



BS 1394 : Part 1 : 1987

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British Standard

Stationary circulation pumps for heating and hot water service systems

Part 1. Specification for safety requirements

Pompes fixes de circulation pour systèmes de chauffage et d'eau chaude
Partie 1. Caractéristiques de sécurité — Spécifications

Ortsfeste Umwälzpumpen für Heizungs- und Warmwassersysteme
Teil 1. Sicherheitsanforderungen

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Foreword

This Part of BS 1394 has been prepared under the direction of the Light Electrical Engineering Standards Committee and, together with the revision of Part 2, supersedes BS 1394 : Parts 1 and 2, both of which were published in 1971, which are now withdrawn.

The opportunity has been taken in this revision of BS 1394 to follow the general principle of separating requirements for safety from other requirements. In this respect Part 1 specifies safety requirements and aligns with a draft IEC standard for safety of stationary circulation pumps (soon to be published as a Part 2 in the IEC 335 series of publications) while Part 2 specifies physical and performance requirements. Both Parts 1 and 2 cover glanded and glandless pumps having a rated input not exceeding 300 W. Previously, Part 1 specified safety and performance requirements for glanded and glandless pumps with power input above 200 W and not exceeding 2000 W, while Part 2 specified safety and performance of domestic glandless pumps with power input not exceeding 200 W.

This Part of BS 1394 comprises a combination of BS 3456* : Part 101 : 1987 and a draft Part 2, entitled 'Stationary circulation pumps for heating and service water plants', to IEC 335 : 1976 'Safety of household and similar electrical appliances: Part 1: General requirements' published by the International Electrotechnical Commission (IEC) as modified by Amendment No. 1: 1977 and Amendment No 2: 1979. The safety requirements in this Part of this standard have been widened to include those for starting, input and current, and endurance. Pumps are also required to be at least drip-proof.

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

*BS 3456 : Part 101 : 1987 is in exact agreement with IEC 335-1 : 1976 as modified by Amendment No. 1: 1977 and Amendment No. 2: 1979, except where this has been amended by HS 251-83 or by declared United Kingdom deviations to the IEC.

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Specification

1 Scope

This Part of BS 1394 specifies the safety requirements of electric stationary circulation pumps intended to be used in heating systems or hot water service systems, and having a rated input not exceeding 300 W.

Pumps not intended for normal household use, but which nevertheless may be a source of danger to the public, such as pumps intended to be used by laymen in shops, in commercial use and on farms, are within the scope of BS 1394, but only if they have a rated input not exceeding 300 W.

BS 1394 does not take into account the special hazards which exist in nurseries and other places where there are young children or aged or infirm persons without supervision; in such cases, additional requirements may be necessary.

BS 1394 does not apply to:

- (a) pumps within the scope of BS 3456 : Part 2: Section 2.35 and pumps for circulating liquids other than water, which are covered by a separate British Standard;
- (b) pumps designed exclusively for industrial purposes;
- (c) pumps intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour, or gas).

For pumps intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary.

For pumps intended to be used in tropical countries, special requirements may be necessary.

This Part of BS 1394 is concerned with safety and takes into account the influence on safety of components necessary to achieve a required degree of radio and television interference suppression.

NOTE. The titles of the publications referred to in this Part of BS 1394 are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 1394 the following definitions, with the exception of definitions 2.13 and 2.14, apply.

NOTE 1. Definitions 2.13 and 2.14 have been included because, although these classes of pump are not permitted in the UK, they are referred to in corresponding international standards.

NOTE 2. Where the terms 'voltage' and 'current' are used, they imply the r.m.s. values unless otherwise specified. Where the term motor is used, it includes magnetic drive units.

2.1 rated voltage. The voltage (for three-phase supply, the voltage between phases) assigned to the pump by the manufacturer.

2.2 rated voltage range. The voltage range assigned to the pump by the manufacturer, expressed by its lower and upper limits.

2.3 working voltage. The maximum voltage to which the part under consideration can be subjected when the pump is operating at its rated voltage and under normal conditions of use.

NOTE 1. Normal conditions of use include changes of voltage within the pump imposed by likely occurrences such as the operation of a circuit breaker or the failure of a lamp.

NOTE 2. When deducing the working voltage, the effect of possible transient voltages on the supply mains is ignored.

2.4 rated input. The input under conditions of normal load and at normal operating temperature assigned to the pump by the manufacturer.

2.5 rated current. The current assigned to the pump by the manufacturer.

NOTE. If no current is assigned to the pump, the rated current for the purpose of this standard is determined by calculation from the rated input and the rated voltage and/or by measuring the current when the pump is operating at rated voltage under normal load and at normal operating temperature.

2.6 rated frequency. The frequency assigned to the pump by the manufacturer.

2.7 rated frequency range. The frequency range assigned to the pump by the manufacturer expressed by its lower and upper limits.

2.8 power supply cord. A flexible cable or cord, for supply purposes, fixed to, or assembled with the pump according to one of the following methods.

type X attachment. A method of attachment such that the flexible cable or cord can easily be replaced, without the aid of special purpose tools, by a flexible cable or cord not requiring any special preparation.

type M attachment. A method of attachment such that the flexible cable or cord can easily be replaced, without the aid of special purpose tools, by a special cable or cord with, for example, a moulded-on cord guard or crimped terminations.

type Y attachment. A method of attachment such that the flexible cable or cord can be replaced only with the aid of special purpose tools normally available only to the manufacturer or his agents.

NOTE. Type Y attachments may be used either with common flexible cables or cords or with special cables or cords.

type Z attachment. A method of attachment such that the flexible cable or cord cannot be replaced without breaking or destroying a part of the pump.

2.9 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.

2.10 supplementary insulation. Independent insulation applied in addition to basic insulation, in order to ensure protection against electric shock in the event of a failure of the basic insulation.

2.11 double insulation. Insulation comprising both basic insulation and supplementary insulation.

2.12 reinforced insulation. A single insulation system applied to live parts that provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this standard.

NOTE. The term 'insulation system' does not imply that the insulation should be one homogeneous piece. It may comprise several layers that cannot be tested singly as supplementary or basic insulation.

2.13 class 0 pump*. A pump in which protection against electric shock relies upon basic insulation; this implies that there are no means for the connection of accessible conductive parts, if any, to the protective (earthing) conductor in the fixed wiring of the installation, reliance in the event of a failure of the basic insulation being placed upon the environment.

NOTE 1. Class 0 pumps have either an enclosure of insulating material which may form a part or the whole of the basic insulation, or a metal enclosure which is separated from live parts by an appropriate insulation. If a pump with an enclosure of insulating material has provision for earthing internal parts, it is considered to be of class I or class OI construction.

NOTE 2. Class 0 pumps may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage.

2.14 class OI pump*. A pump having at least basic insulation throughout and provided with an earthing terminal, but with a power supply cord without earthing conductor and a plug without an earthing contact and which cannot be introduced into a socket-outlet with an earthing contact.

NOTE. Class OI pumps may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage.

2.15 class I pump. A pump in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation so that accessible conductive parts cannot become live in the event of a failure of the basic insulation.

NOTE 1. Class I pumps may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage (see 2.19).

NOTE 2. For pumps intended for use with a flexible cord or cable, this provision includes a protective (earthing) conductor as part of the flexible cord or cable.

2.16 class II pump. A pump in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions.

