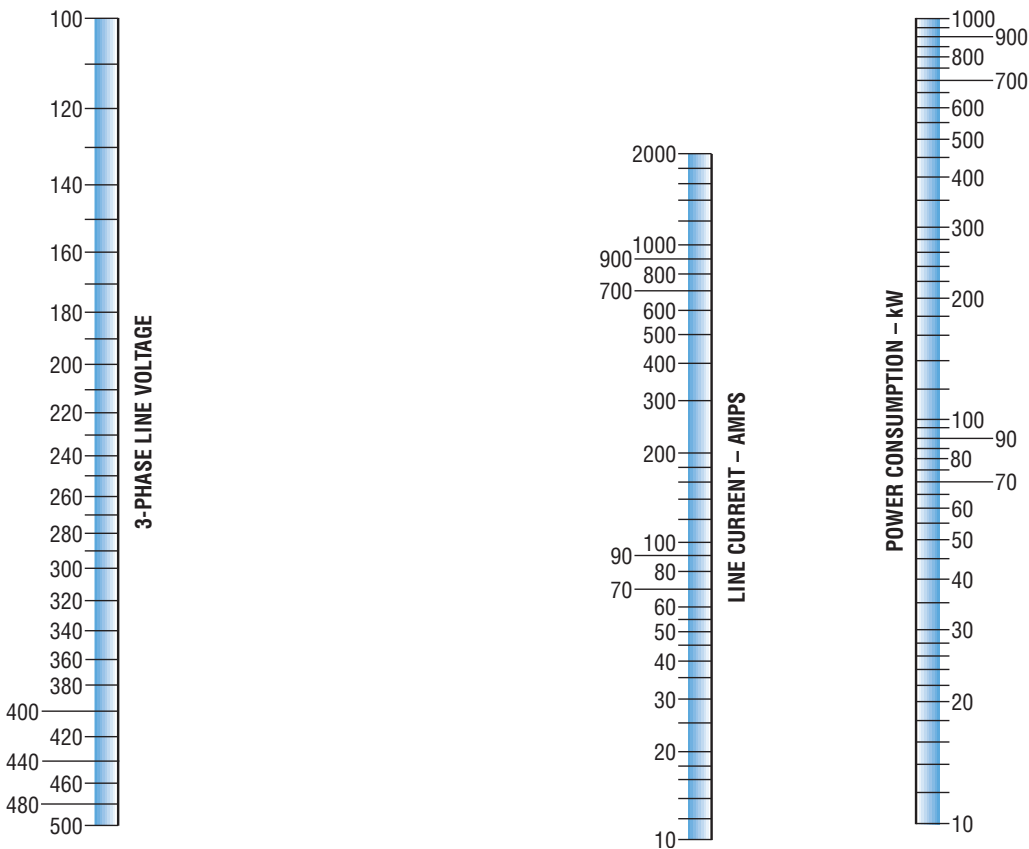
The most practical type of RCD available uses a toroidal coil around the supply cable to sense an imbalance between the supply and return of the feeder. This necessitates a device with a large working tolerance. Consequently to use earth leakage protection with industrial/commercial immersion heaters requires careful consideration of the entire installation system if nuisance tripping is to be avoided.

# Power Consumption



**EXAMPLE:**  
 1000 litres per hour raised from 10° to 60°C.  
 Using straight edge across right-hand scales:  
 Power 58 kW.  
 Nearest standard heater 60 kW.

