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Responsible committee: CPL/72 Electrical control devices for household equipment and appliances

Interested committees:

Title: BS EN IEC 60730-2-9 Automatic electrical controls

Part 2-9: Particular requirements for temperature sensing controls

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



72/1428/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 60730-2-9 ED5

DATE OF CIRCULATION:

2024-06-28

CLOSING DATE FOR VOTING:

2024-09-20

SUPERSEDES DOCUMENTS:

72/1423/RR

IEC TC 72 : AUTOMATIC ELECTRICAL CONTROLS	
SECRETARIAT: United States of America	SECRETARY: Ms Grace Roh
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	
☐ SUBMITTED FOR CENELEC PARALLEL VOTING	☒ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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Recipients of this document are invited to submit, with their comments, notification of any relevant "In Some Countries" clauses to be included should this proposal proceed. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Automatic electrical controls - Part 2-9: Particular requirements for temperature sensing controls

PROPOSED STABILITY DATE: 2028

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

AUTOMATIC ELECTRICAL CONTROLS –

Part 2-9: Particular requirements for temperature sensing controls

FOREWORD

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IEC 60730-2-9 has been prepared by IEC technical committee 72: AUTOMATIC ELECTRICAL CONTROLS. It is an International Standard.

This 5.0 edition cancels and replaces Edition 4 and Amendment 1:2018-01 and Amendment 2:2020-04. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) adoption to IEC 60730-1 Ed.6.0 with all of its significant changes to IEC 60730-1 Ed.5.2,

The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 60730 series, under the general title: AUTOMATIC ELECTRICAL CONTROL, can be found on the IEC website.

This part 2-9 is intended to be used in conjunction with IEC 60730-1. It was established on the basis of the sixth edition of that standard (2022). Consideration may be given to future editions of, or amendments to, IEC 60730-1.

This part 2-9 supplements or modifies the corresponding clauses in IEC 60730-1, so as to convert that publication into the IEC standard: Particular requirements for temperature sensing controls.

Where this part 2-9 states "addition", "modification" or "replacement", the relevant requirement, test specification or explanatory matter in part 1 should be adapted accordingly.

Where no change is necessary part 2-9 indicates that the relevant clause or subclause applies.

In the development of a fully international standard it has been necessary to take into consideration the differing requirements resulting from practical experience in various parts of the world and to recognize the variation in national electrical systems and wiring rules.

The reader's attention is drawn to the fact that Annex R, Annex S and Annex T list all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

In this publication:

1) The following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type;*
- explanatory matter: in smaller roman type.
- Defined terms: **bold type**.

2) Subclauses, notes or items which are additional to those in Part 1 are numbered starting from 101, additional annexes are lettered AA, BB, etc.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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AUTOMATIC ELECTRICAL CONTROLS –

Part 2-9: Particular requirements for temperature sensing controls

1 Scope

This clause of Part 1 is replaced by the following:

This document applies to temperature sensing controls

- for use in, on, or in association with equipment for household appliance and similar use, including equipment for heating, air-conditioning and similar applications. The equipment may use electricity, gas, oil, solid fuel, solar thermal energy, etc., or a combination thereof.

NOTE 1 Throughout this document, the word "equipment" means "appliance and equipment" and "controls" means "temperature sensing controls".

- for building automation within the scope of ISO 16484 series and IEC 63044 series (HBES/BACS);

EXAMPLE 1 Independently mounted temperature sensing controls, controls in smart grid systems and controls for building automation systems within the scope of ISO 16484-2.

- for equipment that is used by the public, such as equipment intended to be used in shops, offices, hospitals, farms and commercial and industrial applications;

EXAMPLE 2 Controls for commercial catering, heating and air-conditioning equipment.

- that are **smart enabled controls**;

EXAMPLE 3 Smart grid control, remote interfaces/control of energy-consuming equipment including computer or smart phone.

- that are AC or DC powered controls with a rated voltage not exceeding 690 V AC or 600 V DC where the DC source is provided by primary or secondary batteries;
- used in, on, or in association with equipment that use electricity, gas, oil, solid fuel, solar thermal energy, etc., or a combination thereof;
- utilized as part of a control system or controls which are mechanically integral with multifunctional controls having non-electrical outputs;
- using NTC or **PTC thermistors** and to discrete **thermistors**, requirements for which are contained in Annex J;
- that have electrical circuits and **control** circuits which are, for example, operated by bimetals, magnet coils, memory metals, pressure elements, temperature-sensitive expansion elements or electronic elements.
- as well as manual controls when such are electrically and/or mechanically integral with automatic controls.

NOTE 2 Requirements for manually actuated mechanical switches not forming part of an automatic control are contained in IEC 61058-1-1.