Such a pump may be of one of the following types:

(a) a pump having a durable and substantially continuous enclosure of insulating material that envelops all metal parts, with the exception of small parts, such as nameplates, screws and rivets, which are isolated from live parts by insulation at least equivalent to reinforced insulation; such a pump is called an 'insulation-encased class II pump';

(b) a pump having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used, because the application of double insulation is manifestly impracticable; such a pump is called a 'metal-encased class II pump';

(c) a pump which is a combination of the types (a) and (b).

NOTE 1. The enclosure of an insulation-encased class II pump may form a part or the whole of the supplementary insulation or of the reinforced insulation.

NOTE 2. If a pump with double insulation and/or reinforced insulation throughout has an earthing terminal or earthing contact, it is considered to be of class I or class OI construction. Class II pumps may be provided with means for maintaining the continuity of protective circuits, provided that such means are within the pumps and are insulated from accessible conductive parts by double insulation or reinforced insulation.

NOTE 3. Class II pumps may have parts operating at safety extra-low voltage.

2.17 class III pump. A pump in which protection against electric shock relies on supply at safety extra-low voltage and in which voltages higher than this are not generated.

NOTE. Pumps intended to be operated at safety extra-low voltage and having internal circuits that operate at a voltage other than safety extra-low voltage are not included in the classification and are subject to additional requirements.

2.18 extra-low voltage. A voltage supplied from a source within the pump and, when the pump is operated at its rated voltage, not exceeding 42 V between conductors and between conductors and earth or, for three-phase supply, not exceeding 24 V between conductors and neutral, the extra-low voltage circuit being separated from other circuits by basic insulation only.

2.19 safety extra-low voltage. A nominal voltage not exceeding 42 V between conductors and between conductors and earth or, for three-phase supply, not exceeding 24 V between conductors and neutral, the no-load voltage not exceeding 50 V and 29 V respectively.

NOTE 1. When safety extra-low voltage is obtained from the supply mains, it is essential that it be through a safety isolating transformer (see 2.20) or a converter with separate windings.

NOTE 2. The voltage limits given are based on the assumption that the safety isolating transformer is operated at its rated supply voltage.

*This definition has been included because, although this class of pump is not permitted in the UK, it is referred to in corresponding international standards.

2.20 safety isolating transformer. A transformer the input winding of which is electrically separated from the output windings by an insulation at least equivalent to double insulation or reinforced insulation, and which is designed to supply a distribution circuit, a pump or other equipment at safety extra-low voltage.

NOTE. Transformers complying with the requirements of BS 3535, without provision for earthing and with the appropriate output voltages are considered to be safety isolating transformers for the purposes of this standard.

2.21 normal load. The load obtained when the pump is operated as in normal use, at rated voltage or at the upper limit of the rated voltage range, with the maximum hydraulic load within the limits specified by the manufacturer.

The temperature of the water at the inlet of the pump being maintained at the maximum value according to the class of temperature of the water circulated marked on the pump, with a tolerance of 0°C $\left(0^{\circ}\text{K}\right)$.

2.22 rated operating time. The operating time assigned to the pump by the manufacturer.

2.23 continuous operation. Operation under normal load for an unlimited period.

2.24 short-time operation. Operation under normal load for a specified period, starting from cold, the intervals between each period of operation being sufficient to allow the pump to cool down approximately to room temperature.

2.25 intermittent operation. Operation in a series of specified identical cycles, each cycle being composed of a period of operation under normal load, followed by a rest period with the pump running idle or switched off.

2.26 non-detachable part. A part that cannot be removed without the aid of a tool (see 2.32).

2.27 detachable part. A part that can be removed without the aid of a tool (see 2.32).

2.28 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 a pump, or of parts of it, between certain limits by automatically opening and closing a circuit.

2.29 thermal cut-out. A device which, during abnormal operation, limits the temperature of a pump, 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.

2.30 self-resetting thermal cut-out. A thermal cut-out that automatically restores the current after the relevant part of the pump has cooled down sufficiently.

2.31 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.

2.32 tool. A screwdriver, a coin or any other object that may be used to operate a screw or similar fixing means.

2.33 creepage distance. The shortest path between two conductive parts, or between a conductive part and the bounding surface of the pump, measured along the surface of the insulating material.

2.34 clearance. The shortest distance between two conductive parts, or between a conductive part and the bounding surface of the pump, measured through air.

NOTE. The bounding surface of the pump is the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material.

2.35 all-pole disconnection. For single-phase a.c. pumps and for d.c. pumps, disconnection of both supply conductors by a single switching action or, for pumps to be connected to more than two supply conductors, disconnection of all supply conductors, except the earthed (neutral) conductor, by a single switching action.

NOTE. The protective (earthing) conductor is not considered to be a supply conductor.

2.36 accessible part or accessible surface. A part or surface that can be touched by means of the test finger shown in figure 1.

2.37 body. All accessible metal parts, shafts of handles, knobs, grips, etc. and metal foil in contact with all accessible surfaces of insulating material; but excluding inaccessible metal parts.

2.38 pump. The combination of the mechanical part, the hydraulic part and the electrical part of a device for circulating water.

3 General requirement

3.1 Pumps shall be so designed and constructed that, in normal use, they function safely so as to cause no danger to persons or surroundings, even in the event of such careless use as may occur in normal service.

TEST. In general, compliance shall be checked by carrying out all the relevant tests specified.

3.2 Where this Part of BS 1394 is used for the purposes of granting nationally recognized certification marks, designs or constructions to which the tests specified do not fully apply but which give an equivalent degree of safety and durability of safety, shall be deemed to comply with the requirements of this Part of BS 1394, subject to the findings of a special investigation by the authority granting the certification mark and pending the issue of an amendment to the standard.

4 General conditions for the tests

4.1 Tests carried out in accordance with this Part of BS 1394 are type tests.

4.2 Unless otherwise specified in this Part of BS 1394, the tests shall be carried out on a single sample as delivered, which has to withstand all the relevant tests.

NOTE 1. If it is evident from the design of the pump that a particular test is not applicable, this test is not carried out.

NOTE 2. If the pump is designed for different supply voltages, for both a.c. and d.c., for different speeds, etc., more than one sample may be required.

NOTE 3. If it is necessary to dismantle a class II pump (2.16) for the relevant tests, one additional sample is required.

NOTE 4. The testing of components may necessitate the submission of additional samples of these components. When the submission of such samples is necessary, they should be submitted together with the pump.

NOTE 5. The test specified in 16.2 may be made on a separate sample.

4.3 The tests shall be carried out in the order of the clauses of this standard.

NOTE. Before testing is started, the pump has to be operated at rated voltage in order to verify that it is in working order.

4.4 The tests shall be carried out with the pump, or any movable part of it, placed in the most unfavourable position that may occur in normal use.

4.5 If the test results are influenced by the temperature of the ambient air, the room temperature shall be, in general, maintained at $20 \pm 5^\circ\text{C}$. If, however, the temperature attained by any part is limited by a temperature-sensitive device, or is influenced by the temperature at which a change of state occurs, for example, the temperature of boiling water, the room temperature shall be, in case of doubt, maintained at $23 \pm 2^\circ\text{C}$.

For pumps intended to be located within the enclosure of a boiler heater, where the test results may be influenced by the temperature of the ambient air, the ambient temperature shall be maintained between 55°C and 60°C .

