भारतीय मानक
Indian Standard

IS 302-2-35 : 2017

घरेलू और समान विद्युत साधित्रों की सुरक्षा

भाग 2 विशेष अपेक्षाएँ

अनुभाग 35 बिजली के पानी गर्म करने के इंस्टेंट हीटर

(दूसरा पुनरीक्षण)

Safety of Household and Similar Electrical Appliances

Part 2 Particular Requirements

Section 35 Electric Instantaneous Water Heaters

(Second Revision)

ICS 13.120; 97.040.50

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FOREWORD

This Indian Standard (Part 2/Sec 35) (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrical Appliances Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1993, and revised in 2011. This revision has been undertaken primarily to align the existing standard with the latest International Standard.

It has been assumed in the formulation of this standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

This standard takes into account the requirements of IS 732 : 1989 'Code of practice for electrical wiring installations (third revision), as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, in case of any deviation, wiring rules take precedence.

If an appliance within the scope of this standard also incorporates functions that are covered by another Part 2 of IS 302, the relevant Part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

When a Part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE — This means that in such a case, it has been decided that for the part 2 standards, it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE — Horizontal and generic standards covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IS 302 series of standards.

An appliance that complies with the text of this standard will not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features which impair the level of safety covered by these requirements.

An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the standard.

This standard is to be read in conjunction with the latest edition of IS 302-1 'Safety of household and similar electrical appliances : Part 1 General Requirements' and its amendments. This standard was formulated on the basis of IS 302-1 : 2008.

NOTE — When 'Part 1' is mentioned in this standard, it refers to IS 302-1.

This Part 2 supplements or modifies the corresponding clauses in IS 302-1, so as to convert that standard into the Indian standard: Particular requirements for Electrical Instantaneous Water heaters.

When a particular subclause of Part 1 is not mentioned in this Part 2, that subclause applies as far as is reasonable. When this standard states addition, modification or replacement, the relevant text in Part 1 is to be adapted accordingly.

(*Continued on third cover*)

Indian Standard

SAFETY OF HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES

PART 2 PARTICULAR REQUIREMENTS

SECTION 35 ELECTRIC INSTANTANEOUS WATER HEATER

(Second Revision)

1 SCOPE

This clause of Part 1 is replaced by the following.

This Indian Standard deals with the safety of electric instantaneous water heaters for household and similar purposes and intended for heating water below boiling temperature, their rated voltage being not more than 250 V for single-phase appliances and 480 V for other appliances.

NOTE 101 — Instantaneous water heaters incorporating bare heating elements are not permitted for safety reasons.

Appliances not intended for normal household use but which nevertheless may be a source of danger to the public, such as appliances intended for use in shops, in light industry and on farms, are within the scope of this standard.

As far as is practicable, this standard deals with the common hazards presented by appliances which are encountered by all persons in and around the home. However, in general, it does not take into account

a) persons (including children) whose
   1. physical, sensory or mental capabilities; or
   2. lack of experience and knowledge

   prevents them from using the appliance safely without supervision or instruction;
b) children playing with the appliance.

NOTE 102 — Attention is drawn to the fact that for appliances intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary;

NOTE 103 — This standard does not apply to

1. appliances for heating liquids (IS 302-2-15);
2. storage water heaters (IS 302-2-21);
3. appliances intended exclusively for industrial purposes;
4. appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas);
5. commercial dispensing appliances and vending machines (IS 302-2-75 (under preparation)).

2 REFERENCES

This clause of Part 1 is applicable.

3 TERMS AND DEFINITIONS

This clause of Part 1 is applicable except as follows.

3.1.9 *Replacement:*

Normal operation

operation of the appliance while supplied with water, the flow being adjusted to attain the highest outlet water temperature without operation of the thermal cut-out.

3.101 Instantaneous Water Heater

stationary appliance for heating water while it flows through the appliance

Note 1 to entry: Instantaneous water heaters are referred to as water heaters.

3.102 Closed Water Heater

instantaneous water heater intended to operate at the pressure of the water system, the flow of water being controlled by one or more valves in the outlet system

Note 1 to entry: The operating pressure can be the output pressure of a reducing or boosting device.

3.103 Open-outlet water heater

instantaneous water heater in which the flow of water is controlled by a valve in the inlet pipe, there being no valve in the outlet pipe

3.104 Bare-element Water Heater

instantaneous water heater in which uninsulated heating elements are immersed in the water

NOTE — Manufacturing and use of bare-element water heaters are not allowed for safety reason.

3.105 Rated pressure

water pressure assigned to the appliance by the manufacturer

3.106 Flow switch

device that operates in response to a flow of water

3.107 Pressure switch

device that operates in response to a change in pressure

4 GENERAL REQUIREMENT

This clause of Part 1 is applicable.

5 GENERAL CONDITIONS FOR THE TESTS

This clause of Part 1 is applicable except as follows.

5.2 Addition:

NOTE 101— Additional samples can be required for the tests of 22.109.

5.3 Addition:

When the tests are carried out on a single appliance, the tests of **22.102, 22.107, 22.108** and **24.102** are carried out before the tests of **19**.

5.7 Addition:

Water having a temperature of 25 ± 5 °C is used for the tests.

6 CLASSIFICATION

This clause of Part 1 is applicable except as follows.

6.1 Modification:

Water heaters shall be Class I, Class II or Class III.

6.2 Addition:

Water heaters shall be at least IPX1.

NOTE — 101 Specific zones in which the water heater is installed require a higher degree of protection as specified in NEC(SP 30:2011).

7 MARKING AND INSTRUCTIONS

This clause of Part 1 is applicable except as follows.

7.1 Addition:

Appliances shall be marked with the rated pressure in pascals.

7.12 Addition:

The instructions for open-outlet water heaters to be used with a spray head shall state that the spray head must be descaled regularly.

The instructions for an appliance not incorporating a flow switch shall include the substance of the following:

WARNING: Do not switch on if there is a possibility that the water in the heater is frozen.