# Line Current

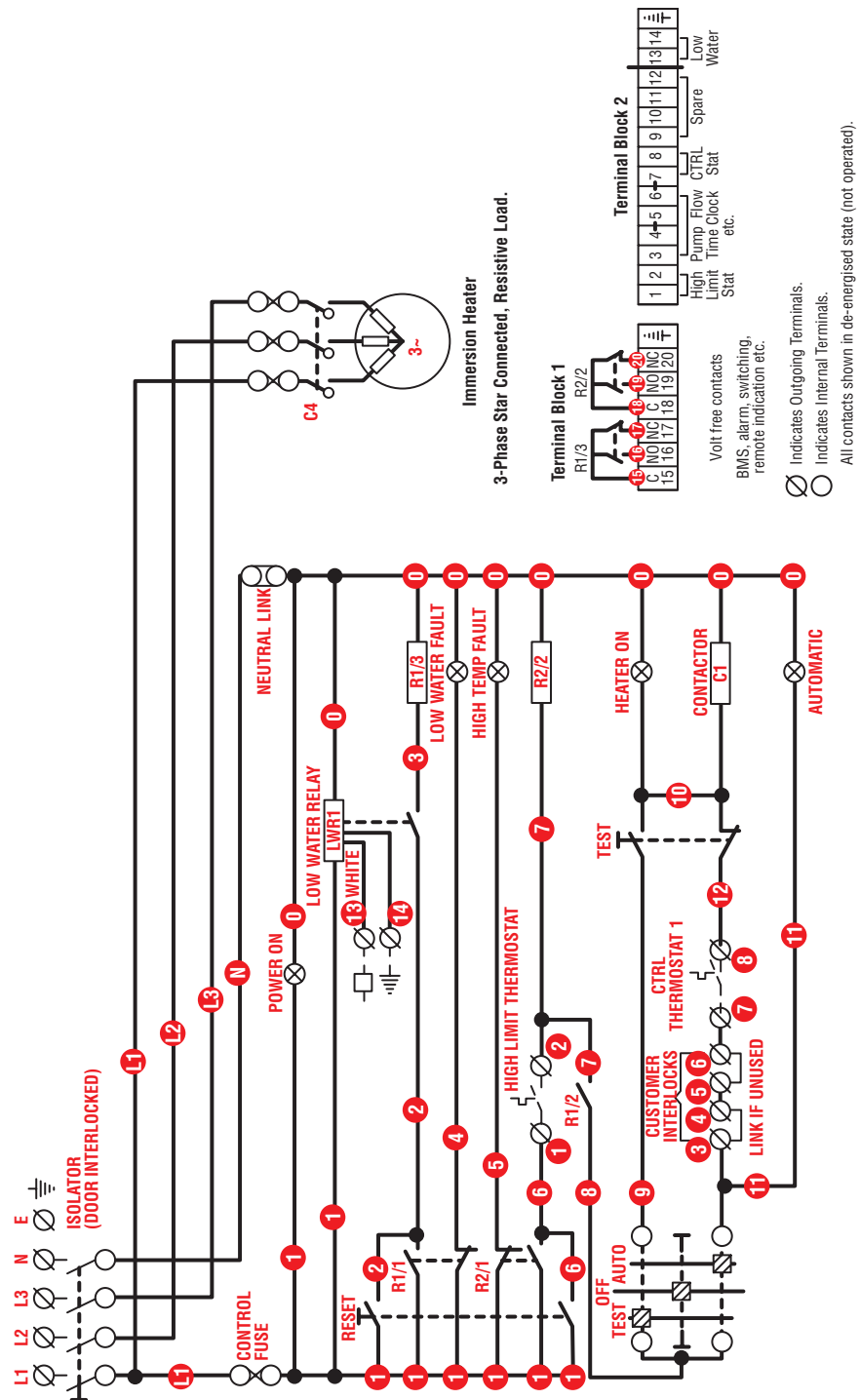


**EXAMPLE:**  
 60 kW with 415 volt 3 phase supply.  
 Using straight edge:  
 line current 83 amps.

# Typical Control Panel Operation

- With the test/off/auto switch in the off position turn on the main isolator, the power on indicator, the high temperature fault, low flow (optional) and the low water fault (optional) lamps will illuminate.
- The calorifier cannot be put into service until the fault reset push button is momentarily depressed, if the calorifier is clear of faults the fault lamps will extinguish.
- Switch the test/off/auto switch to the test position and push the test buttons, either individually, if there are several, or push and keep depressed in the case of one button, until all the stage indication lamps have been on.
- Switch the test/off/auto switch to the automatic position, the automatic lamp will illuminate and the heater comes on, this will remain the case until the desired temperature is achieved when the heater will switch off. The control panel will now maintain the temperature at the required preset value.
- Shutting down: Switch off the calorifier panel using the on/off/auto switch and isolate the panel from the mains. Drain the vessel down.