4.6 Pumps for a.c. only shall be tested with a.c., at rated frequency if marked; those for d.c. only shall be tested with d.c.; and those for a.c./d.c. shall be tested at the more unfavourable supply.

Pumps for a.c. that are not marked with a rated frequency shall be tested at 50 Hz.

Pumps for a.c. that are marked with a rated frequency range of 50 Hz to 60 Hz shall be tested at 50 Hz or 60 Hz, whichever is the more unfavourable.

Pumps marked with a rated frequency range other than 50 Hz to 60 Hz shall be tested at the most unfavourable frequency within the range.

Pumps designed for more than one rated voltage shall be tested at the most unfavourable voltage.

Pumps designed for one or more rated voltage ranges shall be tested at the most unfavourable voltage within the relevant range.

When it is specified in this Part of BS 1394 for pumps marked with a rated voltage range, that the supply voltage is equal to the rated voltage multiplied by a factor, the supply voltage shall be equal to one of the following:

(a) the upper limit of the rated voltage range multiplied by this factor, if greater than one;

(b) the lower limit of the rated voltage range multiplied by this factor, if smaller than one.

NOTE 1. Where reference is made to maximum or minimum rated input, the rated input related to the upper limit or lower limit, respectively, of the rated voltage range is meant.

When testing pumps for d.c. only, the possible influence of polarity on the operation of the pump shall be taken into consideration.

NOTE 2. If the pump is designed for more than one rated voltage or rated voltage range, it may be necessary to carry out some of the tests at the minimum, the mean and the maximum values of the rated voltage or the rated voltage range in order to establish the most unfavourable voltage.

4.7 Pumps provided with a thermostat, a regulating device or a similar control, shall be tested with these controls adjusted to their most unfavourable setting, if the setting can be altered by the user.

NOTE 1. If the adjusting means of the control is accessible without the aid of a tool, 4.7 applies whether the setting can be altered by hand or with the aid of a tool. If the adjusting means is not accessible without the aid of a tool, 4.7 applies only if the setting can be altered by hand.

NOTE 2. Adequate sealing is regarded as preventing alteration of the setting by the user.

4.8 Unless otherwise specified in this Part of BS 1394, pumps intended to be supplied by means of a flexible cable or cord shall be tested with the appropriate flexible cable or cord connected to the pump.

4.9 Class III pumps (2.17) shall be tested together with their supply transformers if these are sold with the pumps.

4.10 For the purpose of 8.4, 15.3, 23.9 and 25.1, parts separated from live parts by double insulation or reinforced insulation shall be regarded as not being likely to become live in the event of an insulation fault; connection of accessible metal parts to an earthing terminal does not remove the necessity for carrying out the relevant tests.

4.11 If class I pumps (2.15) have accessible metal parts that are not connected to an earthing terminal and that are not separated from live parts by an intermediate metal part which is connected to an earthing terminal, such parts shall be checked for compliance with the appropriate requirements specified for class II pumps.

4.12 If class I or class II pumps have parts operating at safety extra-low voltage, such parts shall be checked for compliance with the appropriate requirements specified for class III pumps.

4.13 For testing pumps incorporating electronic circuits, see appendix A.

5 Rating

5.1 The maximum rated voltage shall be 440 V.

TEST. Compliance shall be checked by inspection of the marking.

NOTE. The requirements of this Part of BS 1394 are based on the assumption that, in normal use, the voltage between the supply lines and earth does not exceed 254 V.

5.2 Single-phase pumps intended for direct connection to the UK mains supply shall have a rated voltage that covers use at 240 V and a rated frequency that covers use at 50 Hz.

TEST. Compliance shall be checked by inspection of the marking.

5.3 The minimum system pressure shall be:

- (a) 0.6 MPa (60 N/cm², 6 bar), for pumps for heating systems;
- (b) 1.0 MPa (100 N/cm², 10 bar), for pumps for hot water service systems.

TEST. Compliance shall be checked by inspection of the marking or of the instruction sheet.

6 Classification

Pumps shall be classified as follows:

- (a) according to protection against electric shock:
 - class I pumps (defined in 2.15);
 - class II pumps (defined in 2.16);
 - class III pumps (defined in 2.17).

NOTE 1. The class numbers are not intended to reflect the safety level of the pumps, but only the means by which the safety is achieved.

NOTE 2. If class III pumps are sold with a separate safety isolating transformer for their supply from the mains, their classification is not altered.

- (b) according to degree of protection against moisture:
 - drip-proof pumps;
 - splash-proof pumps;
 - watertight pumps.

- (c) according to temperature of the water circulated as in table 1.

Table 1. Maximum water temperature	
Class	Maximum water temperature at inlet
	°C
TF 60	60
TF 95	95
TF 110	110

NOTE 3. The classification according to temperature of the water circulated recognizes the actual temperatures of the water at the inlet of the pump for various heating and service systems, including those where the pump is located in the enclosure of a gas heater or used for similar purposes.

7 Marking

7.1 Pumps shall be marked with the following.

- (a) Rated voltage(s) or rated voltage range(s), in volts.
- (b) Symbol for nature of supply, if applicable.
- (c) Rated frequency or rated frequency range, in hertz, unless the pump is designed for d.c. only or for a.c. of both 50 Hz and 60 Hz.
- (d) Rated input, in watts or kilowatts, if greater than 25 W.
- (e) Rated current, in amperes, if this is necessary for the adjustment of a motor-protection circuit-breaker.
- (f) Rated current of the appropriate fuse-link, in amperes, for pumps where the inrush current requires a fuse of a current rating higher than that appropriate to the marked rating (see 9.2).
If the rated current of the appropriate fuse-link is marked and if the fuse-link is of the time/lag type, information about the time/current characteristic rating shall be included in the relevant marking.
- (g) Manufacturer's or responsible vendor's name, trade mark or identification mark.
- (h) Manufacturer's model or type reference.
- (i) Rated operating time, or rated operating time and rated testing time, in hours, minutes or seconds, if applicable.
- (j) Symbol for class II construction, for class II pumps only.
- (k) Symbol for degree of protection against moisture.
- (l) Maximum system pressure in pascals, bars or newtons per square centimetre, unless this is given in the instruction sheet.
- (m) Class according to the temperature of the water circulated, e.g. TF 60.
- (n) Maximum ambient temperature, in degrees centigrade, if exceeding 35 °C, for pumps other than those intended to be located in the enclosure of a gas heater or oil heater.
- (o) Direction of flow of the water.
- (p) Position of mounting, unless this is given in the instruction sheet.

Pumps for star-delta connection shall be clearly marked with the two rated voltages (e.g. 220 Δ/380 Y).

Rated input or rated current shall be the total maximum input or current of the circuits that can be in operation simultaneously.

If a pump has alternative components that can be selected by a control device, the rated input given shall be that corresponding to the highest loading possible.

Pumps with windings insulated with class B, class F or class H material only shall be marked with the class designation of their winding insulation.

NOTE. Additional markings are allowed, provided they do not give rise to misunderstanding.

7.2 Except for pumps for star-delta connection, if the pump can be adjusted to suit different rated voltages or different rated inputs, the voltage or input to which the pump is adjusted shall be easily and clearly discernible.