7.12.1 *Addition:*

The installation instructions for open-outlet water heaters shall state that the outlet must not be connected to any tap or fitting other than those specified.

If a pressure relief device is required for closed water heaters, the instructions shall state that it must be fitted during installation, unless it is incorporated in the appliance.

In a multiple water outlet system where the water temperature can be set at each individual water outlet, the instructions shall state the substance of the following:

The system shall be installed so that the control for setting the water temperature in normal use installed at a shower outlet shall take priority over any other controls in the system that set the water temperature in normal use at other water outlets.

7.101 The water inlet and water outlet shall be identified. This identification shall not be on detachable parts. If colours are used, blue shall be used for the inlet and red for the outlet. An alternative means of identification may be by means of arrows showing the direction of the water flow.

Compliance is checked by inspection.

7.102 BIS Certification Marking

The appliances may also be marked with the Standard Mark.

7.102.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

8 PROTECTION AGAINST ACCESS TO LIVE PARTS

This clause of Part 1 is applicable except as follows.

8.1.5 *Addition*:

The connections to the water mains and electrical supply are assumed to be in position during the test.

The requirement does not apply to wall-mounted appliances intended to be permanently connected to fixed wiring by cables having a nominal cross-sectional area more than 2.5 mm^2.

However, the cross-sectional area of the cable entry shall not exceed 25 cm^2 and there shall be no accessible live parts within the projection of the opening.

9 STARTING OF MOTOR-OPERATED APPLIANCES

This clause of Part 1 is not applicable.

10 POWER INPUT AND CURRENT

This clause of Part 1 is applicable.

11 HEATING

This clause of Part 1 is applicable except as follows.

11.7 Replacement:

The appliance is operated until steady conditions are established.

12 VOID

13 LEAKAGE CURRENT AND ELECTRIC STRENGTH AT OPERATING TEMPERATURE

This clause of Part 1 is applicable.

14 TRANSIENT OVERVOLTAGES

This clause of Part 1 is applicable.

15 MOISTURE RESISTANCE

This clause of Part 1 is applicable except as follows.

15.1.2 *Addition:*

Wall-mounted appliances are fixed at a distance of 3 mm from the mounting surface, unless the installation instructions specify a larger value.

16 LEAKAGE CURRENT AND ELECTRIC STRENGTH

This clause of Part 1 is applicable.

17 OVERLOAD PROTECTION OF TRANSFORMERS AND ASSOCIATED CIRCUITS

This clause of Part 1 is applicable.

18 ENDURANCE

This clause of Part 1 is not applicable.

19 ABNORMAL OPERATION

This clause of Part 1 is applicable except as follows.

19.2 Not Applicable.

19.3 Not Applicable.

19.4 Addition:

For open-outlet water heaters, flow switches and pressure switches that operate during the test of **11** are short-circuited, the water-control valve being adjusted to the most unfavourable position.

NOTE 101 — The closed position of the valve can be the most unfavourable position.

Flow switches and thermostats of closed water heaters are short-circuited and any pressure relief device rendered inoperative, the outlet valve being closed. However, if the appliance has no flow switch and back-siphonage is likely to occur, the water heater is filled with just sufficient water to cover the heating element and operated with the outlet valve open.

NOTE 102 — Back-siphonage is not considered likely to occur if a non-return valve or a pipe interrupter is incorporated in the appliance or if the instructions state that a non-return valve has to be included in the installation.

19.13 Addition:

During the test of **19.4**, the water container shall not rupture and the water temperature shall not exceed

a) 99 °C, for open-outlet water heaters having a capacity exceeding 1 litre;
b) 140 °C, for closed water heaters having a capacity exceeding 1litre.

20 STABILITY AND MECHANICAL HAZARDS

This clause of Part 1 is applicable.

21 MECHANICAL STRENGTH

This clause of Part 1 is applicable.

22 CONSTRUCTION

This clause of Part 1 is applicable except as follows.

22.6 Addition:

The enclosure shall have a drain hole positioned so that the water can drain without impairing the electrical insulation, unless water cannot accumulate within the enclosure in normal use. The hole shall be at least 5 mm in diameter or 20 mm2 in area with a width of at least 3 mm.

Compliance is checked by inspection and by measurement.

22.47 Replacement:

Appliances shall withstand the water pressure occurring in normal use.

Compliance is checked by subjecting the appliance to a water pressure of

a) Twice the rated pressure, for closed water heaters and ;
b) 0.15 MPa, for open-outlet water heaters.

If an open-outlet water heater incorporates a valve that regulates the water flow, a water pressure of 2 MPa is applied to the inlet of the appliance, the valve being closed.

Pressure-relief devices are rendered inoperative. The pressure is raised at a rate of 0.13 MPa/s to the specified value and is maintained at that value for 5 min.

Water shall not leak from the appliance and there shall be no permanent deformation to such an extent that compliance with this standard is impaired.

22.48 Not Applicable.

22.50 Addition:

The requirement is not applicable provided the maximum temperature of the water from the system cannot exceed 55 °C in normal use.

If the maximum temperature of the water from the system exceeds 55 °C in normal use then the requirement is not applicable provided that the system is such that a shower outlet normal use water temperature control takes precedence in setting the system temperature. In the case of systems with multiple

shower outlets, the shower with the lowest temperature setting shall take precedence, the other shower outlets taking precedence over non-shower outlets.

22.101 The rated pressure of closed water heaters shall be at least 0.6 MPa.

The rated pressure of closed water heaters intended to be supplied by a pressure reducing valve shall be at least 0.1 MPa.

NOTE — The rated pressure of open-outlet water heaters is 0 Pa.

Compliance is checked by inspection.

22.102 The outlet water of appliances other than those intended to supply water for showering shall not attain an excessive temperature due to a sudden pressure drop in the water supply.

Compliance is checked by the following test.

The appliance is operated at rated power input with the controls or switching devices adjusted to their most unfavourable possible setting to attain the maximum water temperature. Any regulating valve is fully opened and the water flow is adjusted so that the flow switch or the pressure switch is on the verge of operating.