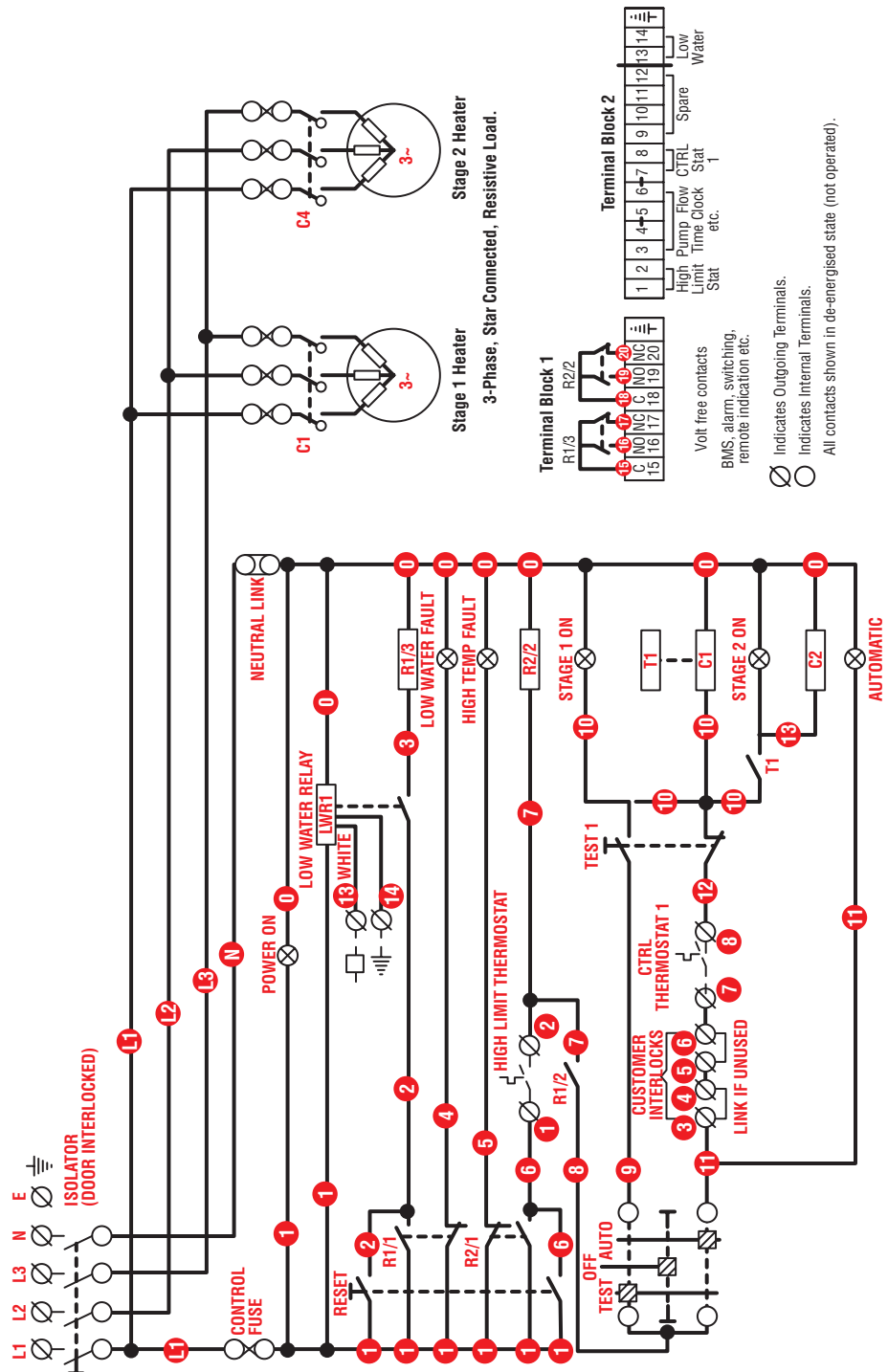
Wiring diagram: Single stage immersion heater with high limit and low water cut outs.  
Power supply requirements – 3 phase and neutral.



# Typical Control Panel Operation

- With the test/off/auto switch in the off position turn on the main isolator, the power on indicator, the high temperature fault, low flow (optional) and the low water fault (optional) lamps will illuminate.
- The calorifier cannot be put into service until the fault reset push button is momentarily depressed, if the calorifier is clear of faults the fault lamps will extinguish.
- Switch the test/off/auto switch to the test position and push the test buttons, either individually, if there are several, or push and keep depressed in the case of one button, until all the stage indication lamps have been on.
- Switch the test/off/auto switch to the automatic position, the automatic lamp will illuminate and the heater comes on, this will remain the case until the desired temperature is achieved when the heater will switch off. The control panel will now maintain the temperature at the required preset value.
- Shutting down: Switch off the calorifier panel using the on/off/auto switch and isolate the panel from the mains. Drain the vessel down.

Wiring diagram: Two stage immersion heater with high limit cut out and low water.  
Power supply requirements – 3 phase and neutral.