NOTE. For pumps for which frequent changes in voltage setting are not required, the requirement is considered to be complied with if the rated voltage or the rated input to which the pump is adjusted can be determined from a wiring diagram fixed to the pump. This wiring diagram may be on the inside of a cover which has to be removed to connect the supply conductors. This diagram may be on a card riveted to the cover, or on a paper or similar label secured to the cover by an adhesive.

If a wiring diagram is used it shall not be on a label loosely attached to the pump.

7.3 For pumps marked with more than one rated voltage or rated voltage range, the rated input for each of these voltages or ranges shall be marked, if greater than 25 W.

The upper and lower limits of the rated input shall be so marked on the pump that the relation between input and voltage appears distinctly unless the difference between the limits of a rated voltage range does not exceed 10 % of the mean value of the range, in which case the marking for rated input may be related to the mean value of the range.

If the input of the pump in cold condition differs by more than 25 % from the input at operating temperature, the input in cold condition shall be marked in addition, and shall be placed in brackets after the marking of the input at operating temperature.

7.4 When symbols are used, they shall be as follows:

V	volts
A	amperes
Hz	hertz
W	watts
kW	kilowatts
μF	microfarads
L	litres
kg	kilograms
*N/cm ²	newtons per square centimetre
*Pa	pascals
*bar	bar
h	hours
min	minutes
s	seconds

*For the purposes of this Part of BS 1394 the recommended unit of pressure is the bar and preference should be given to its use.
1 bar = 10⁵ N/m² = 100 kPa.

~	alternating current (417-IEC-5032a, BS 6217 : 1981)
3~	three-phase alternating current
3N~	three-phase alternating current with neutral direct current (417-IEC-5031a, BS 6217 : 1981)
	fuse-link (417-IEC-5016a, BS 6217 : 1981)
 XA	rated current of the appropriate fuse-link where X is the numerical value of the current
	time-lag D-type fuse-link
 X	time-lag miniature fuse-link where X is the symbol for time/current characteristic as given in BS 4265
	class II construction (417-IEC-5172a, BS 6217 : 1981)
	drip-proof construction
	splash-proof construction
	watertight construction

The symbol for nature of supply shall be placed next to the marking for rated voltage.

The dimensions of the symbol for class II construction shall be such that the length of the sides of the outer square is about twice the length of the sides of the inner square. The length of the sides of the outer square shall be not less than 5 mm, unless the largest dimension of the pump does not exceed 150 mm, in which case it is permissible for the dimensions of the symbol to be reduced, but the length of the sides of the outer square shall be not less than 3 mm.

NOTE. This list of symbols is not exclusive and other symbols for different purposes are allowed if they do not lead to misunderstanding.

The symbol for class II construction shall be so placed that it will be obvious that it is a part of the technical information and is unlikely to be confused with any other marking.

7.5 For class I pumps, the line terminal shall be indicated by the letter L.

Terminals intended exclusively for the neutral conductor shall be indicated by the letter N.

Earthing terminals shall be indicated by the symbol $\perp$.

These indications shall not be placed on screws, removable washers or other parts that might be removed when conductors are being connected.

If, for single-phase class I pumps intended to be permanently connected to fixed wiring, a single-pole switch or a single-pole protection device is inserted in the line conductor inside the pump, the corresponding terminal shall be clearly indicated to enable the correct connection to the supply to be made.

7.6 Pumps to be connected to more than two supply conductors shall be provided with a connection diagram, fixed to the pump, unless the correct mode of connection is obvious.

For pumps for star-delta connection, the connection diagram shall show how the windings are to be connected. The correct mode of connection is considered to be obvious if, for three-phase pumps, the terminals for the supply conductors are indicated by arrows pointing towards the terminals. The earthing conductor is not a supply conductor.

Marking in words is an acceptable means of indicating the correct mode of connection.

The connection diagram may be the wiring diagram referred to in 7.2.

7.7 Unless it is obviously unnecessary, switches, the operation of which might cause a hazard, shall be so marked or placed that they indicate clearly which part of the pump they control. Indications used for this purpose shall, wherever practicable, be comprehensible without a knowledge of languages, national standards, etc.

7.8 The different positions of regulating devices, and the different positions of switches on pumps shall be indicated by figures, letters or other visual means. The 'off' position shall not be indicated by words only.

If figures are used for indicating the different positions, the 'off' position shall be indicated by the figure zero and the position for a greater output, input, speed, cooling effect, etc., shall be indicated by a higher figure.

The figure zero shall not be used for any other indication.

7.9 Thermostats, regulating devices, etc. intended to be adjusted during installation or in normal use, shall be provided with an indication for the direction of adjustment to increase or to decrease the value of the characteristic being adjusted.

NOTE. An indication of the symbol + and the symbol - is considered to be sufficient.

7.10 Pumps shall be accompanied by an instruction sheet giving the operating limits in terms of flow or pump generated head.

If a pump is not provided with a non-detachable flexible cable or cord intended to be connected to a plug or with other means for disconnection from the supply having a contact separation of at least 3 mm in all poles, the instruction sheet shall state that such means for disconnection have to be incorporated in the fixed wiring.

If the supply wires of a pump can come into contact with parts of a terminal block or compartment for fixed wiring and these parts have, under conditions of normal use, a temperature such that the insulation of the wire is subjected to a temperature rise exceeding that given in table 4, the instruction sheet shall also state that the pump

is to be connected by means of wires having appropriate 7-marking or temperature rating.

For pumps with type Z attachment the instruction sheet shall contain the substance of the following information:

'The supply cord of this pump cannot be replaced; if the cord is damaged, the pump should be discarded.'

7.11 Instruction sheets and other texts required by this Part of BS 1394 shall be written in the official language(s) of the country in which the pump is to be sold. For pumps for sale in the UK, instructions shall be in English.

Where symbols are used, they shall be those indicated in this Part of BS 1394 although additional symbols are permitted if they do not give rise to misunderstanding.

TEST for 7.1 to 7.11. Compliance with the requirements of 7.1 to 7.11 shall be checked by inspection.

7.12 Marking required by this Part of BS 1394 shall be easily legible and durable.

Marking on, and indications for, switches, thermostats, thermal cut-outs and other control devices shall be placed in the vicinity of these components; they shall not be placed on removable parts if these parts can be replaced in such a way that the marking is misleading.

TEST. Compliance shall be checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After all the tests specified in this Part of BS 1394, the marking shall be easily legible. It shall not be possible to remove marking plates easily and they shall show no curling.

NOTE. In considering the durability of the marking, the effect of normal use is taken into account. Thus, for example, marking by means of paint or enamel other than vitreous enamel on containers that are likely to be cleaned frequently is not considered to be durable.

7.13 A label shall be attached to the flexible cord of all class I pumps fitted with a flexible cable or cord having cores coloured green-and-yellow, blue and brown. This label shall state the following:

'IMPORTANT

The wires in this mains lead are coloured in accordance with the following code:

Green-and-yellow: Earth
Blue: Neutral
Brown: Live'

In addition, the user instructions and label shall include the substance of the following:

'As the colours of the wires in the mains lead of this pump may not correspond with the coloured markings identifying the terminals in your plug, proceed as follows:

The wire that is coloured green-and-yellow must be connected to the terminal in the plug which is marked with the letter E or by the earth symbol  or coloured green or green-and-yellow.

The wire that is coloured blue must be connected to the terminal that is marked with the letter N or coloured black.

The wire that is coloured brown must be connected to the terminal that is marked with the letter L or coloured red.'

