

Specification for

Industrial immersion heaters using metal-sheathed elements

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- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- British Glass Manufacturers' Confederation
- British Industrial Furnace Construction Association
- British Lighting Association for the Preparation of Standards (BRITLAPS)
- British National Committee for Electroheat
- British Steel plc
- Committee for Electrical Equipment for Use in Flammable Atmosphere (BEAMA Ltd.)
- Electric Trace Heating Industry Council (ETHIC)
- Electricity Association
- Energy Industries Council
- Engineering Equipment and Materials Users' Association
- Engineering Industries Association
- Health and Safety Executive
- Induction and Dielectric Heating Manufacturers' Association
- Institution of Electrical Engineers
- Lighting Industry Federation Ltd.

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Foreword

This British Standard has been prepared by Technical Committee PEL/27.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

Specification

1 Scope

This British Standard specifies requirements for industrial electric immersion heaters designed for permanent installation in cylinders or tanks, for the heating of liquids.

The heaters may have fixed, replaceable or removable elements.

This standard does not apply to immersion heaters for mounting over the side of tanks, nor to heaters designed for household use.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 18. For dated references, only the edition cited applies: any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the following definitions apply.

3.1 (metal-sheathed heating) element

A heating assembly comprising a resistance alloy within, and insulated from, a tubular metal sheath.

3.2 fixed element

An element which is permanently attached to its supporting body by adhesive bonding, soldering, brazing, welding or any type of mechanical joint.

3.3 replaceable element

An element which can only be removed with the aid of a tool, normally after removal of the immersion heater from its containment vessel.

3.4 removable element

An element which can be extracted without the need for removing the immersion heater from its containment vessel.

3.5 element head

The screwed member to which the heating element(s) is(are) attached.

3.6 element plate

The non-screwed member to which the heating element(s) is(are) attached.

3.7 element plate thickness

The distance between the two faces of the element plate, or, if the bolt holes are spot faced, the distance between the front face and the spot facing.

3.8 immersed length

The total distance by which the immersion heater projects beyond the joint face of the element head or plate into the containment vessel.

3.9 thermostat

A temperature-sensing device, the operating temperature of which may be either fixed or adjustable and which, during normal operation, keeps the temperature of the liquid between certain limits by automatically opening or closing a circuit.

3.10 temperature limiter

A temperature-sensing device, the operating value of which may be either fixed or adjustable and which during normal use, functions by opening or closing a circuit when the temperature reaches a predetermined value.

NOTE. A temperature limiter does not make the reverse operation during the normal duty cycle of the heater. It may or may not require manual resetting.

3.11 thermal cut-out

A device which, during abnormal operation, limits the temperature of a heater, or of parts of it, by automatically opening the circuit or by reducing the current, and which is so constructed that its setting cannot be altered by the user.

3.12 self-resetting thermal cut-out

A thermal cut-out that automatically restores the current after the relevant part of the appliance has cooled down sufficiently.

3.13 non-self-resetting thermal cut-out

A thermal cut-out that requires resetting by hand, or replacement of a part, in order to restore the current.

3.14 metal conducting surface

The metal surface interface between the heater and the liquid, excluding any cold or dead areas.

3.15 watts density

The power (in watts) dissipated per unit surface area of the metal conducting surface in contact with liquid.

3.16 basic insulation

Insulation applied to live parts to provide basic protection against electric shock.

NOTE. Basic insulation does not necessarily include insulation used exclusively for functional purposes.

3.17 supplementary insulation

Independent insulation applied in addition to basic insulation, for protection against electric shock in the event of a failure of the basic insulation.

3.18 double insulation

Insulation comprising both basic and supplementary insulation.

3.19 reinforced insulation

A single insulation system applied to live parts that provides a degree of protection against electric shock equivalent to double insulation.

NOTE. The term ‘insulation system’ does not imply that the insulation is one homogeneous piece. It may comprise several layers that cannot be tested singly.

3.20 stud terminal

Screw-type terminal in which the conductor is clamped under one or two nuts. The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, clamping plate or anti-spread device.

3.21 pillar terminal

Screw-type terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw or screws. The clamping pressure may be applied directly by the shank of the screw or through an intermediate part to which pressure is applied by the shank of the screw.

3.22 thermal insulation

A material or system that has the property of resisting the transfer of heat.

3.23 rated voltage

The voltage assigned to the heater by the manufacturer.

3.24 rated power

The wattage, at rated voltage, assigned to the heater by the manufacturer.