This document applies to

- the inherent safety of automatic electrical controls, and
- functional safety of temperature **sensing controls** and safety related systems,
- controls where the performance (for example the effect of EMC phenomena) of the product can impair the overall safety and performance of the controlled system,
- the operating values, operating times, and operating sequences where such are associated with equipment safety and to the testing of automatic electrical temperature **sensing control** devices used in, or in association with, equipment.

EXAMPLE 4 **boiler thermostats, fan controls, temperature limiters** and **thermal cut-outs**.

– electrical safety of temperature sensing controls with non-electrical outputs such as refrigerant flow and gas **controls**.

– **single operation devices** as defined in this standard.

This document specifies the requirements for construction, operation and testing of automatic electrical controls used in, on, or in association with an equipment.

This document does not

- apply to automatic electrical temperature **sensing controls** intended exclusively for industrial process applications unless explicitly mentioned in the relevant part 2 or the equipment standard. However, this document can be applied to evaluate automatic electrical controls intended specifically for industrial applications in cases where no relevant safety standard exists.

- take into account the response value of an automatic action of a control, if such a response value is dependent upon the method of mounting the control in the equipment. Where a response value is of significant purpose for the protection of the user, or surroundings, the value defined in the appropriate equipment standard or as determined by the manufacturer will apply.

- address the integrity of the output signal to the network devices, such as interoperability with other devices unless it has been evaluated as part of the control system.

2 Normative references

Addition:

IEC 60216-1 *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60691, *Thermal links – Requirements and application guide*

3 Terms and definitions

This clause of Part 1 is applicable except as follows:

3.2 Definitions of types of controls according to purpose

Additional definitions:

3.2.101

single-operation device

SOD

control having a temperature **sensing element** which is intended to operate only once and then requires complete replacement

3.2.101.1

bimetallic single-operation device

single operation device (SOD) having a bimetallic temperature **sensing element**

Note 1 to entry: A **bimetallic single operation device (SOD)** does not reset above a declared temperature (see 11.4.103).

Note 2 to entry: Requirements for thermal links (which are not allowed to reset) are contained in IEC 60691.

3.2.101.2**non-bimetallic single-operation device**

single operation device (SOD) having a temperature **sensing element** which is part of a combination action **control**, the **operation** of which cannot be separated from other functions of the **control** and having a non-bimetallic thermal element that operates only once and then requires complete or partial replacement

Note 1 to entry: When such parts can be tested separately, they are considered to be thermal links within the scope of IEC 60691.

Note 2 to entry: The ageing period and thermal response of the device is dependent on the intended use of the device. As a result, the nature of the testing applicable to the device is representative of the application conditions for which the **protective control** is intended (see 7.2).

Note 3 to entry: **Non-bimetallic SODs** provide the equivalent of **micro-disconnection**.

3.2.102**room thermostat**

independently mounted or incorporated **thermostat** intended to control the temperature of habitable space

3.2.103**boiler thermostat**

thermostat intended to control boiler/liquid temperature

3.2.104**voltage maintained thermal cut-out**

thermal cut-out which is maintained in its operated condition by the voltage which appears across it in that condition

3.2.105**agricultural thermostat**

thermostat intended for use in agricultural confinement buildings

3.3 Definitions relating to the function of controls

Additional definition:

3.3.101**time factor**

transient response of temperature **sensing controls** by defined change of the **activating quantity**

3.5 Definitions of types of control according to construction

Add the following new definitions

3.5.101**push-and-turn actuation**

two-step actuation accomplished by first pushing, then rotating the **actuating member** of the control

3.5.102**pull-and-turn actuation**

two-step actuation accomplished by first pulling, then rotating the **actuating member** of the control

4 General

This clause of Part 1 is applicable except as follows

4.3 General notes on tests**4.3.2 Conditions of test**

Additional subclauses:

4.3.2.101 For the purposes of the tests of this standard and unless otherwise indicated, ambient temperature excursions beyond $T_{\max}$ during abnormal **operation** as a precursor to the **operation** of a manual reset **thermal cut-out** or a **bimetallic SOD** are ignored.

4.3.2.102 For manual reset **thermal cut-outs** and **bimetallic SODs** which have an **operating value** above $T_{\max}$, the temperature at the **sensing element** is raised, as necessary, to achieve any cycling required during the tests.

4.3.3 Samples required**4.3.3.1 Addition:**

Six samples of **bimetallic SODs** are used for the test of Clause 17 and a further six for the test of Clause 19.