For class II pumps fitted with a flexible cord, instructions shall be given by the manufacturer for the correct connection of the plug. These instructions shall make it clear that neither core is to be connected to the earth terminal of a three-pin plug.

TEST. Compliance shall be checked by inspection.

7.14 For class I pumps the following warning shall be included in the user instructions.

'WARNING – THIS PUMP MUST BE EARTHED'

TEST. Compliance shall be checked by inspection.

NOTE. For pumps intended for export, alternative labelling to that specified in 7.13 and 7.14 may be required.

8 Protection against electric shock

8.1 Pumps shall be so constructed and enclosed that there is adequate protection against accidental contact with live parts and, for class II pumps, with metal parts separated from live parts by basic insulation only. This requirement applies for all positions of the pump when it is wired and operated as in normal use, even after opening of covers and removal of detachable parts, except for lamps located behind a detachable cover, provided that the pump can be isolated from the supply by means of a plug or an all-pole switch, the 'off' position of which is clearly indicated. During the insertion or removal of lamps, protection against accidental contact with live parts of the lamp cap shall also be ensured.

There shall be, in addition, adequate protection against the risk of contact with basic insulation. Such insulation may, however, be accessible after removing a cover that requires the use of tools for removal and has to be removed for user maintenance, or after removing a cover that can be removed without tools if marked 'Remove plug before removing this cover' or 'Disconnect from the mains before removing this cover'.

The insulating properties of lacquer, enamel, ordinary paper, cotton, oxide film on metal parts, beads and sealing compound shall not be relied upon to give the required protection against accidental contact with live parts.

The enclosure of the pump shall have no openings, other than those necessary for the use and working of the pump, giving access to live parts and, for class II pumps, to parts separated from live parts by basic insulation only.

For the purpose of assessing compliance with these requirements the following conditions shall apply.

(a) Unless otherwise specified in this Part of BS 1394, parts operating at safety extra-low voltage not exceeding 24 V are not considered to be live parts.

(b) If a manufacturer instructs the user to remove a part during normal operation or user maintenance, that part is regarded as a detachable part even if a tool has to be used for its removal.

NOTE. The requirements of 8.1 preclude the use of screw-type fuses, and screw-type miniature circuit-breakers if they are accessible without the aid of a tool.

(c) Self-hardening resins are not regarded as sealing compound.

TEST. Compliance shall be checked by inspection and by a test with the test finger shown in figure 1.

In addition, all apertures in class II pumps and apertures in class I pumps other than those in metal parts connected to an earthing terminal or earthing contact and those giving access to live parts in socket outlets and lamp caps, shall be tested with the test pin shown in figure 2 (identical with test pin I specified in BS 3042 : 1971). The test finger and the test pin are applied, without appreciable force, in every possible position.

For pumps provided with movable devices, the test shall be carried out with the devices adjusted to their most unfavourable position within their range of adjustment.

Apertures preventing the entry of the finger shall be further tested by means of a straight unjointed test finger of the same dimensions, which is applied with a force of 20 N; if this finger enters, the test with the test finger shown in figure 1 is repeated, the finger being introduced through the aperture. If the unjointed test finger does not enter, the force applied is increased to 30 N. If then the guard is so displaced or the aperture so distorted that the test finger shown in figure 1 can be inserted without force, the test with the latter finger is repeated. An electrical contact indicator shall be used to show contact.

It shall not be possible to touch bare live parts or live parts protected by lacquer, enamel, ordinary paper, cotton, oxide film, beads or sealing compound only, with the test finger shown in figure 1.

It shall not be possible to touch basic insulation with the test finger shown in figure 1 unless it is under a detachable cover that either requires the use of a tool for removal or is marked, 'Remove plug before removing this cover' or 'Disconnect from the mains before removing this cover'.

For class II pumps it shall not be possible to touch bare live parts with the test pin shown in figure 2 or to touch metal parts separated from live parts by basic insulation only with the test finger shown in figure 1.

NOTE 1. When applying the test finger shown in figure 1, either or both of the jointed sections should be turned through any angle up to 90° with respect to the axis of the finger and in the same direction only.

NOTE 2. It is recommended that a lamp be used for the indication of contact and that the voltage be not less than 40 V.

8.2 For pumps other than those of class III, flexible shafts that are handled in normal use shall be insulated from the motor shafts by suitable couplings of insulating material.

TEST. Compliance shall be checked by inspection and by the tests specified for supplementary insulation (see clause 15).

8.3 Shafts of operating knobs, handles, levers, etc. shall not be live.

TEST. Compliance shall be checked by inspection.

8.4 For pumps other than those of class III, handles, levers and knobs that are held or actuated in normal use shall not become live in the event of an insulation fault. If these handles, levers or knobs are of metal, and if their shafts or fixings are likely to become live in the event of an insulation fault, they shall either be adequately covered by insulating material or their accessible parts shall be separated from their shafts or fixings by supplementary insulation.

This requirement does not apply to handles, levers and knobs, other than those of electrical components, provided they are either reliably connected to an earthing terminal or earthing contact, or separated from live parts by earthed metal.

TEST. Compliance shall be checked by inspection and, if necessary, by the tests specified for supplementary insulation (see clause 15).

8.5 For class II pumps, capacitors shall not be connected to accessible metal parts, and their casings, if of metal, shall be separated from accessible metal parts by supplementary insulation.

TEST. Compliance shall be checked by inspection and by the tests specified for supplementary insulation (see clause 15).

8.6 Pumps intended to be connected to the supply by means of a plug shall be so designed that in normal use there is no risk of electric shock from charged capacitors when touching the pins of the plug.

TEST. Compliance shall be checked by the following test, which is carried out ten times.

The pump is operated at rated voltage or at the upper limit of the rated voltage range.

The pump switch, if any, is then moved to the 'off' position and the pump is disconnected from the supply by means of the plug.

The voltage between the pins of the plug is measured 1 s after disconnection with an instrument that does not appreciably affect the value to be measured.

This voltage shall not exceed 34 V.

NOTE. Capacitors having a rated capacitance not exceeding 0.1 μF are not considered to entail a risk of electric shock.

9 Starting of pumps

9.1 Pumps shall start under all normal voltage conditions that may occur in use.

Centrifugal and other automatic starting switches shall operate reliably and without contact chattering.

TEST. Compliance shall be checked by starting the pump three times at a voltage equal to 0.85 times rated voltage, the pump being at room temperature at the beginning of the test.

The pump shall be started each time under the conditions occurring at the beginning of normal operation the pump being allowed to come to rest between successive starts.

For pumps having other than centrifugal starting switches, this test shall be repeated at a voltage equal to 1.06 times rated voltage.

In all cases, the pump shall function in such a way that safety is not affected.

NOTE. The supply source is such that, during the test, the drop in voltage does not exceed 1 %.

9.2 The starting current shall not blow a quick-acting fuse-link having a rated current as follows:

(a) according to the marking, if the rated current of the appropriate fuse-link is marked on the pump;

(b) equal to the rated current of the pump, with a minimum of 10 A for pumps having a rated voltage exceeding 130 V and 16 A for pumps having a rated voltage of 130 V and less, if the rated current of the appropriate fuse-link is not marked on the pump.

TEST. Compliance shall be checked by the following test.

The pump is connected in series with a silver wire having a length of 85 mm and the diameter given in table 2.