Any control devices that operate during the test of **11** are short-circuited. The water flow is reduced in steps of 10 percent per minute until;

a) for closed water heaters, the thermal cut-out incorporated to comply with **22.106** operates or steady conditions are established; and

b) for open outlet water heaters, a non-self-resetting thermal cut-out operates or steady conditions are established.

If the rupture of a heating element or an intentionally weak part leads to a permanent open circuit, the test is repeated on a second sample. This second test shall be terminated in the same mode unless the test is otherwise satisfactorily completed.

22.103 Water heaters shall be supplied with a pressure relief device that prevents excessive pressure.

Compliance is checked by inspection and by subjecting the appliance to a slowly increasing water pressure.

The pressure relief device shall operate before the water pressure exceeds the rated pressure by more than 0.1 MPa.

NOTE — The pressure relief device can be fitted during installation.

22.104 The outlet of open-outlet water heaters shall be constructed so that the water flow is not limited to such an extent that the container is subjected to a significant pressure in normal use.

Compliance is checked by inspection.

The requirement is considered to be met, if the cross-sectional area of the water outlet is not less than that of the inlet.

22.105 Open oulet water heaters incorporating a flow switch shall be constructed so that if there is no water flow, the heating element cannot be switched on, and it is switched off, if the water flow ceases.

Compliance is checked by inspection and by manual test.

However, if compliance with this subclause relies on the correct operation of an electronic circuit, the appliance is further tested as follows.

a) The appliance is operated for one cycle. In addition, the electromagnetic phenomena tests of **19.11.4.1** to **19.11.4.7** are applied during the test. The tests are carried out with surge protective devices disconnected, unless they incorporate spark gaps.

   If there is no water flow, the heating element shall not be switched on, and it is switched off without delay if the water flow ceases.

b) The appliance is operated for one cycle. The fault conditions in **19.11.2** are then considered and applied one at a time to the electronic circuit.

If there is no water flow, the heating element shall not be switched on, and it is switched off without delay if the water flow ceases.

One cycle consists of opening and closing of the water tap.

If the electronic circuit is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.

22.106 Closed water heaters shall incorporate a thermal cut-out that operates independently from a thermostat or flow switch. It shall only be possible to reset the thermal cut-out after removal of a non-detachable cover.

If the capacity does not exceed 1litre and the appliance incorporates a flow switch, an alternative protective device, such as a pressure switch, may be used instead of the thermal cut-out.

Compliance is checked by inspection.

22.107 Water shall not attain an excessive temperature in normal use.

Compliance is checked by the following test.

The appliance is operated at rated power input. Any regulating valve is fully opened and the water flow is

adjusted so that the flow switch or pressure switch or thermostat is on the verge of operating.

The temperature of the outlet water shall not be higher than 95 °C and shall not exceed the temperature of the inlet water by more than 75 K.

For appliances intended to supply water for showering the test is carried out under normal operation and with a water pressure of 0.2 MPa. The temperature of the water at the outlet shall not exceed 55 °C.

22.108 The outlet water of appliances intended to supply water for showering shall not attain an excessive temperature due to a sudden pressure drop in the water supply.

Compliance is checked by the following test.

The appliance is supplied with water at a pressure of 0.4 MPa. It is operated at rated power input with the regulating valve adjusted so that the outlet water temperature is 25 ± 1 K above the inlet water temperature. The water pressure is then reduced to 0.2 MPa within 1 s.

The outlet water temperature shall not rise by more than 25 K within 10 s.

The outlet water temperature is measured by means of a fine-wire thermocouple placed in the centre of a plastic cylindrical receptacle having a diameter of 30 mm and a height of 12 mm. The receptacle is positioned 25 mm below the shower head.

If compliance relies on the operation of an electronic circuit, the test is repeated under the following conditions applied separately;

a) the fault conditions of **19.11.2** applied one at a time to the electronic circuit;
b) the electromagnetic phenomena tests of **19.11.4.1** to **19.11.4.7** applied to the appliance.

The outlet water temperature shall not rise by more than 25 K within 10 s during or after each of the tests.

If the electronic circuit is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.

22.109 Water containers of open-outlet water heaters having a pressure switch shall not rupture due to excessive internal pressure.

Compliance is checked by inspection and for;

a) appliances having a weak part that is ejected or ruptures when the pressure is excessive, by the test of 22.109.1;

NOTE 1 — Examples of weak parts are diaphragms and plugs.

b) appliances having other means for relieving pressure, by the tests of **22.109.1** and **22.109.3**;
c) appliances having heating elements that
   1) rupture before the internal pressure is excessive, or
   2) cannot be energized when the internal pressure is excessive, by the tests of **22.109.2** and **22.109.3**.

After the tests, the appliance shall comply with **8** and **16.2**.

NOTE 2 — The tests simulate a blocked outlet or frozen water in the container.

22.109.1 The appliance is filled with water, the water outlet being sealed. The water pressure is then steadily increased.

The weak part shall be ejected or rupture, or the pressure relief device operate, before the internal pressure reaches 1.1 MPa.

After the pressure has been relieved, water is allowed to flow for a period of 1 min.

22.109.2 The appliance is filled with water, the water outlet being sealed and the inlet valve closed. Controls are short-circuited or open-circuited, whichever is more unfavourable. The appliance is then operated at rated power input.

The heating element shall rupture without causing a hazard unless it remains de-energized.

If the heating element ruptures, the inlet valve is opened and the water pressure steadily increased until it reaches 1.1 MPa. The pressure is maintained for 1 min.

22.109.3 The appliance is filled with water, the water inlet and outlet being sealed. Controls are short-circuited or open-circuited, whichever is more unfavourable.

The appliance is placed as in normal use in an ambient having a temperature not exceeding –5°C until the water is frozen. The appliance is then placed in the normal ambient and operated at rated power input.

The heating element shall rupture without causing a hazard or any excessive pressure shall be relieved by means of a pressure relief device, unless the heating element remains de-energized.