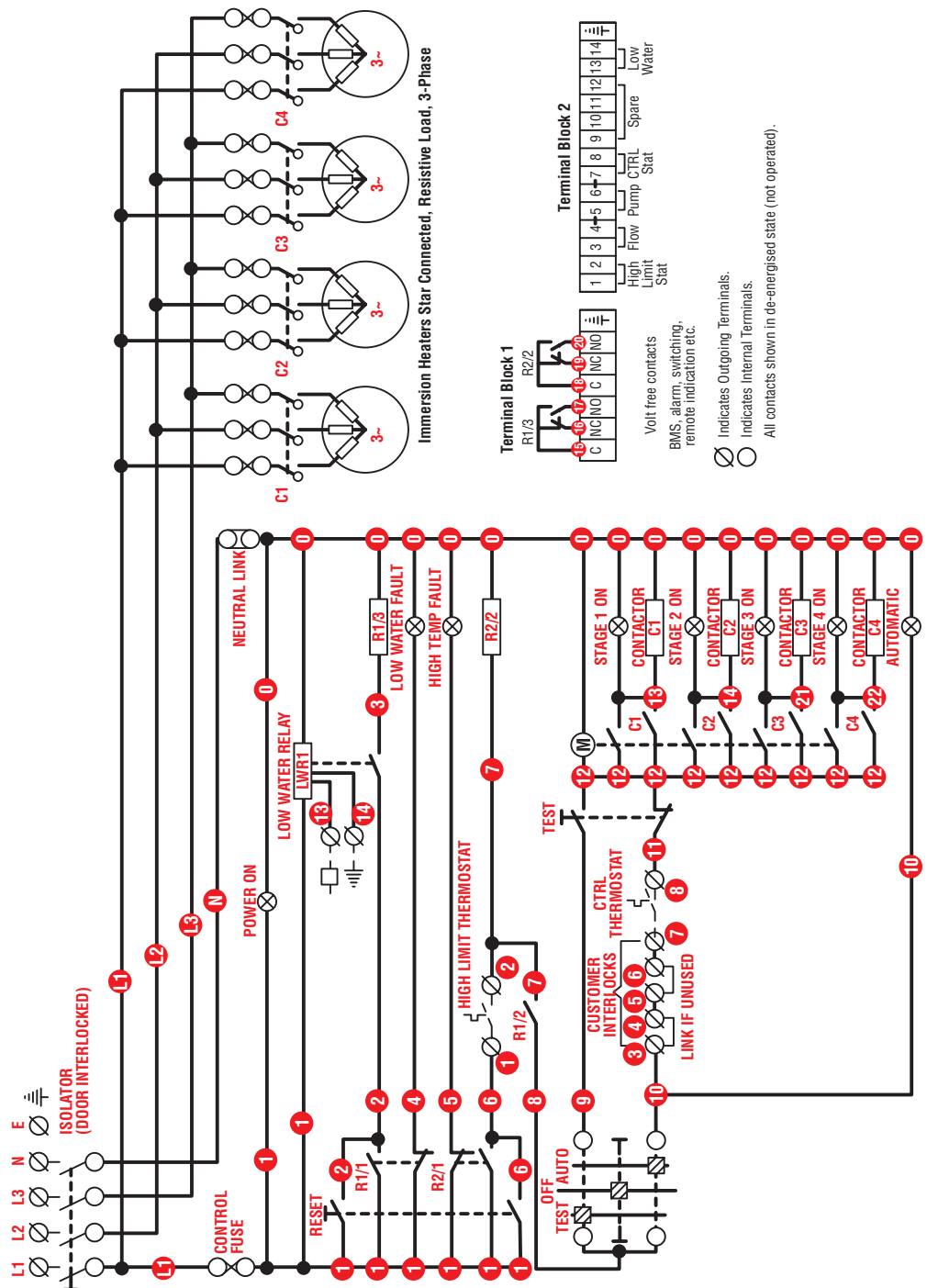


# Typical Control Panel Operation

- With the test/off/auto switch in the off position turn on the main isolator, the power on indicator, the high temperature fault, low flow (optional) and the low water fault (optional) lamps will illuminate.
- The calorifier cannot be put into service until the fault reset push button is momentarily depressed, if the calorifier is clear of faults the fault lamps will extinguish.
- Switch the test/off/auto switch to the test position and push the test buttons, either individually, if there are several, or push and keep depressed in the case of one button, until all the stage indication lamps have been on.
- Switch the test/off/auto switch to the automatic position, the automatic lamp will illuminate and the heater comes on, this will remain the case until the desired temperature is achieved when the heater will switch off. The control panel will now maintain the temperature at the required preset value.
- Shutting down: Switch off the calorifier panel using the on/off/auto switch and isolate the panel from the mains. Drain the vessel down.