3.25 screw terminal

Screw-type terminal in which the conductor is clamped under a bolt and washer, the bolt passing through a fixed nut or threaded bush.

3.26 creepage distance

The path between two conductive parts, or between a conductive part and the bounding surface of the element, measured across the surface of the insulating material.

3.27 clearance

The distance between two conductive parts, or between a conductive part and the bounding surface of the element, measured through air.

4 Heating elements

All the heating elements shall conform to BS 7351 : 1990.

5 Rating

5.1 Rated voltage

Heaters shall be rated for a line voltage not greater than 440 V.

NOTE. The requirements of this standard are based on the assumption that, in normal use, the voltage between the supply lines and neutral does not exceed 254 V.

5.2 Rated power

The actual power output from the heater at the operating temperature, on application of the rated voltage, shall not vary from the rated power output by more than the tolerances given in table 1, when verified in accordance with A.1.

Table 1. Power output	
Rated power kW	Tolerance %
0 to 50	± 7.5
≥ 51	± 5.5

5.3 Watts density

NOTE. During the construction of the immersion heater and/or its selection for a particular application, care should be taken to ensure that the watts density is compatible with the liquid to be heated.

6 Degree of protection

The minimum degree of protection provided by heater enclosures shall be in accordance with IP 40 of BS EN 60529 : 1992.

7 Electrical insulation

7.1 The mounting of electrically insulating parts shall be designed so as to prevent breakage or damage due to expansion and contraction.

7.2 Electrically insulating washers, bushings and the like, which are integral parts of the heater, and bases or supports of the mounting of current-carrying parts shall be of a moisture-resistant material which will not be damaged by the temperatures to which they will be subjected under conditions of actual use.

7.3 The insulation between any parts operating at extra-low voltage and other live parts, and between the core of the isolating transformer and other metal parts, shall be as specified in BS 3535 : Part 1 and Part 2 .

7.4 Reinforced insulation shall only be used when it is manifestly impracticable to provide separate functional insulation and supplementary insulation.

NOTE 1. Appliance inlets and switches are examples of where reinforced insulation may be used.

NOTE 2. Insulating material in which heating conductors are embedded is deemed to be functional insulation.

7.5 Parts which serve as supplementary insulation or reinforced insulation shall either:

- a) be fixed in such a way that they cannot be removed without being seriously damaged; or
- b) be designed so that they cannot be replaced in an incorrect position, and so that, if they are omitted, the appliance is rendered inoperable or manifestly incomplete.

NOTE 1. Sleeving may be used as supplementary insulation on internal wiring, if it can only be removed by breaking or cutting, or if it is clamped at both ends.

NOTE 2. Lining metal enclosures with a coating of lacquer, or with other material in the form of a coating which can be easily removed by scraping, is not deemed to meet this requirement.

7.6 Inside the terminal enclosure, the sheath of a flexible cable or cord shall only be used as supplementary insulation where it is not subject to undue mechanical or thermal stresses and if its insulating properties are not less than those specified for the sheaths of flexible cables and cords in BS 6004, BS 6007, or BS 6500.

8 Thermal insulation

8.1 Thermal insulation materials shall not make contact with the heated part of the element sheath or pocket.

8.2 Where terminal enclosures are stood off from the element head or element plate to give cooling via natural convection, the stand-off areas shall not be thermally insulated.

9 Construction

NOTE 1. Heaters should be so constructed that they operate in all positions to be expected in normal use. Any limitations of use should be specified by the manufacturer.

NOTE 2. The cold length of the element should be sufficient to minimize the risk of local overheating caused by an air lock under the element head or element plate.

9.1 Heaters shall be constructed so that, after being removed for servicing or maintenance, they can be refitted correctly with normal tools.

9.2 A thermal cut-out or temperature limiter shall be provided. The sensor shall be mounted so as to protect the complete heater unit.

9.3 If element surface temperature monitors are fitted, they shall be attached to the element sheath by brazing, welding or mechanical clamping.

9.4 Heaters shall be provided with an enclosure.

9.5 The minimum thickness of metallic enclosures shall be as stated in table 2.

9.6 All threaded bushes, plugs or caps shall engage to the extent of at least five full threads.

9.7 Non-metallic enclosures shall conform to the appropriate glow-wire test requirements of BS 6458 : Section 2.1.

NOTE. Special consideration should be given to any non-metallic enclosure to ensure that it has sufficient physical strength, and that it has adequate resistance to impact, moisture absorption, corrosion and to distortion with respect to thermal ageing.