The appliance is switched off and allowed to reach room temperature.

If the heating element remains de-energized or has ruptured, water is supplied through the inlet and the pressure is steadily increased until it reaches 1.1 MPa.

The pressure is maintained for 1 min.

If a pressure relief device has operated, the appliance is connected to the water supply for a period of 1 min with the outlet still sealed.

22.110 Appliances for wall-mounting shall have reliable provision for fixing to a wall, independent of the connection to the water mains.

Compliance is checked by inspection.

23 INTERNAL WIRING

This clause of Part 1 is applicable.

24 COMPONENTS

This clause of Part 1 is applicable except as follows.

24.1.3 *Addition:*

Flow switches are tested for 50 000 cycles of operation.

Pressure switches for open-outlet water heaters and pressure switches for appliances intended to supply water for showering only are tested for 20 000 cycles of operation. Pressure switches for other water heaters are tested for 50 000 cycles of operation.

24.1.4 *Addition:*

Thermal cut-outs incorporated in closed water heaters shall comply with the requirements for type 2B controls in Clauses **13, 15, 16, 17** and **20** of IS/IEC 60730-1, unless they are tested with the appliance.

If a self-resetting thermal cut-out operates during the test of 22.107, the number of cycles of operation is increased to

3 000, for waters heaters intended to supply water for showering;

1 000, for other appliances.

24.101 The thermal cut-out or other protective device incorporated to comply with **22.106** shall be non-self-resetting and, for multi-phase appliances, provide all-pole disconnection.

Compliance is checked by inspection.

24.102 The thermal cut-out or other protective device, incorporated for compliance with 22.106 in closed water heaters having a capacity not exceeding 1 litre, shall maintain its operating characteristics.

Compliance is checked by the following test.

The appliance is supplied at rated voltage and operated under normal operation but with any control that operates during the test of **11** short-circuited. The water flow is adjusted so that the temperature of the water increases by approximately 1 K / min.

The thermal cut-out is caused to operate five times, the temperatures at which it operates are measured and the mean value determined. The thermal cut-out is subjected to 50 000 cycles of temperature fluctuation. Each cycle consists of a variation in temperature between the maximum value measured during the test of **22.107** and half this value.

The thermal cut-out is then caused to operate 20 times and the mean value of the temperatures at which it operates shall not deviate by more than 20 percent from the mean value previously determined.

If the protective device is sensitive to pressure, the appliance is not energized and is subjected to a slowly increasing water pressure. The mean operating pressure of the protective device is determined over five cycles. The protective device is subjected to 50 000 cycles of pressure fluctuation. Each cycle consists of a variation in pressure between the rated pressure of the appliance and half this value.

The protective device is then caused to operate 20 times and the mean value of the pressures at which it operates shall not deviate by more than 20 percent from the mean value previously determined.

25 SUPPLY CONNECTION AND EXTERNAL FLEXIBLE CORD

This clause of Part 1 is applicable.

26 TERMINALS FOR EXTERNAL CONDUCTORS

This clause of Part 1 is applicable.

27 PROVISION FOR EARTHING

This clause of Part 1 is applicable except as follows.

27.1 Addition:

For Class I appliances, the sheath of the heating element shall be permanently and reliably connected to the earthing terminal, unless

a) the container is provided with inlet and outlet pipes of metal, which are permanently and reliably connected to the earthing terminal, and

b) other accessible metal parts of the container in contact with the water are permanently and reliably connected to the earthing terminal.

28 SCREWS AND CONNECTIONS

This clause of Part 1 is applicable.

29 CLEARANCE, CREEPAGE DISTANCES AND

SOLID INSULATION

This clause of Part 1 is applicable.

30 RESISTANCE TO HEAT AND FIRE

This clause of Part 1 is applicable except as follows.

30.2.2 Not applicable.

31 RESISTANCE TO RUSTING

This clause of Part 1 is applicable.

32 RADIATION, TOXICITY AND SIMILAR HAZARDS

This clause of Part 1 is applicable.

101 TESTS

101.1 Type Tests

The tests specified in Table 101 shall constitute the type tests and shall be carried out on a sample selected preferably at random from regular production lot (*see* **5.3**). Before commencement of the tests, the water heater shall be visually examined and inspected of components, parts and their assembly, constructions, mechanical hazards, marking provision of suitable terminals for supply connections, earthing and the effectiveness screws and connection. The external surface finish shall be even and free from finishing defects.

101.1.1 *Criteria of Acceptance*

Sample shall successfully pass all the type tests for proving conformity with the requirements of the standard. If the sample fails in any of the type tests, the testing authority at its discretion, may call for fresh samples not exceeding twice the original number and subject them again to all tests or to the test (s) in which failure (s) had occurred. No failure should be permitted in the repeat tests (s).

Table 101 Schedule of Type Tests
(*Clause* 101.1)

Sl No.	Tests	Ref to Clause
(1)	(2)	(3)
i)	Protection against access to live parts	8
ii)	Power input and current	10
iii)	Heating	11
iv)	Leakage current and electric strength at operating temperature	13
v)	Transient over voltages	14
vi)	Moisture resistance	15
vii)	Leakage current and electric strength	16
viii)	Overload protection of transformers and associated circuits	17
ix)	Abnormal operation	19
x)	Stability and mechanical hazards	20
xi)	Mechanical Strength	21
xii)	Construction	22
xiii)	Internal wiring	23
xiv)	Components	24
xv)	Supply connection and external flexible cords	25
xvi)	Terminals for external conductors	26
xvii)	Provision for earthing	27
xviii)	Screw and connections	28
xix)	Clearances, creepage distances and solid insulation	29
xx)	Resistance to heat and fire	30
xxi)	Resistance to rusting	31
xxii)	Radiation, toxicity and similar hazards	32

101.2 Acceptance Tests

The following shall constitute the acceptance tests:

Sl No.	*Tests*	*Ref to Clause*
(1)	(2)	(3)
i)	Protection against access to live parts	08
ii)	Power input and current	10
iii)	Heating	11
iv)	Leakage current and electric strength at operating Temperature	13
v)	Moisture resistance	15
vi)	Leakage current and electric strength	16
viii)	Provision for ear thing	27

NOTE — For the purpose of acceptance tests, the humidity treatment shall be done for 24 h while conducting the test for moisture resistance (***see*** **15**).