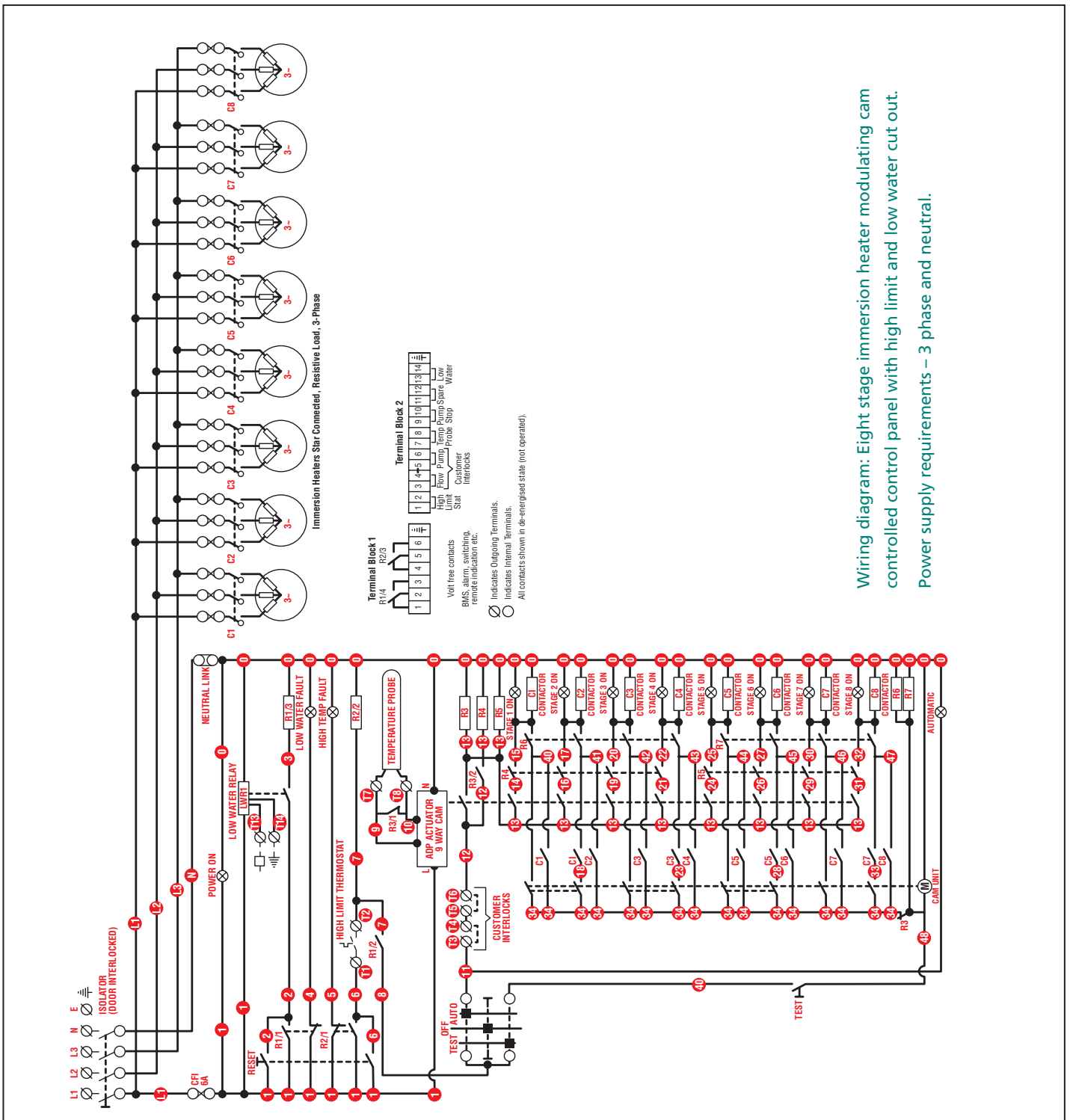
Wiring diagram: Four stage immersion heater random cam controlled control panel with high limit and low water cut out.

Power supply requirements – 3 phase and neutral.



