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Remarks:

None**PLEASE NOTE:**

- The technical committee, StanSA **IC75** responsible for the preparation of this standard has reached consensus that the attached document should become a South African standard. It is now made available by way of public enquiry to all interested and affected parties for public comment, and to the technical committee members for record purposes. Any comments should be sent by the indicated closing date, either by mail, or by fax, or by e-mail to

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Any comment on the draft must contain in its heading the number of the clause/subclause to which it refers. A comment shall be well motivated and, where applicable, contain the proposed amended text.

- The public enquiry stage will be repeated if the technical committee agrees to significant technical changes to the document as a result of public comment. Less urgent technical comments will be considered at the time of the next amendment.

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Immersion heaters for electric storage water heaters

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Table of changes

Change No.	Date	Scope
Amdt 1	1999	Amended to correct a number of typographical errors and to clarify an ambiguity in the test procedure for insulation resistance.
Amdt 2	2006	Amended to update the definition of "acceptable", to update normative reference, and to remove reference to the SABS as the body for inspection and testing.
Amdt 3	2007	Amended to delete a test on name plates.

Foreword

This South African standard was approved by National Committee StanSA TC 75, *Performance of household and similar electrical appliances*, in accordance with procedures of Standards South Africa, in compliance with annex 3 of the WTO/TBT agreement.

This edition supersedes edition 3.2 (SANS 514:2006).

A vertical line in the margin shows where the text has been technically modified by amendment No. 3.

Annexes A and B form an integral part of this standard. Annexes C, D, E and F are for information only.

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Immersion heaters for electric storage water heaters

1 Scope

1.1 This standard specifies requirements for withdrawable and non-withdrawable types of electric immersion heater for use in thermostatically controlled storage water heaters. The electric immersion heaters are intended for use in single-phase circuits, the voltage of which does not exceed 250 V phase to neutral and that have a load rating not exceeding 10 kW.

1.2 This standard is also applicable to thermostatic immersion heaters that are intended for use in single-phase circuits with the same voltage and load rating as stated above.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from Standards South Africa.

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads – Part 1: Dimensions, tolerances and designation.* **Amdt 2**

SANS 181, *Thermostats for electric storage water heaters.*

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1

acceptable

acceptable to the authority administering this standard, or to the parties concluding the purchase contract, as relevant **Amdt 2**

3.2

defective

an immersion heater that fails in one or more respects to comply with the relevant requirements of this standard

3.3

head

that portion of an immersion heater that carries the terminal base of the immersion heater, and to which the heating element sheaths or pockets are attached

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3.4

lot

not fewer than 4 and not more than 200 immersion heaters, from one manufacturer, submitted at any one time for inspection and testing

3.5

type 1 immersion heater

an immersion heater so constructed that the heating element(s) cannot be withdrawn from the enclosing sheath without breaking a water joint

3.6

type 2 immersion heater

an immersion heater so constructed that the heating element(s) can be withdrawn from the enclosing sheath without breaking a water joint

4 Constructional requirements

4.1 Type

Immersion heaters shall be of type 1 or type 2, as required (see annex A).

4.2 Enclosure of elements

4.2.1 Type 1 immersion heaters shall have the element(s) completely enclosed in a watertight metal casing of copper of purity at least 99,85 % (by mass) and of thickness at least 0,70 mm, or other acceptable material. The element shall be located centrally within the outer casing and so secured that relative movement or contact between the element and the casing is prevented. A loose filling without rigid spacers shall not be deemed sufficient protection against contact between the element and the casing. The casing shall be sealed at the point at which the element leaves the casing.

4.2.2 In the case of type 2 immersion heaters, if the heating element(s) are supported in rigid refractory formers, the formers shall be secured independent of the heating element(s) and so supported that in the event of breakage or severance of an element, contact between the element and the casing will be prevented. The tie rod shall be of heat-resistant material and able to withstand a temperature of 600 °C. A rigid spacer, bushing, or filling shall be fixed at the point where an element leaves the casing.