101.2.1 A recommended sampling procedure for acceptance tests is given in Annex J of IS 302-1.

101.3 Routine Test — The following shall constitute the routine tests:

Sl No.	*Test*	*Ref to Clause*
(1)	(1)	(1)
i)	Protection against access to live parts	8
ii)	High voltage	13.3.2 of IS 302-1 : 2008
iii)	Provision for earthing	27

ANNEXES

The annexes of Part 1 are applicable except as follows.

ANNEX A

(*Informative*)

ROUTINE TESTS

This annex of Part 1 is applicable except as follows.

A-101 PRESSURE TEST

The water container is subjected to a pressure test using a fluid.

When a liquid is used, the pressure is

a) for closed water heaters, 0.7 MPa for those having a rated pressure not greater than 0.6 MPa, and 1.1 times rated pressure for others;

b) for open-outlet water heaters, 0.05 MPa;

When gas is used, these pressures may be reduced but are to be sufficient to reveal leakage.

Leakage of the fluid is not to occur during the test.

ANNEX R

(*Informative*)

SOFTWARE EVALUATION

R-0 Programmable electronic circuits requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2 shall be validated in accordance with the requirements in this annex.

NOTE — Tables R.1 and R.2 are based on Table H.11.12.7 of IEC 60730-1 that is, for the purpose of this annex, divided in two tables, Table R.1 for general fault/error conditions and Table R.2 for specific fault/error conditions.

R-1 Programmable electronic circuits using software

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2 shall be constructed so that the software does not impair compliance with the requirements of this standard.

Compliance is checked by the inspections and tests, according to the requirements of this annex, and by examination of the documentation as required by this annex.

R-2 Requirements for the architecture

R-2.1 General

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2 shall use measures to control and avoid software-related faults/errors in safety-related data and safety-related segments of the software.

Compliance is checked by the inspections and tests in R.2.2 to R.3.3.3 inclusive.

R-2.1.1 Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.2 shall have one of the following structures:

- single channel with periodic self-test and monitoring (see IEC 60730-1, H.2.16.7);
- dual channel (homogenous) with comparison (see IEC 60730-1, H.2.16.3);
- dual channel (diverse) with comparison (see IEC 60730-1, H.2.16.2).

NOTE 1— Comparison between dual channel structures may be performed by:

- use of a comparator (see IEC 60730-1 H.2.18.3), or
- reciprocal comparison (see IEC 60730-1 H.2.18.15).

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 shall have one of the following structures:

- single channel with functional test (see IEC 60730-1, H.2.16.5);
- single channel with periodic self-test (see IEC 60730-1, H.2.16.6);
- dual channel without comparison (see IEC 60730-1, H.2.16.1).

NOTE 2 — Software structures incorporating measures to control the fault/error conditions specified in Table R.2 are also acceptable for programmable **electronic circuits** with functions requiring software measures to control the fault/error conditions specified in Table R.1.

Compliance is checked by the inspections and tests of the software architecture in R.3.2.2.

R-2.2 Measures to control faults/errors

R-2.2.1 When redundant memory with comparison is provided on two areas of the same component, the data in one area shall be stored in a different format from that in the other area (see software diversity, IEC 60730-1 H.2.18.19).

Compliance is checked by inspection of the source code.

R-2.2.2 Programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.2 and that use dual channel structures with comparison shall have additional fault/error detection means (such as periodic functional tests, periodic self tests, or independent monitoring) for any fault/errors not detected by the comparison.

Compliance is checked by inspection of the source code.

R-2.2.3 For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, means shall be provided for the recognition and control of errors in transmissions to external safety-related data paths. Such means shall take into account errors in data, addressing, transmission timing and sequence of protocol.

Compliance is checked by inspection of the source code.

R-2.2.4 For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, the programmable **electronic circuits** shall incorporate measures to address the fault/errors in safety-related segments and data indicated in Table R.1 or Table R.2 as appropriate.

Compliance is checked by inspection of the source code.

Table R.1 [e] — General Fault/Error Conditions

Component [a]	Fault/error	Acceptable measures [b, c]	Definitions See IEC 60730-1
1 Central processing unit (CPU)			
1.1 Registers	Stuck at	Functional test, or periodic self-test using either: – static memory test, or – word protection with single bit redundancy	H.2.16.5 H.2.16.6 H.2.19.6 H.2.19.8.2
1.2 VOID			
1.3 Programme counter	Stuck at	Functional test, or periodic self-test, or independent time-slot monitoring, or logical monitoring of the programme sequence	H.2.16.5 H.2.16.6 H.2.18.10.4 H.2.18.10.2
2 Interrupt handling and execution	No interrupt or too frequent interrupt	Functional test, or time-slot monitoring	H.2.16.5 H.2.18.10.4
3 Clock	Wrong frequency (for quartz synchronized clock: harmonics/ sub-harmonics only)	Frequency monitoring, or time slot monitoring	H.2.18.10.1 H.2.18.10.4
4 Memory			
4.1 Invariable memory	All single bit faults	Periodic modified checksum, or multiple checksum, or word protection with single bit redundancy	H.2.19.3.1 H.2.19.3.2 H.2.19.8.2
4.2 Variable memory	DC fault	Periodic static memory test, or word protection with single bit redundancy	H.2.19.6 H.2.19.8.2
4.3 Addressing (relevant to variable and invariable memory)	Stuck at	Word protection with single bit redundancy including the address	H.2.19.8.2
5 Internal data path	Stuck at	Word protection with single bit redundancy	H.2.19.8.2
5.1 VOID			
5.2 Addressing	Wrong address	Word protection with single bit redundancy including the address	H.2.19.8.2