# Typical Control Panel Operation

- With the test/off/auto switch in the off position turn on the main isolator, the power on indicator, the high temperature fault, low flow (optional) and the low water fault (optional) lamps will illuminate.
- The calorifier cannot be put into service until the fault reset push button is momentarily depressed, if the calorifier is clear of faults the fault lamps will extinguish.
- Switch the test/off/auto switch to the test position and push the test buttons, either individually, if there are several, or push and keep depressed in the case of one button, until all the stage indication lamps have been on.
- Switch the test/off/auto switch to the automatic position, the automatic lamp will illuminate and the heater comes on, this will remain the case until the desired temperature is achieved when the heater will switch off. The control panel will now maintain the temperature at the required preset value.
- Shutting down: Switch off the calorifier panel using the on/off/auto switch and isolate the panel from the mains. Drain the vessel down.



**Wiring diagram: Eight stage immersion heater modulating cam controlled control panel with high limit and low water cut out. Power supply requirements – 3 phase and neutral.**

# Handling, Storage and Commissioning

## Handling and Storage

Storage should ideally always be indoors, in a dry dust free atmosphere, away from any possibility of physical damage. Care must be taken not to damage the vessel, lagging case, controls or conduits while unloading and transporting. It is preferable to put the packages into service as quickly as possible.

Under normal operating conditions, the immersion heater will be running warm, consequently damp conditions are less of a concern, however, prolonged storage in a damp atmosphere can lead to problems.

The insulation in the heater elements is hygroscopic in nature and may readily absorb moisture.

## Commissioning

This is a general procedure to suit most calorifiers and should only be carried out by qualified personnel.

- Isolate the mains supply to the unit and any separate supplies such as BMS or separate controls and interlocks.
- Ensure that the unit is full of water and that the pipefitting works are complete with no leaks.
- When this is proven to be the case, remove all the electrical enclosure covers.
- Check that all the electrical connections are tight with the appropriate size spanners and screwdrivers, whilst paying particular attention to the mains isolator, fuses, contactors and heater head connections.
- Check that the cable insulation is not damaged and that there are no potential short circuits between phases and earth or between circuits. Look for any signs of water and address the cause if there are.
- Remove the low water relay when fitted. Note that the electronic control relay will not tolerate the high voltages used in Megger testing the unit.
- Megger the heater element phases to earth and note the readings. One would expect to see a minimum of 500K Ohms. A reading less than this would indicate moisture has been absorbed into the heater elements, and they must be dried out before powering up.
- If all appears well, set the control thermostat to an arbitrary lower value, eg 50°C and replace all the covers, except the low water probe and high limit stat. The high temperature limit thermostat should be set at approximately 10°C below the control thermostat setting.
- Put the low water relay into its 8 pin socket, close all the circuit breakers, shut the control panel door and make sure that the test off Auto switch is in the 'Off' position. Power up the unit.
- With the power On, the High Temperature and Low Water lights will also be on. Press the Reset button and the High Temperature and Low Water lights will go out.
- Empty the vessel to below the low water probe level, the Low Water light will come on and the Plant Ready light will go out. Re-fill the vessel, the two lights will return to normal upon pressing the Reset button.
- Turn the Test/Off/Auto switch to Test and push the test button(s). Hold in until the 'Heater On' lamps have illuminated.
- Turn the Test/Off/Auto switch to Auto. the automatic light will illuminate and the stage(s) on light(s) shortly after.
- The calorifier will warm to around 40°C and trip on high limit, the high temperature lamp will illuminate, the automatic, stage(s) on lamps will go out.
- Increase the high limit thermostat to around 70°C and push the reset button. The calorifier will return to heating duty.
- The calorifier heater will Off around the 50°C setting. The water will be maintained at this temperature.
- Switch the Test/Off/Auto switch to the Off position and isolate the supply, set the control thermostat to the desired temperature (65°C) replace the covers.
- The calorifier may now be switched On and put into service.
- Should the final required vessel temperature be slightly different, or nuisance high limit tripping occur alter the thermostats as described until the optimum running conditions are achieved.



# Installation and Maintenance

## Maintenance of Electric Immersion Heaters

Electric immersion heaters are virtually maintenance free, however it is wise to carry out some simple periodic checks, especially in harsher conditions.

A common cause for premature heater failure is poor or loose connections. **All main connections should be checked and tightened prior to initial start up and annually after that.**

Should the heater be out of service for prolonged periods, silica gel bags should be placed in the heater heads and control panels. The bags should be dried out frequently in damp and humid conditions.

After three months in service the elements should be inspected for any form of scaling or build up of deposits. If this is the case some action must be taken to prevent this.

### Note

When returning immersion heaters to service after long periods of non operation, refer to the commissioning and insulation resistance notes. Do not overtighten connections.