4.3 Head

4.3.1 Material

The head of the immersion heater shall be of copper of purity at least 99,85 % (by mass), or other acceptable material.

4.3.2 Attachment

Each immersion heater shall be equipped with one of the following means for attaching it to the water container:

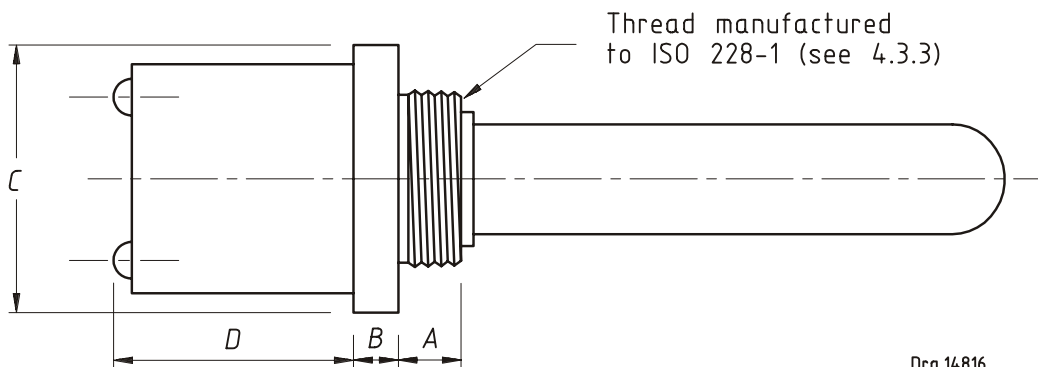
- a) a screwed connection; or
- b) a clamping boss; or
- c) other acceptable means, as required (see annex A).

4.3.3 Dimensions

4.3.3.1 In the case of screwed connections, the head of the immersion heater (see figure 1) shall be either

- a) a hexagonal head that has a G1B, G1¼B or G1½B thread and that complies with the relevant requirements of ISO 228-1; or **Amdt 2**
- b) an octagonal head that has a G2B or G2¼B thread and that complies with the relevant requirements of ISO 228-1; or as required (see annex A). **Amdt 2**

The dimensions of the head shall conform to the values given in figure 1, appropriate to the nominal size of the head. The screw thread shall be so formed that a ring gauge can be screwed up to within 0,8 mm of the joint face.



Amdt 2

Dimensions in millimetres

Dimensions of head				
1	2	3	4	5
Nominal size of head	Thread length A	Thickness of flange on head B	Distance across flats C	Overall projection of cover (including fixings, etc.) D, max.
25	12,5 ± 1,5	5,0 ± 0,4	41 ± 1	70
32		10,0 ± 0,8	56 ± 1	70
40		10,0 ± 0,8	56 ± 1	70
50		10,0 ± 0,8	86 ± 1	108
58		10,0 ± 0,8	86 ± 1	108

Figure 1 — Dimensions of head

4.3.3.2 The tilt of the bearing surface of the joint face, i.e. the maximum departure in an axial direction of the flange of the head, measured at the middle of the flat of the hexagon or octagon from a plane in contact with a part of the flange and normal to the axis of the thread, shall not exceed 0,25 mm.

4.4 Jointing washer

4.4.1 A jointing washer shall be provided with each type 1 immersion heater.

4.4.2 The jointing washer shall be of copper or of an acceptable non-conducting material.

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4.4.3 If the jointing washer is of a flat surface-contact type, it shall be of thickness at least 2 mm.

4.4.4 In the case of an immersion heater with a screwed connection, the external and internal diameters of the jointing washer and the diameter of the undercut of the thread of the head, and the concentricity of these diameters shall be such that, for all positions of the washer on the undercut, the external edge of the washer always protrudes beyond the flat of the hexagon or octagon.