Table R. 1 — (*Concluded*)

Component [a]	Fault/error	Acceptable measures [b, c]	Definitions See IEC 60730-1
6 External communication	Hamming distance 3	Word protection with multi-bit redundancy, or CRC – single word , or transfer redundancy, or protocol test	H.2.19.8.1 H.2.19.4.1 H.2.18.2.2 H.2.18.14
6.1 VOID			
6.2 VOID			
6.3 Timing	Wrong point in time	Time-slot monitoring, or scheduled transmission Time-slot and logical monitoring, or comparison of redundant communication channels by either: – reciprocal comparison – independent hardware comparator	H.2.18.10.4 H.2.18.18 H.2.18.10.3 H.2.18.15 H.2.18.3
	Wrong sequence	Logical monitoring, or time-slot monitoring, or scheduled transmission	H.2.18.10.2 H.2.18.10.4 H.2.18.18
7 Input/output periphery	Fault conditions specified in 19.11.2	Plausibility check	H.2.18.13
7.1 VOID			
7.2 Analog I/O			
7.2.1 A/D- and D/A- convertor	Fault conditions specified in 19.11.2	Plausibility check	H.2.18.13
7.2.2 Analog multiplexer	Wrong addressing	Plausibility check	H.2.18.13
8 VOID			
9 Custom chips d e.g. ASIC, GAL, gate array	Any output outside the static and dynamic functional specification	Periodic self test	H.2.16.6

NOTE — A Stuck-at fault model denotes a fault model representing an open circuit or a non-varying signal level. A DC fault model denotes a stuck-at fault model incorporating short circuits between signal lines.

a For fault/error assessment, some components are divided into their sub-functions.
b For each sub-function in the table, the Table R.2 measure will cover the software fault/error.
c Where more than one measure is given for a sub-function, these are alternatives.
d To be divided as necessary by the manufacturer into sub-functions.
e Table R.1 is applied according to the requirements of R.1 to R.2.2.9 inclusive.

Table R.2 [e] — Specific Fault/Error Conditions

Component [a]	Fault/error	Acceptable measures [b, c]	Definitions See IEC 60730-1
1 Central Processing Unit (CPU)			
1.1 Registers	DC fault	Comparison of redundant CPUs by either:	
		– reciprocal comparison	H.2.18.15
		– independent hardware comparator, or	H.2.18.3
		internal error detection, or	H.2.18.9
		redundant memory with comparison, or	H.2.19.5
		periodic self-tests using either	
		– walkpat memory test	H.2.19.7
		– Abraham test	H.2.19.1
		– transparent GALPAT test; or	H.2.19.2.1
		word protection with multi-bit redundancy, or	H.2.19.8.1
		static memory test and	H.2.19.6
		word protection with single bit redundancy	H.2.19.8.2
1.2 Instruction decoding and execution	Wrong decoding and execution	Comparison of redundant CPUs by either:	
		– reciprocal comparison	H.2.18.15
		– independent hardware comparator, or	H.2.18.3
		internal error detection, or	H.2.18.9
		periodic self-test using equivalence class test	H.2.18.5
1.3 Programme counter	DC fault	Periodic self-test and monitoring using either:	H.2.16.7
		– independent time-slot and logical monitoring	H.2.18.10.3
		– internal error detection, or	H.2.18.9
		comparison of redundant functional channels by either:	
		– reciprocal comparison	H.2.18.15
		– independent hardware comparator	H.2.18.3
1.4 Addressing	DC fault	Comparison of redundant CPUs by either:	
		– reciprocal comparison	H.2.18.15
		– independent hardware comparator; or	H.2.18.3
		internal error detection; or	H.2.18.9
		periodic self-test using	H.2.16.7
		– a testing pattern of the address lines; or	H.2.18.22
		– a full bus redundancy	H.2.18.1.1
		– a multi bus parity including the address	H.2.18.1.2
1.5 Data paths instruction decoding	DC fault and execution	Comparison of redundant CPUs by either:	
		– reciprocal comparison, or	H.2.18.15
		– independent hardware comparator, or	H.2.18.3
		– internal error detection, or	H.2.18.9
		– periodic self-test using a testing pattern, or	H.2.16.7
		– data redundancy, or	H.2.18.2.1
		– multi-bit bus parity	H.2.18.1.2
2 Interrupt handling and execution	No interrupt or too frequent interrupt related to different sources	Comparison of redundant functional channels by either	
		– reciprocal comparison,	H.2.18.15
		– independent hardware comparator, or	H.2.18.3
		– independent time-slot and logical monitoring	H.2.18.10.3

Table R. 2 — (*Continued*)[e]

Component [a]	Fault/error	Acceptable measures [b, c]	Definitions See IEC 60730-1
3 Clock	Wrong frequency (for quartz synchronized clock: harmonics/ subharmonics only)	Frequency monitoring, or time-slot monitoring, or comparison of redundant functional channels by either: – reciprocal comparison – independent hardware comparator	H.2.18.10.1 H.2.18.10.4 H.2.18.15 H.2.18.3
4. Memory			
4.1 Invariable memory	99,6 % coverage of all information errors	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or redundant memory with comparison, or periodic cyclic redundancy check, either – single word – double word, or word protection with multi-bit redundancy	 H.2.18.15 H.2.18.3 H.2.19.5 H.2.19.4.1 H.2.19.4.2 H.2.19.8.1
4.2 Variable memory	DC fault and dynamic cross links	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or redundant memory with comparison, or periodic self tests using either: – walkpat memory test – Abraham test – transparent GALPAT test, or word protection with multi-bit redundancy	 H.2.18.15 H.2.18.3 H.2.19.5 H.2.19.7 H.2.19.1 H.2.19.2.1 H.2.19.8.1
4.3 Addressing (relevant to variable and invariable memory)	DC fault	Comparison of redundant CPUs by either: – reciprocal comparison, or – independent hardware comparator, or full bus redundancy testing pattern, or periodic cyclic redundancy check, either: – single word – double word, or word protection with multi-bit redundancy including the address	 H.2.18.15 H.2.18.3 H.2.18.1.1 H.2.18.22 H.2.19.4.1 H.2.19.4.2 H.2.19.8.1
5 Internal data path			
5.1 Data	DC fault	Comparison of redundant CPUs by either – reciprocal comparison – independent hardware comparator, or word protection with multi-bit redundancy including the address, or data redundancy, or testing pattern, or protocol test	 H.2.18.15 H.2.18.3 H.2.19.8.1 H.2.18.2.1 H.2.18.22 H.2.18.14