### Insulation Resistance

All immersion heaters are thoroughly dried out and tested before leaving the factory. However, storage conditions after despatch are not always ideal and some moisture may collect in the heater, particularly if it is several months before the equipment is commissioned.

Before connecting the heaters to the mains carry out an insulation test across each element to earth. If the insulation resistance is less than 500,000 ohms the heater must be dried out by placing in a low temperature oven (100°C) or by passing a low voltage through the elements in air. This voltage should not exceed 25% of the working voltage. Do not allow the heater sheath temperature to rise above 60°C. Switch off at intervals if necessary to prevent overheating.

## Maintenance for Copper Lined Calorifiers

- AN ANTI-VACUUM VALVE IS FITTED TO HELP PROTECT THE LINING FROM DAMAGE WHEN DRAINING DOWN THE CYLINDER.
- DO NOT COVER THE ANTI-VACUUM VALVE WITH INSULATION OR OBSTRUCT THE FREE PASSAGE OF AIR TO THE VALVE.

As a precaution against damage to the lining the following procedures should be observed when draining down:

1. Isolate the primary supply to the calorifier.
2. Isolate the cold feed to the cylinder.
3. If the secondary flow and return are common to other calorifiers isolate the cylinder to be drained down.
4. REDUCE THE PRESSURE IN THE CYLINDER SLOWLY.
  - a) If the calorifier has its own open vent the pressure will fall naturally as the drain is gently opened and the head of water drops in the vent pipe.
  - b) If the calorifier shares a common vent it will be fitted with a 3-port escape cock. Turn this cock very slowly to avoid a sudden release of pressure when isolating the cylinder from the system.
  - c) If the calorifier is normally coupled to a pressurisation set and fitted with an automatic air vent open the drain very carefully to avoid a sudden release of pressure.
5. When the cylinder pressure has reduced to atmospheric pressure check the anti-vacuum valve is free to open.

6. Empty the cylinder slowly through the drain cock.
7. If the anti-vacuum valve is removed for maintenance make sure it is refitted before filling the calorifier.

This vessel has been hydraulically tested on the secondary and primary side before despatch. However, after transportation and long standing some joints may relax and require further tightening after installation.

Always tighten bolts in a diametrically opposite sequence. Do not tighten them consecutively round the flange. If the wrong procedure has been adopted it may be necessary to drain the cylinder, relax all the bolts and retighten in the correct manner.

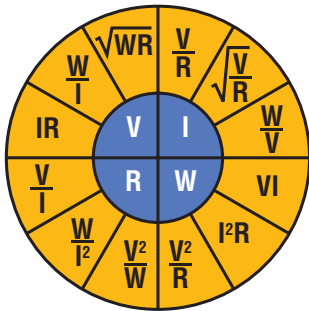
All pipework and valves connected to the vessel must be square and central before fitting the bolts. Support the pipework or valve at the flange face until the bolts are tight. **Remember to use a diametrically opposite sequence for tightening the bolts.**

# Trouble Shooting

Fault	Cause	Solution
High limit thermostat tripping before set point is reached on control thermostat.	High limit thermostat set below control thermostat setting.	Set the high limit thermostat approximately 10°C above the control thermostat setting.
Low water tripping	Water not covering probe or electrical fault.	Check that the calorifier is full of water. Check the voltage of the plug in module. Check that the calorifier is correctly earthed. Check tightness of all wires. Two indicator lights are fitted to the low water module and should be on. Replace the low water plug in module.
Immersion heater circuit breaker trips.	Damp or failed element.	Test element to earth. Dry out or replace as necessary.
Calorifier not heating water to correct temperature and tripping high limit thermostat.	Control thermostat failed.	Replace control thermostat with similar type thermostat.
Earth leakage tripping.	Damp or failed element.	See nuisance tripping of ELCB.
Indicators not illuminated.	Loss of main supply or control circuit supply fuse blown. Bulbs blown.	Check mains voltage present. Check control circuit fuse. Replace damaged bulbs.
Automatic indicator illuminated, but heating is off.	Interrupted control circuit.	Check interlock and interlock terminals for continuity. If there are no interlocks used check that links are fitted.
Only one stage of heating energises.	Faulty timer or contactor coil.	Check the supply through the delay timer contact after the set time has elapsed. If there is no supply change the timer. Supply through to the relevant contactor but it is not energised – replace the contactor.
Fault light will not reset.	Persistent calorifier fault or faulty latching circuit.	Check the calorifier for the fault showing to ensure there is no actual fault, ie low water, flow or high temperature.
	The fault light remains steady whilst the Reset button is depressed.	Check external wiring through the thermostat or probe showing the fault. Check the thermostat or probe contacts are closed. Check the fault relay associated with that fault. Check the Reset button contact.
Water not heating (but everything else appears to be working).	Heater Protection Tripped.	Check heater element resistance to earth – replace heater or elements if damaged.
	Faulty Contactor Coils.	Check continuity through the contactor coil, if open circuit replace the coil or contactor.