Amdt 1

4.4.5 Where an element with a jointing washer of a resilient material (for example, neoprene) is fixed to a water heater as for use, it shall be so constructed that the area of the jointing washer that effects the seal does not so move away from the corresponding surfaces between which it is held or secured, that its sealing effect is impaired, or the jointing washer damaged.

4.5 Terminals

4.5.1 An immersion heater shall have terminals for the connection of current-carrying conductors. Each terminal shall be capable of accommodating a stranded conductor of the size given in column 2 of table 1, appropriate to the current rating of the immersion heater. Unless of a form that prevents the conductor strands from spreading, the terminals shall be fitted with special washers or other suitable devices to prevent such spreading. Pigtails or other suitable connections can be used for connection to the supply.

4.5.2 Each pillar terminal shall have a cheese-headed or pan-headed pinching screw long enough to extend to the far side of the conductor hole. The hole for the pinching screw shall not extend beyond the far side of the conductor hole. The wall through which the pinching screw passes, shall have a length of thread at least equal to the value specified in column 4 of table 1, appropriate to the rating of the immersion heater. When clamping screws are used, they shall be cheese-headed or pan-headed. Pinching and clamping screws used in making electrical connections shall have a root area not smaller than that of the screw specified in column 3 of table 1, appropriate to the rating of the immersion heater.

Table 1 — Conductor sizes

1			2	3	4
Rating / A			Nominal cross-sectional area of conductor mm ²	Minimum size of screw mm	Minimum length of threads in pillar wall mm
	≤ /	6	1,0	3	2,0
6	< /	10	1,5	4	2,5
10	< /	16	2,5	4	2,5
16	< /	25	4,0	4	3,0
25	< /	32	6,0	5	3,0

4.5.3 In a thermostatic type immersion heater the phase (live) terminal shall be connected direct to the thermostat.

4.6 Corrosion protection

Iron and steel parts shall be acceptably protected against corrosion. Corrosion protection shall be applied after threads, if any, have been cut. Suitable methods of protection include galvanizing, zinc impregnation, or plating with copper, nickel, cadmium, silver, tin or zinc. Oil treatment shall be considered as suitable protection for steel springs. Corrosion protection shall be effective under any adverse conditions likely to be encountered in service and, when tested in accordance with 6.11,

the surfaces shall show no sign of corrosion. Traces of corrosion on sharp edges and any film that is removable by rubbing with a soft clean cloth shall be ignored. **Amdt 1**

4.7 Current-carrying parts

Current-carrying parts shall be of acceptable, robust construction. Unless iron is a constituent of a corrosion-resistant alloy, it shall not be used for current-carrying parts. Clamping agents or pressure devices, such as pinching screws, clamps, or wire binding screws and nuts, may be of iron or steel provided that they are acceptably protected against corrosion (see 4.6).

4.8 Thermostats

Thermostats, if fitted, shall have ratings not lower than those of the elements they control, and shall comply with the requirements of SANS 181.

5 Electrical and physical requirements

5.1 Earthing

When measured in accordance with 6.4, the resistance of the earthing connection, if provided, shall not exceed 0,1 Ω . **Amdt 1**

5.2 Insulation resistance

When an immersion heater is tested in accordance with 6.6 before and immediately after the dielectric strength test given in 6.7, the insulation resistance shall be at least 2 M Ω . **Amdt 1**

5.3 Dielectric strength

When tested in accordance with 6.7, an immersion heater shall withstand the test without puncture of insulation or arcing over.

5.4 Leakage current

When measured in accordance with 6.8, the leakage current shall not exceed 0,75 mA per kilowatt of rated input, or 5 mA, whichever is the lesser.

5.5 Loading

When measured in accordance with 6.9, the actual loading of an immersion heater shall not differ by more than 10 % from the rated loading marked on the immersion heater.

5.6 Endurance

An immersion heater shall withstand the test given in 6.10 without electrical or mechanical failure.

5.7 Mechanical strength

When tested in accordance with 6.5, a type 1 immersion heater shall not leak or show any signs of permanent distortion.