9.8 All parts of the heater in contact with liquids shall be manufactured from materials resistant to service corrosion or protected by a corrosion-resistant finish.

Details of any protective finish, including its method of application and recommended intervals for recoating, shall be specified in the maintenance instructions.

Table 2. Minimum thickness of metallic enclosures

Material	Reinforced flat surfaces mm	Surfaces to which a wiring system is to be connected on site mm	Unreinforced flat surfaces mm
Die-cast steels	1.20	—	2.00
Cast malleable iron	1.60	—	2.40
Other cast metal	2.40	—	3.20
Uncoated sheet steel	0.66	0.81	0.66
Galvanized sheet steel	0.74	0.86	0.74
Non-ferrous sheet steel	0.91	1.14	0.91

9.9 All external parts open to the atmosphere shall be manufactured from materials resistant to the atmosphere or protected by a corrosion-resistant finish.

NOTE. Particular care should be taken in the selection of the materials used within the terminal enclosures, where airborne vapours or corrosive gases may exist.

Details of any protective finish, including its method of application and recommended intervals for recoating, shall be specified in the maintenance instructions.

9.10 Internal surfaces shall be smooth and free from sharp edges, burrs, flashes and the like, which might abrade the insulation of the wiring.

9.11 Where terminal enclosures are stood off from the flange plate to allow cooling by natural convection, suitable safety guards shall be fitted.

9.12 Castings shall be manufactured from materials which do not warp.

9.13 Element support assemblies intended to prevent the immersion heater from overheating its containment vessel shall be so fixed that it is not possible to remove them from the outside of the immersion heater by means of a screwdriver or spanner.

9.14 For heaters having compartments to which access can be gained without the aid of a tool and which are likely to be cleaned in normal use, the electrical connections shall be so arranged that they are not subject to pulling during user maintenance. It shall be possible to remove the lid of such compartments without disturbing the internal wiring.

9.15 The heaters shall be so constructed that the setting of thermostats or other control devices cannot be accidentally altered.

9.16 The location and mounting of any integral controls shall be such as to protect them from damage when in use and when the heater is removed for servicing.

9.17 Handles, knobs, grips and levers shall be securely fixed so that they will not work loose in normal use. If handles or knobs are used to indicate the position of switches or similar components, it shall not be possible to fix them in an incorrect position.

9.18 Materials which support combustion shall not be used in the construction of the heaters.

9.19 Wood, cotton, silk, paper and similar fibrous or hygroscopic material shall not be used as insulation unless impregnated. Ceramic materials not fully sintered and insulating beads alone shall not be used as supplementary or reinforced insulation.

Asbestos shall not be used for any purpose.

10 Supply connections

All cables for supply connections shall conform to one of the following British Standards:

BS 5467, BS 6004, BS 6007, BS 6141, BS 6207, BS 6346.

NOTE. It is recommended that sizes be selected to suit the nominal rating of the heater plus an allowance for the increase in rating due to power factor, increase in supply voltage and the heater manufacturing tolerances.

11 Terminations for external conductors

11.1 General

11.1.1 Terminals for external connection shall be mounted in a manner that prevents self-loosening.

NOTE 1. Terminals may be secured with two screws, or with one screw in a recess such that there is no appreciable play, or by other suitable means.

NOTE 2. Covering with sealing compound without any other means of locking is not deemed to be adequate. Self-hardening resins may, however, be used to lock terminals which are not subject to torsion in normal use.

11.1.2 Terminals shall be such that proper contact is assured without deterioration of the conductors, even if multi-stranded cores are used in terminals which are intended for direct clamping of the cores.

11.1.3 Terminals shall not have sharp edges which could damage the conductors.

NOTE. Conductors are considered to be damaged if they show deep or sharp indentations.

11.1.4 Terminals shall be of a type which cannot turn, or be twisted or permanently deformed during normal tightening.

11.1.5 The terminals shall be such that the contact they apply is not impaired by the temperature changes likely in normal service. Insulating material shall not be used to transmit the contact pressure.

11.1.6 Terminals which are intended for clamping stranded cores shall include a resilient intermediate part.

NOTE. Special precautions may be necessary against vibration or mechanical shocks.

11.1.7 The minimum size of terminal used shall be for conductors of 4 mm² cross-section.

11.1.8 Terminals made of aluminium, or material containing aluminium, shall be protected against electrolytic corrosion.