Table R. 2 — (*Continued*)[e]

Component [a]	Fault/error	Acceptable measures [b, c]	Definitions See IEC 60730-1
5.2 Addressing	Wrong address and multiple addressing	Comparison of redundant CPUs by: – reciprocal comparison – independent hardware comparator, or word protection with multi-bit redundancy, including the address, or full bus redundancy; or testing pattern including the address	 H.2.18.15 H.2.18.3 H.2.19.8.1 H.2.18.1.1 H.2.18.22
6 External communication			
6.1 Data	Hamming distance 4	CRC – double word, or data redundancy or comparison of redundant functional channels by either: – reciprocal comparison – independent hardware comparator	H.2.19.4.2 H.2.18.2.1 H.2.18.15 H.2.18.3
6.2 Addressing	Wrong address Wrong and multiple addressing	Word protection with multi-bit redundancy, including the address, or CRC single word including the addresses, or transfer redundancy or protocol test CRC – double word, including the address, or full bus redundancy of data and address, or comparison of redundant communication channels by either: – reciprocal comparison – independent hardware comparator	H.2.19.8.1 H.2.19.4.1 H.2.18.2.2 H.2.18.14 H.2.19.4.2 H.2.18.1.1 H.2.18.15 H.2.18.3
6.3 Timing	Wrong point in time	Time-slot monitoring, or scheduled transmission	H.2.18.10.4 H.2.18.18
7 Input/output periphery			
7.1 Digital I/O	Fault conditions specified in 19.11.2	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or input comparison, or multiple parallel outputs, or output verification, or testing pattern, or code safety	 H.2.18.15 H.2.18.3 H.2.18.8 H.2.18.11 H.2.18.12 H.2.18.22 H.2.18.2
7.2 Analog I/O			
7.2.1 A/D- and D/A- convertor	Fault conditions specified in 19.11.2	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or input comparison, or multiple parallel outputs, or output verification, or testing pattern	 H.2.18.15 H.2.18.3 H.2.18.8 H.2.18.11 H.2.18.12 H.2.18.22
7.2.2 Analog multiplexer	Wrong addressing	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or input comparison or testing pattern	H.2.18.15 H.2.18.3 H.2.18.8 H.2.18.22

Table R. 2 — (*Concluded*)[e]

Component [a]	Fault/error	Acceptable measures [b, c]	Definitions See IEC 60730-1
8 Monitoring devices and comparators	Any output outside the static and dynamic functional specification	Tested monitoring, or redundant monitoring and comparison, or error recognizing means	H.2.18.21 H.2.18.17 H.2.18.6
9 Custom chips [d] e.g. ASIC, GAL, gate array	Any output outside the static and dynamic functional specification	Periodic self-test and monitoring, or dual channel (diverse) with comparison, or error recognizing means	H.2.16.7 H.2.16.2 H.2.18.6
NOTE — A DC fault model denotes a stuck-at fault model incorporating short circuits between signal lines.			

[a] For fault/error assessment, some components are divided into their sub-functions.

[b] For each sub-function in the table, the software measure will cover the Table R.1 fault/error.

[c] Where more than one measure is given for a sub-function, these are alternatives.

[d] To be divided as necessary by the manufacturer into sub-functions.

[e] Table R.2 is applied according to the requirements of R.1 to R.2.2.9 inclusive, only if required by a part 2.

R-2.2.5 For programmable electronic circuits with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, detection of a fault/error shall occur before compliance with Clause **19**, **22.105** and **22.108** is impaired.

R-2.2.6 The software and safety-related hardware under its control shall be initialized and shall terminate before compliance with Clause **19**, **22.105 and 22.108** is impaired.

R-2.2.7 Where labels are used for memory locations, these labels shall be unique.

Compliance is checked by inspection of the source code.

R-2.2.8 The software shall be protected from user alteration of safety-related segments and data.

Compliance is checked by inspection of the source code.

R-2.2.9 The software and safety-related hardware under its control shall be initialized and shall terminate before compliance with **19** is impaired.

Compliance is checked by testing of the source code.

R-3 MEASURES TO AVOID ERRORS

R-3.1 General

For programmable electronic circuits with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, the following measures to avoid systematic faults in the software shall be applied.

Software that incorporates measures used to control the fault/error conditions specified in

Table R.2 is inherently acceptable for software required to control the fault/error conditions specified in Table R.1.

NOTE — The content of these requirements is extracted from IEC 61508-3 and adapted to the needs of this Standard.

R-3.2 Specification

R-3.2.1 Software Safety Requirements

The specification of the software safety requirements shall include:

- a description of each safety related function to be implemented, including its response time(s):
  - functions related to the application including their related software faults required to be controlled;
  - functions related to the detection, annunciation and management of software or hardware faults;
- a description of interfaces between software and hardware;

- a description of interfaces between any safety and non-safety related functions;
- a description of any compiler used to generate the object code from the source code, including details of any compiler switch settings used such as library function options, memory model, optimization, SRAM details, clock rate and chip details;
- a description of any linker used to link the object code to executable library routines.

Compliance is checked by inspection of the documentation and as specified in R.3.2.2.2.

NOTE — Examples of some techniques/measures to meet these requirements can be found in Table R.3.