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5.8 Watts density

Under conditions of normal use, the calculated watts density (at the surface in contact with the water) at rated voltage shall not exceed the following: **Amdt 1**

a) in the case of type 1 heater elements: 0,1 W/mm²; and

b) in the case of type 2 heater elements: 0,05 W/mm². **Amdt 1**

6 Inspection and methods of test**6.1 Order of tests**

The tests shall be done in the order that they are given.

6.2 Inspection

Inspect a sample of immersion heaters, taken in accordance with annex B, for compliance with all the relevant requirements of this standard for which tests to assess compliance are not given in 6.4 to 6.11 (inclusive). **Amdt 3**

6.3 Preparation (type 2 immersion heaters only) **Amdt 1**

In the case of a type 2 immersion heater, fit the heating element(s) into enclosing sheaths of the same type and size as those with which they would be fitted in actual service.

6.4 Earthing test

Pass a direct current equal to the full load current of the immersion heater between the earthing terminal and non-current carrying metal parts, using a voltage not exceeding 6 V. Measure the voltage drop between the terminal and the non-current carrying metal parts and use this to calculate the resistance of the earthing connection. Check for compliance with 5.1.

6.5 Mechanical strength test (type 1 immersion heaters only)

Mount the immersion heater as in normal service and subject it, for 2 min., to an external hydrostatic pressure of 500 kPa. Check for compliance with 5.7.

6.6 Insulation resistance test

6.6.1 Operate the immersion heater in water continuously for 1 h at its maximum rated voltage and allow it to cool to room temperature.

6.6.2 Place it in a controlled atmosphere at a temperature of 20 °C ± 5 °C and a relative humidity of 75 % ± 5 %. **Amdt 1**

6.6.3 Keep the immersion heater in the controlled atmosphere for 72 h.

6.6.4 Immediately after removing it from the controlled atmosphere, measure the insulation resistance at a d.c. voltage of 500 V between current-carrying connections and non-current carrying metal parts.

6.6.5 Check for compliance with 5.2. **Amdt 1**

6.7 Dielectric strength test

6.7.1 Apparatus

High-voltage test transformer, that

- a) has a rating of at least 500 VA,
- b) operates at a frequency of 50 Hz,
- c) is capable of supplying a waveform as nearly sinusoidal as practicable,
- d) has an output current of at least 40 mA at the appropriate test voltage, and
- e) has a limit of error of the high-voltage indicating voltmeter not exceeding 3 %.

6.7.2 Procedure

6.7.2.1 Operate the immersion heater in water continuously for 1 h at its maximum rated voltage. Allow it to cool to room temperature.

6.7.2.2 Apply, between the current-carrying connections and non-current carrying parts, an r.m.s. test voltage not exceeding 500 V.

6.7.2.3 Increase the test voltage to the full test value of 1 500 V as rapidly as is consistent with its value being indicated on the measuring voltmeter.

6.7.2.4 Maintain the full test voltage for 1 min and then decrease the voltage to not more than one-third of the full test voltage before switching off the high-voltage test transformer.