Table 2. Diameter of silver wire for fuse test

Rated current of fuse	Diameter of silver wire	
	Starting time not exceeding 1 s	Starting time exceeding 1 s
A	mm	mm
10	0.29	0.39
16	0.39	0.52
20	0.46	0.60
25	0.53	0.66

The wire has a silver content not less than 99.9 %, and it is stretched horizontally along the centre line of a box with inside dimensions of 80 mm x 80 mm x 150 mm.

The pump is so loaded that the conditions for starting are the most unfavourable encountered in normal use.

The pump is then started 10 times at a voltage equal to 0.9 times rated voltage and 10 times at a voltage equal to 1.1 times rated voltage. The interval between consecutive starts is made sufficiently long to prevent undue heating but not less than 5 min.

During the test, the silver wire shall not melt and neither shall any overload protection device operate.

NOTE. The supply source is such that, during the test, the drop in voltage does not exceed 1 %.

9.3 Overload protection devices shall not operate under normal starting conditions.

TEST. Compliance shall be checked during the test described in 9.2.

10 Input and current

10.1 The input of the pump at rated voltage and at normal operating temperature shall not deviate from the rated input by more than the deviation given in table 3.

Table 3. Permissible variations in rated input

Rated input	Deviation
W	
Up to and including 33.3	+ 10 W*
Over 33.3 up to and including 150	+ 30 %*
Over 150 up to and including 300	+ 45 W*
*The negative deviation is not limited.	

For pumps marked with a rated voltage range having limits differing by more than 10 % of the mean value of the range, the permissible deviations apply for both limits of the range.

TEST. Compliance shall be checked by measuring the input of the pump operated at rated voltage and in accordance with conditions of normal load, when the input has stabilized. If the pump load varies throughout the operating cycle, the input shall be measured by means of a watt-hour meter, and determined as the mean value of the input occurring during a representative period.

10.2 If a pump is marked with rated current, the current taken by the pump shall not exceed the rated current by more than 10 %.

TEST. Compliance shall be checked by measuring the current taken by the pump operating under normal load, rated voltage and rated frequency.

NOTE. For pumps marked with one or more rated voltage ranges, the tests specified in 10.1 and 10.2 are carried out at both the upper and lower limits of the ranges, unless the marking of the rated input is related to the mean value of the relevant voltage range, in which case the tests are carried out at a voltage equal to the mean value of that range.

11 Heating

11.1 Pumps and their surroundings shall not attain excessive temperatures in normal use.

TEST. Compliance shall be checked by determining the temperature or temperature rise, as appropriate, of the various parts under the conditions specified in 11.2 to 11.5.

11.2 Pumps shall be mounted between appropriate pipes, taking into account the manufacturer's instructions, and shall be placed against, or fixed to, a support of dull black painted plywood having a thickness of 20 mm.

11.3 Temperature rises other than those of windings shall be determined by means of fine-wire thermocouples so chosen and positioned that they have the minimum effect

on the temperature of the part under test.

Thermocouples used for determining the temperature rise of the surface of walls, ceiling and floor shall be attached to the back of small blackened discs of copper or brass, 15 mm in diameter and 1 mm thick, which are flush with the surface.

As far as possible, the pump shall be so positioned that parts likely to attain the highest temperatures touch the discs.

In determining the temperature rises of handles, knobs, grips, etc., consideration shall be given to all parts that are gripped in normal use and, if of insulating material, to parts that are in contact with hot metal.

The temperature rise of electrical insulation, other than that of windings, shall be determined on the surface of the insulation, at places where failure could cause a short circuit, contact between live parts and accessible metal parts, bridging of insulation or reduction of creepage distances or clearances below the values specified in 27.1.

Temperature rises of windings shall be determined by the resistance method unless the windings are non-uniform or it involves severe complications to make the necessary connections, in which case the temperature rise shall be determined by means of thermocouples.

NOTE 1. If it is necessary to dismantle the pump to position thermocouples, the input should be measured again to check that the pump has been correctly reassembled.

NOTE 2. The point of separation of the cores of a multicore cable or cord and the place at which insulated wires enter lampholders are examples of places where thermocouples are positioned.

11.4 Pumps shall be operated under normal load and at the most unfavourable voltage between 0.94 times the minimum rated voltage and 1.06 times the maximum rated voltage.

11.5 Pumps shall be operated until steady conditions are established.

11.6 During the test, thermal cut-outs shall not operate. Sealing compound, if any, shall not flow out. The temperatures or temperature rises, as appropriate, shall be monitored continuously and they shall not exceed the values given in table 4, except that it is permissible to exceed the temperature rise limits in table 4 if it can be shown that the temperatures are not in excess of the thermal capabilities of the materials as determined by ageing tests made on the materials themselves. It is permissible to use other materials not listed in table 4 under the same conditions.

The measurements specified in 12.1 shall be made at the end of this test.

Table 4. Permissible temperature or temperature rises

Part	Temperature	Temperature rise
	°C	K
Windings, where water flows through the motor, if the winding insulation is:		
of class A material ²	105	
of class E material ²	120	
of class B material ²	130	
of class F material ²	155	
of class H material ²	180	
Windings ¹ , where water does not flow through the windings, if the winding insulation is:		
of class A material ²		75 (65)
of class E material ²		90 (80)
of class B material ²		95 (85)
of class F material ²		115
of class H material ²		140
Terminals, including earthing terminals, for external conductors of pumps, unless they are provided with a power supply cord		60
Ambient of switches and thermostats ³ :		
without <i>T</i> -marking or temperature rating		30
with <i>T</i> -marking or temperature rating		<i>T</i> - 25
Rubber or polyvinyl chloride insulation of internal and external wiring including power supply cords:		
without <i>T</i> -marking or temperature rating		50 ⁴
with <i>T</i> -marking or temperature rating		<i>T</i> - 25 ⁵
Cord sheaths used as supplementary insulation		35
Rubber, other than synthetic, used for gaskets or other parts, the deterioration of which could affect safety:		
when used as supplementary insulation or as reinforced insulation		40
in other cases		50
Lampholders E26 and E27:		
metal or ceramic type		160
insulated type, other than ceramic		120
Lampholders E14, B15 and B22:		
metal or ceramic type		130
insulated type, other than ceramic		90
with <i>T</i> -marking		<i>T</i> - 25

Table 4. (continued)

Part	Temperature rise
	K
Material used as insulation other than that specified for wires and windings ⁶ :	
impregnated or varnished textile, paper or press board laminates bonded with:	70
melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins	85 (175)
urea-formaldehyde resin	65 (150)
mouldings of:	
phenol-formaldehyde with cellulose fillers	85 (175)
phenol-formaldehyde with mineral fillers	100 (200)
melamine-formaldehyde	75 (150)
urea-formaldehyde	65 (150)
polyester with glass fibre reinforcement	110
silicone rubber	145
polytetrafluoroethylene	265
pure mica and tightly sintered ceramic material, when such materials are used as supplementary insulation or reinforced insulation	400
thermoplastic material ⁷	—
Wood, in general ⁸	65
wooden supports, walls, ceiling and floor of the test corner and wood cabinets	
Outer surface of capacitors:	
with marking of maximum operating temperature (<i>T</i>)	<i>T</i> - 35
without marking of maximum operating temperature:	
small ceramic capacitors for radio and television interference suppression	50
other capacitors	20
Handles, knobs, grips and the like which, in normal use, are held for short periods only (e.g. of switches):	
of metal	35
of porcelain or vitreous material	45
of moulded material, rubber or wood	60
Parts in contact with oil having a flash-point of <i>t</i> °C	<i>t</i> - 50
Any point where the insulation of wires can come into contact with parts of a terminal block or compartment for fixed wiring of a pump not provided with a power supply cord:	
where the instructions require <i>T</i> -marked or temperature rated wires	<i>T</i> - 25
in other cases	50 ⁴

NOTES TO TABLE 4

¹ To allow for the fact that the temperature of windings of universal motors is usually below the average at the points where thermocouples are placed, the figures without parentheses apply when the resistance method is used and those within parentheses apply when thermocouples are used. For windings of a.c. motors, the figures without parentheses apply in both cases.