Table R.3 - Semi-formal methods

Technique / Measure	Informative references
Semi-formal methods	
Logical/ block diagrams	
Sequence diagrams	
Finite state machines/state transition diagrams	IEC 61508-7, B.2.3.2
Decision/truth tables	IEC 61508-7, C.6.1

R-3.2.2 Software architecture

R-3.2.2.1 The specification of the software architecture shall include the following aspects:

- techniques and measures to control software faults/errors (refer to R.2.2);
- interactions between hardware and software;
- partitioning into modules and their allocation to the specified safety functions;
- hierarchy and call structure of the modules (control flow);
- interrupt handling;
- data flow and restrictions on data access;
- architecture and storage of data;
- time-based dependencies of sequences and data.

Compliance is checked by inspection of the documentation and as specified in R.3.2.2.2.

NOTE — Examples of some techniques/measures to meet these requirements can be found in Table R.4.

Table R.4 - Software Architecture Specification

Technique / Measure	Informative references
Fault detection and diagnosis	IEC 61508-7, C.3.1
Semi-formal methods: • Logic/function block diagrams • Sequence diagrams • Finite state machines / state transition diagrams • — Data flow diagrams	IEC 61508-7, B.2.3.2 IEC 61508-7, C.2.2

R-3.2.2.2 *The architecture specification shall be validated against the specification of the software safety requirements by static analysis*.

NOTE— Example methods for static analysis are:

- control flow analysis; (IEC 61508-7, C.5.9);
- data flow analysis; (IEC 61508-7, C.5.10);
- walk-throughs/design reviews. (IEC 61508-7, C.5.16).

R-3.2.3 Module Design and Coding

R-3.2.3.1 Based on the architecture design, software shall be suitably refined into modules. Software module design and coding shall be implemented in a way that is traceable to the software architecture and requirements.

Compliance is checked by R.3.2.3.3 and by inspection of the documentation.

NOTE 1 — The use of computer aided design tools is accepted.

NOTE 2 — Defensive programming (IEC 61508-7, Subclause C.2.5) is recommended (e.g. range checks, check for division by 0, plausibility checks).

NOTE 3 — The module design shall specify:

- function(s),
- interfaces to other modules,
- data.

NOTE 4 — Examples of some techniques/measures to meet these requirements can be found in Table R.5.

Table R.5 - Module Design Specification

Technique / Measure	Informative references
Limited size of software modules	IEC 61508-7, C.2.9
Information hiding / encapsulation	IEC 61508-7, C.2.8
One entry / one exit point in subroutines and functions	IEC 61508-7, C.2.9
Fully defined interface	IEC 61508-7, C.2.9
Semi-formal methods: • Logic/function block diagrams • Sequence diagrams • Finite state machines / state transition diagrams • Data flow diagrams	IEC 61508-7, B.2.3.2 IEC 61508-7, C.2.2

R-3.2.3.2 Software code shall be structured.

Compliance is checked by **R-3.2.3.3** and by inspection of the documentation.

NOTE 1 Structural complexity can be minimized by applying the following principles:

- keep the number of possible paths through a software module small, and the relation between the input and output parameters as simple as possible;
- avoid complicated branching and, in

particular, avoid unconditional jumps (GOTO) in higher level languages;

- where possible, relate loop constraints and branching to input parameters;
- avoid using complex calculations as the basis of branching and loop decisions.

NOTE 2 Examples of some techniques/measures to meet these requirements can be found in Table R.6.

Table R.6 - Design and Coding Standards

Technique / Measure	Informative references
Use of coding standard (see NOTE)	IEC 61508-7, C.2.6.2
No use of dynamic objects and variables (see NOTE)	IEC 61508-7, C.2.6.3
Limited use of interrupts	IEC 61508-7, C.2.6.5
Limited use of pointers	IEC 61508-7, C.2.6.6
Limited use of recursion	IEC 61508-7, C.2.6.7
No unconditional jumps in programs in higher level languages	IEC 61508-7, C.2.6.2
NOTE — Dynamic objects and/or variables are allowed if a compiler is used which ensures that sufficient memory for all dynamic objects and/or variables will be allocated before runtime, or which inserts runtime checks for the correct online allocation of memory.	

R-3.2.3.3 *Coded software shall be validated against the module specification by static analysis. The module specification shall be validated against the architecture specification by static analysis.*

R-3.3.3 Software validation

The software shall be validated with reference to the requirements of the software safety requirements specification.

NOTE 1 — Validation is confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Therefore, for example, software validation means confirming by examination and provision of objective evidence that the software satisfies the software safety requirements specification.

Compliance is checked by simulation of

- input signals present during normal operation,
- anticipated occurrences,
- undesired conditions requiring system action.

Test cases, test data and test results shall be reported.

NOTE 2 — Examples of some techniques/measures to meet these requirements can be found in Table R.7.

Table R.7 - Software Safety Validation

Technique / Measure	Informative references
Functional and black-box testing: • Boundary value analysis • Process simulation	IEC 61508-7, B.5.1, B.5.2 IEC 61508-7, C.5.4 IEC 61508-7, C.5.18
Simulation, modelling: • Finite state machines • Performance modelling	IEC 61508-7, B.2.3.2 IEC 61508-7, C.5.20

NOTE 3 — Testing should be the main validation method for software; modelling may be used to supplement the validation activities.

(*Continued on second cover*)

NOTE — The following numbering system is used:

a) Subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;
b) Unless notes are in a new subclause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
c) Additional annexes are lettered AA, BB, etc.

This standard is based on IEC 60335-2-35 : 2012 (Ed. 5.0). As this standard refers to IS 302-1, the differences of IS 302-1 from IEC 60335-1 shall apply. Apart from that, this standard differs from IEC 60335-2-35 as regards bare element heating elements, which are not permitted as per this Indian standard.

The principal changes in this revision are as follows (minor changes are not listed):

a) Converted notes to normative text (***See*** **7.12**, **7.102**, **8.1.5**, **22.104**, and **22.109.3**);
b) Deleted notes in **19.13**, **22.109**, and **A.101**;
c) Added Annex R and **22.108** for appliances with programmable electronic circuits;
d) Added requirements for water heaters (***See*** **22.50** and **22.51**).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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