# Useful Formulae

## OHMS Law



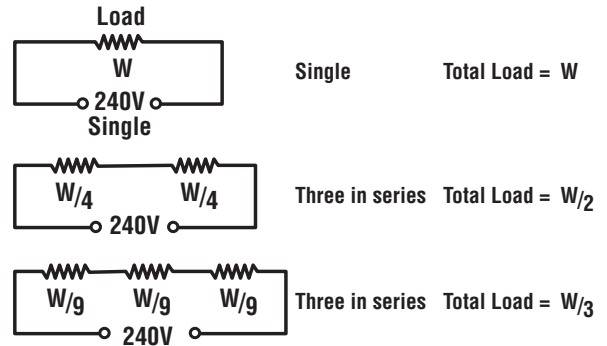
## 3-Phase Formulae

$$\text{kW} = \frac{\text{Line Amps} \times \text{Line Volts} \times 1.732 \times \text{Power Factor}}{1000}$$

$$\text{kVa} = \frac{\text{Line Amp} \times \text{Line Volts} \times 1.732}{1000}$$

$$\text{kW} = \text{kVa} \times \text{P.F. (Power Factor)}$$

Loading obtained with similar elements rated at 240 volts wired in series.



## Temperature

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9$$

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 9/5) + 32$$

# Conversion Factors

## Area

1 mm <sup>2</sup>	=	0.01 cm <sup>2</sup>
1 cm <sup>2</sup>	=	0.155 in <sup>2</sup>
1 m <sup>2</sup>	=	10000 cm <sup>2</sup>
	=	10.76 ft <sup>2</sup>
	=	1.196 yd <sup>2</sup>
1 in <sup>2</sup>	=	6.452 cm <sup>2</sup>
	=	645.2 mm <sup>2</sup>
1 ft <sup>2</sup>	=	144 in <sup>2</sup>
	=	929 cm <sup>2</sup>
	=	0.0929 m <sup>2</sup>
1 yd <sup>2</sup>	=	9 ft <sup>2</sup>
	=	0.8361 m <sup>2</sup>

## Pressure

1 Bar	=	100 kPa
	=	100 kN/m <sup>2</sup>
	=	14.5 psi
1 kPa	=	0.01 Bar
	=	0.145 psi
1 psi	=	0.06895 Bar
	=	6.895 kPa
	=	6.895 kN/m <sup>2</sup>

## Length

1 m	=	1000 mm
	=	3.28 ft
	=	1.0936 yd
1 inch	=	0.8333 ft
	=	25.4 mm
1 yd	=	3 ft
	=	0.9144 m

## Weight

1 kg	=	1000 g
	=	2.204 lb
1 tonne	=	1000 kg
	=	0.984 ton
	=	2204 lb
1 lb	=	16 oz
	=	0.454 kg
1 ton	=	2240 lb

## Energy

1 kW	=	1000 J/S
1 kWh	=	1 kW for 1 hour
	=	(3600 seconds)
	=	860 kcal
	=	3412 BTU
1 kJ	=	0.2388 kcal
	=	0.952 BTU
1 kcal	=	energy required to raise 1 kg
	=	of water through 1 deg. C.
	=	4187 J
	=	3.97 BTU

## Volume

1 litre	=	1000 ml
	=	0.22 gal (UK)
	=	1 kg water
1 m <sup>3</sup>	=	1000 litres
	=	220 gal (UK)
1 gal (UK)	=	4.546 litres

## Element heating surface

1 W/in <sup>2</sup>	=	6.45 W/cm <sup>2</sup>
1 W/cm <sup>2</sup>	=	0.155 W/in <sup>2</sup>

- SUPAPAC Plate Heat Exchangers
- Shell and Tube Heat Exchangers
- COMPAC Plate Heat Exchanger Packages
- MAXIMISER Semi-Storage Calorifiers
- Calorifiers/Cylinders
- Unvented Packages
- Pressurisation
- Electric Water Heaters
- Rycroft Process Solutions

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