6.7.2.5 Check for compliance with the requirements of 5.3.

6.7.2.6 After this test, repeat the measurement given in 6.6.4. Check for compliance with 5.2.

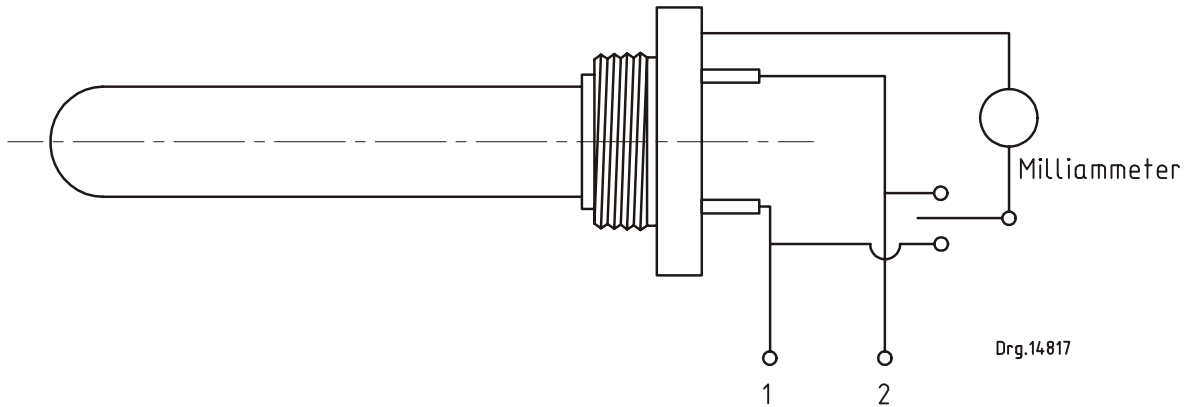
Amdt 1

6.8 Leakage current test

Arrange a single-pole change-over switch as shown in figure 2 to connect a milliammeter, that has an impedance not exceeding 1 500 Ω , between the earthing terminal of the immersion heater and each of the lines of the supply, in turn. Care must be taken to ensure that the immersion heater is either insulated from earth or that an unearthed supply is used. Operate the immersion heater in water continuously for 1 h in an a.c. circuit at a voltage of 1,06 times the upper limit of its rated voltage. At the end of this period, with the immersion heater still connected to the supply mains, connect the milliammeter alternately to line 1 and line 2. Take the mean of the two readings as the leakage current. Check for compliance with 5.4.

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**Figure 2 — Circuit for determining the leakage current****6.9 Loading test**

Operate the immersion heater for at least 10 min at rated voltage under normal conditions of service and measure its loading, in kilowatts. Check for compliance with 5.5. Amdt 1

6.10 Endurance test**6.10.1 Conditions of test**

Immerse the immersion heater horizontally in a tank that contains water at $20\text{ °C} \pm 5\text{ °C}$ in the quantity given in column 2 of table 2 appropriate to the rating of the immersion heater, given in column 1 of table 2. Ensure that the quantity remains substantially constant throughout the test.

6.10.2 Procedure

Operate the immersion heater at 1,1 times the marked maximum voltage in an a.c. circuit for 2 000 cycles, with each cycle consisting of 55 min of heating and 5 min of cooling. During the cooling, reduce the temperature of the water to its initial value. Check for compliance with 5.6.

Table 2 — Quantities of water used for endurance test

1		2
Rating <i>R</i> of immersion heater W		Quantity of water L
–	$R \leq 500$	25
500	$500 < R \leq 1\ 000$	35
1 000	$1\ 000 < R \leq 2\ 000$	45
2 000	$2\ 000 < R \leq 3\ 000$	65
3 000	$3\ 000 < R \leq 4\ 500$	90
4 500	$4\ 500 < R \leq 10\ 000$	120

6.11 Corrosion resistance test

Immerse the component to be tested in trichloro-ethylene for 10 min to remove all grease. Remove the component from the trichloro-ethylene and allow it to dry. Immerse it for 10 min in a 10 % (by mass) aqueous solution of ammonium chloride at a temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. Remove the component from the solution and shake off any drops of ammonium chloride solution but do not dry it. Place it for 10 min in a cabinet that contains air saturated with moisture and at a temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. Remove the component from the cabinet and dry it for 10 min in an oven maintained at a temperature of $100\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. Inspect the surfaces of the component for compliance with 4.6.

6.12 Deleted by amendment No. 3.

7 Marking

7.1 Marking of immersion heaters

Every immersion heater shall be legibly and indelibly marked with the following information, in a place where the markings are readily visible:


- a) the manufacturer's name or trade name or registered trade mark;
- b) the rated voltage;
- c) the loading, in watts or amperes, at the rated voltage;

NOTE If an immersion heater is marked with two voltage ratings and the higher voltage exceeds the lower by more than 10 % of the latter, the immersion heater shall be marked with a wattage or ampere rating for each voltage. In other cases where an immersion heater is marked with two voltage ratings, it shall be marked with the greater wattage or ampere rating.