² The classification is in accordance with BS 2757.

Examples of class A material are:

impregnated cotton, silk, artificial silk and paper; enamels based on oleo- or polyamide resins.

Examples of class B material are:

asbestos, glass fibre, melamine formaldehyde and phenol formaldehyde resins.

Examples of class E material are:

mouldings with cellulose fillers, cotton fabric laminates and paper laminates, bonded with melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins;
cross-linked polyester resins, cellulose triacetate films, polyethylene terephthalate films;
varnished polyethylene terephthalate textile bonded with oil-modified alkyd resin varnish;
enamels based on polyvinylformal, polyurethane or epoxy resins.

For totally enclosed pumps the temperature rise limits for class A, class E and class B may be increased by 5 K.

A totally enclosed pump is a pump so constructed that the circulation of the air between the inside and the outside of the case is prevented but it is not necessarily sufficiently enclosed to be called airtight.

³ T signifies the maximum operating temperature.

For the purposes of this test, switches and thermostats marked with individual ratings may be considered as having no marking for the maximum operating temperature, if requested by the pump manufacturer.

⁴ This limit applies to cables, cords and wires complying with BS 6500.

⁵ This limit applies to cables and flexible cords for use in high temperature areas that comply with the requirements of BS 6141.

⁶ The values in parentheses apply if the material is used for handles, knobs, grips, etc. and it is in contact with hot metal.

⁷ There is no specific limit for thermoplastic material which has to withstand the tests specified in 28.1 or 28.2, for which purpose the temperature rise has to be determined.

⁸ The limit specified concerns the deterioration of wood and it does not take into account deterioration of surface finishes.

The values in table 4 are based on an ambient temperature not normally exceeding 25 °C but occasionally reaching 35 °C. However, the temperature rise values specified are based on 25 °C.

The value of the temperature rise, Δt (in K), of a copper winding shall be calculated from the following equation:

$$\Delta t = \frac{R_2 - R_1}{R_1} (234.5 + t_1) - (t_2 - t_1)$$

where

R_1 is the resistance at the beginning of the test (in Ω);

R_2 is the resistance at the end of the test (in Ω);

t_1 is the room temperature at the beginning of the test (in °C);

t_2 is the room temperature at the end of the test (in °C).

At the beginning of the test, the windings shall be at room temperature.

NOTE 1. It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off. For pumps where water flows through the motor, the resistance R_1 is measured before the test at any temperature t_1 . Δt is determined with the formula given by inserting t_2 the temperature of the water at the inlet of the pump. The winding temperature is calculated from the formula $t = t_2 + \Delta t$.

NOTE 2. The classification of handles, knobs, grips and the like according to their materials is derived from the constant, b , as follows:

$$b = \sqrt{\lambda \cdot c \cdot \gamma}$$

where

λ is the thermal conductivity of the material (in W/(m·K));

c is the specific heat of the material (in J/(kg·K));

γ is the specific mass of the material (in kg/m³).

The materials are classified as follows:

value of b greater than 3500 denotes a metal;

value of b between 1000 and 3500 denotes a porcelain or vitreous material;

value of b less than 1000 denotes a moulded material, rubber or wood.

An alternative method of determining the constant, b , is as follows:

Samples of materials with known values of the constant, b , and a sample of the material to be classified, all samples having the same dimensions, are fixed to a heated metal plate.

The temperatures of the upper surfaces of the various samples are measured and the temperatures of the reference samples are plotted as a function of the constant, b .

The constant, b , of the material to be classified is derived from this curve by reading off the value of b , corresponding to the temperature attained by the sample under investigation.

12 Electrical insulation and leakage current at operating temperature

The electrical insulation of the pump at operating temperature shall be adequate and the leakage current in normal use shall not be excessive.

TEST. Compliance shall be checked as follows.

The pump shall be operated under normal load and at a supply voltage equal to 1.06 times rated voltage. Three-phase pumps which are also suitable for single-phase supply shall be tested as single-phase pumps with the three sections connected in parallel.

The leakage current shall be measured between any pole of the supply and the following:

(a) accessible metal parts and metal foil with an area not exceeding 200 mm × 100 mm in contact with accessible surfaces of insulating material, connected together;

(b) metal parts of class II pumps separated from live parts by basic insulation only.

The measuring circuit shall be as shown in the following figures:

(1) for single-phase pumps having a rated voltage not exceeding 250 V and for three-phase pumps to be tested as single-phase pumps:

(i) if of class II, figure 4;

(ii) if other than class II, figure 5.

(2) For single-phase pumps having a rated voltage exceeding 250 V and for three-phase pumps not suitable for single-phase supply:

- (i) if of class II, figure 6;
- (ii) if other than class II, figure 7.

Single-phase pumps having rated voltage exceeding 250 V shall be connected to two of the phase conductors, the remaining phase conductor not being used.

The resistance of the measuring circuit shall be $2000 \pm 100 \Omega$, and if it is suspected that high-frequency currents are being generated in a pump, the measuring instrument shall have an accuracy of at least 5 % for all frequencies within the range of 20 Hz to 5000 Hz, but it shall be insensitive to higher frequencies.

The test shall be carried out with a.c., unless the pump is for d.c. only, in which case the test shall not be carried out.

For single-phase pumps having a rated voltage not exceeding 250 V and for three-phase pumps to be tested as single-phase pumps, the leakage current shall be measured with the selector switch, shown in figures 4 and 5, in each of the positions 1 and 2.

For other pumps, the leakage current shall be measured with the switches a, b and c, shown in figures 6 and 7, closed; for three-phase pumps not suitable for single-phase supply, the measurements shall be repeated with each of the switches a, b and c open in turn, the other two switches being closed; for single-phase pumps, the measurements shall be repeated with one of the switches open.

After steady conditions have been established, the leakage current shall not exceed the following values:

(A) to accessible metal parts and metal foil:

- (1) for class I pumps 3.5 mA
- (2) for class II pumps 0.25 mA
- (3) for class III pumps 0.5 mA

(B) to metal parts of class II pumps separated from live parts by basic insulation only, 3.5 mA.

If the pump incorporates one or more capacitors and is provided with a single-pole switch, the measurements shall be repeated with the switch in the 'off' position.

NOTE 1. The cut-off frequency of 5000 Hz may, for example, be obtained by connecting a capacitor of $150 \pm 7.5 \text{ nF}$ in parallel with the resistive components of the measuring circuit. The measuring circuit may be partly or completely incorporated in the measuring instrument. If an instrument of the rectifier type is used, it should rectify linearly from 0.2 mA upwards within the frequency range of 20 Hz to 10 000 Hz, and should be calibrated in r.m.s. values with a current of substantially sine-wave form. If high-frequency voltages are not present, the cut-off frequency of the measuring instrument may exceed 5000 Hz.

NOTE 2. It is recommended that the pump be supplied through an isolating transformer; otherwise, it should be insulated from earth.

NOTE 3. The metal foil should have the largest area possible on the surface under test, without exceeding the dimensions specified. If its area is smaller than the surface under test, it should be moved so as to test all parts of the surface. However it is essential that the heat dissipation of the pump is not affected by the metal foil.

NOTE 4. The test with the switch in the 'off' position is carried out to verify that capacitors connected behind a single-pole switch do not cause an excessive leakage current.

NOTE 5. If the pump incorporates a thermal control which operates during the test of clause 11, the leakage current is measured immediately before the control opens the circuit.

13 Radio and television interference suppression

The incorporation of components necessary to achieve an adequate degree of radio and television interference suppression shall not adversely affect the safety of the pump.

TEST. Compliance shall be checked by the tests specified in this Part of BS 1394.

NOTE. Compliance with the requirements concerning the limits for interference effects generated by the pump, as specified in BS 800 and when measured in accordance with that standard, will in most cases ensure that the pump has the required degree of radio and television interference suppression.

14 Moisture resistance

14.1 Drip-proof, splash-proof and watertight constructions

The enclosure of drip-proof, splash-proof and watertight pumps shall provide the degree of protection against moisture in accordance with the classification of the pump.

TEST. Compliance shall be checked by the appropriate treatment specified in 14.2, using the apparatus shown in figures 8 to 10.

Immediately after the appropriate treatment for drip-proof and splash-proof pumps, the pump shall withstand the electric strength test specified in 15.3, and inspection shall show that water which may have entered the pump does not impair compliance with this Part of BS 1394; in particular, there shall be no trace of water on insulation for which creepage distances are specified in 27.1.

Immediately after the treatment for watertight pumps, the pump shall withstand the electric strength test specified in 15.3, with the exception of the test already made on the immersed pump.

14.2 Tests for drip-proof, splash-proof and watertight constructions

14.2.1 *Preparation for the tests.* Pumps with type X attachments shall be fitted with the lightest permissible type of flexible cable or cord of the smallest cross-sectional area specified in 24.2; other pumps shall be tested as delivered.

Electrical components, covers and other parts that can be removed without the aid of a tool shall be removed and subjected, if necessary, to the relevant treatment with the main part.

Sealing rings of glands and other sealing means, if any, shall be aged in an atmosphere having the composition and pressure of the ambient air by suspending them freely in a heating cabinet ventilated by natural circulation. They shall be kept in the cabinet at a temperature of $70 \pm 2^\circ\text{C}$, for 10 days (240 h).

NOTE. The use of an electrically-heated cabinet is recommended. Natural circulation may be provided by holes in the walls of the cabinet.

Immediately afterwards, the samples shall be taken out of the cabinet and left at room temperature, avoiding direct daylight, for at least 16 h before being reassembled. The glands and other sealing means shall then be tightened with a torque equal to two-thirds of that applied during the test described in 19.3.

Drip-proof pumps shall then be subjected for 5 min to the vertical rain test (see 14.2.2).

Splash-proof pumps shall then be subjected for 10 min to the oblique rain test (see 14.2.3), followed by subjection for 5 min to the splash test (see 14.2.4).

Watertight pumps shall then be subjected for 24 h to the immersion test (see 14.2.5).

14.2.2 Vertical rain test. For the vertical rain test, an apparatus similar to that shown in figure 8 which delivers 3 mm of rain/min, uniformly distributed over the sample, shall be used.

Pumps shall be placed in the normal position of use, so that the nozzles of the rain apparatus are 2 m above the uppermost point of the pump.

14.2.3 Oblique rain test. For the oblique rain test, the spray apparatus, shown in figure 10, shall be used, the apparatus comprising a tube formed into a semicircle. The radius of the circle is 200 mm or a multiple of 200 mm and is as small as is compatible with the size and position of the sample. The tube is perforated so that jets of water are directed towards the centre of the circle, and the water pressure at the inlet to the apparatus is equivalent to a head of about 10 m.

The tube is caused to oscillate through an angle of 120° , 60° on each side of the vertical, the time for one complete oscillation ($2 \times 120^\circ$) being about 4 s.

Pumps shall be placed on a support having dimensions that are at least 50 mm in excess of those of the orthogonal projection of the pump on the support.

The sample shall be mounted or placed at the centre of the semicircle formed by the tube so that its lowest part is level with the axis of oscillation. The sample shall be turned about its vertical axis during the test.

14.2.4 Splash test. For the splash test, the apparatus shown in figure 9 shall be used. During the test, the water pressure shall be regulated so that the water splashes up 150 mm above the bottom of the bowl. The bowl shall be placed on a horizontal support 50 mm below the lowest edge of the pump; the bowl shall be moved around so as to splash the pump from all directions. Care shall be taken to ensure that the pump is not hit by the direct jet.

Pumps shall be placed on a supporting surface that has dimensions equal to the surface of the pump in contact with the support.

14.2.5 Immersion test. For the immersion test, the pump shall be immersed in water at a temperature of $20 \pm 5^\circ\text{C}$ and containing approximately 1 % sodium chloride (NaCl).

The top of the pump shall be about 50 mm below the water level, except that pumps marked with maximum depth of immersion shall be immersed in accordance with this marking.

Plugs, if any, shall be kept dry and the pump shall be operated under normal load.

Pumps for continuous operation shall be operated for 12 periods of 1 h, with a rest period of 1 h between each.

Pumps for short-time operation or for intermittent operation shall be operated in accordance with their marking for 12 cycles.

After this treatment, the pump shall withstand, while immersed, an electric strength test as specified in 15.3, the following test voltage being applied only between live parts and the water:

- (a) 500 V for class III pumps;
- (b) 3750 V for class II pumps;
- (c) 1250 V for other pumps.

Class III pumps having a rated voltage not exceeding 24 V shall not be subjected to this electric strength test.

During this test, the pins of the plug, if any, shall be connected together and mains switches, if any, shall be in the 'on' position.

NOTE 1. For class II pumps, watertightness may be achieved by means of the supplementary insulation or the reinforced insulation or by means of an enclosure exterior to this insulation.

NOTE 2. This test does not imply suitability for operation where the pump is subjected to water pressure.

14.3 Resistance to spillage of liquids

Pumps subject to leakage of liquid in normal use shall be so constructed that such leakage does not affect their electrical insulation.

TEST. Compliance shall be checked by inspection.

14.4 Resistance to humidity

Pumps shall be proof against humid conditions that may occur in normal use.

TEST. Compliance shall be checked by the humidity treatment described in this subclause, followed immediately by the tests specified in clause 15.

The pump shall be allowed to stand in normal test-room atmosphere for 24 h before this test.

Cable entries, if any, shall be left open; if knock-outs are provided, one of them shall be opened.

Electrical components, covers and other parts that can be removed without the aid of a tool, shall be removed and subjected, if necessary, to the humidity treatment with the main part.

The humidity treatment shall be carried out in a humidity cabinet containing air with a relative humidity of $93 \pm 2\%$. The temperature of the air, at all places where samples can be located, shall be maintained within 1°C (1 K) of any convenient temperature t between 20°C and 30°C .