- d) if an immersion heater includes any component that is suitable for use in a.c. current circuits only, the symbol \sim ; and
- e) when relevant, a catalogue number, type number or name, or other marking that will distinguish it from any other type of immersion heater marketed by the same manufacturer.

7.2 Symbols

Where symbols are used, they shall be as follows:

- | | |
|------------------------|---|
| a) Volt | V |
| b) Ampere | A |
| c) Hertz | Hz |
| d) Watt | W |
| e) Kilowatt | kW |
| f) Alternating current | \sim |
| g) Earth |  |

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7.3 Identification of earthing terminal

The earthing terminal, if provided, shall be identified by the



symbol placed on or adjacent to it.

7.4 Name plates

Name plates shall remain legibly and indelibly marked under all normal conditions of use of the appliance, and, if metal, shall be secured by means of screws or rivets. Adhesive labels shall not be used.

Amdt 1; Amdt 3 |

Annex A
(normative)**Notes to purchasers**

The following requirements shall be specified in tender invitations, in tenders and in each order or contract:

- a) the type of immersion heater (see 4.1);
- b) the means of attachment of the immersion heater (see 4.3.2); and
- c) when relevant, the type of head and the designation of the thread (see 4.3.3).

Annex B
(normative)**Sampling procedure and compliance with this standard**

NOTE The following sampling procedure will be used for inspection and testing before acceptance or rejection of single lots (consignments) in cases where no information about the implementation of quality control or testing during manufacture is available to help in assessing the quality of the lot. **Amdt 2**

B.1 Sampling

The following sampling procedure shall be applied in determining whether a lot complies with the appropriate requirements of this standard. The samples so taken shall be deemed to represent the lot.

B.1.1 Immersion heaters

From the lot, take at random the number of immersion heaters shown in column 2 of table B.1, relative to the appropriate lot size shown in column 1.

B.1.2 Name plates

Obtain at least 15 name plates that are identical in all respects to those used for marking each appliance in the lot.

Table B.1 — Sample sizes

1	2
Lot size	Sample size
4 – 50	2
51 – 100	4
101 – 200	6

Amdt 1

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B.2 Compliance with this standard

The lot shall be deemed to comply with the requirements of this standard if, after inspection and testing of the samples taken in accordance with clause B.1, no defective is found.

Annex C

(informative)

**Recommendations with regard to immersion heaters
for use in corrosive or hard water areas**

It is recommended that if an immersion heater is intended for use in corrosive or hard water areas, a low watt density and a special metal sheathed element be used, and that the purchaser consult with the manufacturer to ensure that he obtain the correct immersion heater for the particular water area in which it is to be installed.

Annex D

(informative)

Recommendations with regard to type 2 immersion heaters

It is recommended that ceramic components of type 2 immersion heaters have a low alkaline content, the percentage Na_2O being not greater than 0,25 % (by mass) and the total alkalinity (Na_2O and K_2O) being not greater than 2 % (by mass).

The element(s) should not be totally enclosed by the ceramic formers, and should be so wired that there is a distance of at least 10 mm between two points at maximum potential difference.

Annex E

(informative)

**Quality verification of immersion heaters for
electric storage water heaters**

When a purchaser requires ongoing verification of the quality of immersion heaters for electric storage water heaters produced to this standard, it is suggested that, instead of concentrating solely on evaluation of the final product, he also direct his attention to the manufacturer's quality system. It should be noted in this regard that SANS 9001 cover the provision of an integrated quality system.

Amdt 2

Annex F
(informative)

Bibliography

SANS 9001/ISO 9001, *Quality management systems – Requirements.*

Amdt 2