5 Required technical information

This clause of Part 1 is applicable except as follows:

5.2 Methods of providing technical information**Table 1 – Required technical information and methods of providing these information**

	Information	Clause or subclause	Method
<i>Modifications:</i>			
<i>Addition:</i>			
101	Maximum sensing element temperature (other than relevant to requirement 105) ¹⁰¹ - Controls for use in or on cooking appliances - Controls for use in or on ovens of the self-cleaning type - Controls for use in or on food-handling appliances - Controls having parts containing liquid metal	16.101	X
102	Time factor with or without sheath	3.3.101 9.101 BB.2.2	X
103	SOD reset temperature (either –35 °C or 0 °C)	3.2.101 9.4.103 19.15.107.1.2	X
104	Number of cycles for bimetallic SOD with 0 °C reset	19.15.107.1.5	X

	Information	Clause or subclause	Method
105	Maximum sensing element temperature in °C of controls used in self-cleaning ovens (T_e)	19.15.105	D
106	Controls having parts containing liquid metal ¹⁰²	20.102	D
107	Tensile yield strength	9.1.101	X
108	Minimum current for the purpose of the test of 23.2.2 ¹⁰³	23.2.2	D
109	$T_{\max,1}$ is the maximum ambient temperature in which the control may remain continuously in the operated condition so that Table 17 temperatures are not exceeded ¹⁰⁴	16.4.101	D
110	Time period t_1 is the maximum time during which the ambient temperature can be higher than $T_{\max,1}$ after the control has operated ¹⁰⁴	16.4.101	D
111	Temperature limit above which automatic reset of a manual reset thermal cut-out or a voltage maintained thermal cut-out shall not occur (not higher than -20 °C)	3.2.104 9.4.106 19.15.106	X
112	For type 2.P controls , the method of test	19.101	X
113	The click rate N or switching operations per minute for the purposes of testing to CISPR 14-1	23	X
114	Rated functioning temperature (T_f) ¹⁰⁷ of the sensing element , which causes a non-bimetallic SOD to change state of conductivity	19.15.107.2	C
115	Ageing temperature for non-bimetallic SOD ^{105,107}	19.15.107.2.2	D
116	Rate of rise of temperature for testing non-bimetallic SOD ^{106,107}	19.15.107.2.2	D
117	Agricultural thermostat	3.2.105 9.4.107 9.6.3.101 Annex DD	D

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Additional notes:
¹⁰¹) This declaration applies only to temperature sensing controls containing liquid metal. For temperature sensing controls used in or on self-cleaning ovens, this declaration is the temperature for the cooking operation .
¹⁰²) Metal is an inclusive term that encompasses chemically metallic elements such as sodium (Na), potassium (K), and others. Mercury (Hg) is generally not allowed.
¹⁰³) When no minimum is declared, the test value is 15 mA.
¹⁰⁴) Consideration should be given to the provision of information by the equipment manufacturer relating to the minimum time that the appliance has to be disconnected from the supply to allow a voltage maintained thermal cut-out to reset.
¹⁰⁵) Determined by the control manufacturer based on the opening temperature of the thermal-cut-out .
¹⁰⁶) Determined by the control manufacturer referring to the actual maximum rate of rise probable in the projected end-use equipment.
¹⁰⁷) Non-bimetallic SODs are limited for use in appliances for heating or employing liquids or steam. They are not suitable for instantaneous water heaters and storage water heaters

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348 **5.3 Class II symbol**

349 This clause of Part 1 is applicable except as follows:

350 **5.3.1 Addition:**

351 The symbol for class II shall be used on controls of class II integrated or incorporated in an
352 assembly utilizing a non-electrical energy source.

353 **6 Protection against electric shock**

354 This clause of Part 1 is applicable.

355 **7 Provision for protective earthing**

356 This clause of Part 1 is applicable.

357 **8 Terminals and terminations**

358 This clause of Part 1 is applicable.

359 **9 Constructional requirements**

360 This clause of Part 1 is applicable except as follows:

361 **9.1 Materials**

362 Additional subclauses:

363 **9.1.101 Parts containing liquid metal**

364 **Controls** containing liquid metal declared under Table 1, requirement 106, and parts of any
365 **control** that contain sodium (Na), potassium (K), or both, shall be constructed of metal that has
366 a tensile yield strength at least four times the circumferential (hoop) or other stress on the parts
367 at 1,2 times the maximum temperature of the **sensing element** (T_e) in °C. *Compliance is checked*
368 *by inspection of the manufacturer's declaration and by the test of 20.102.*

369 **9.1.102 Material for non-bimetallic SODs**

370 Insulating material used in **non-bimetallic SODs** as defined in this standard shall comply with
371 the requirements of IEC 60216-1 and be suitable for the application.

372 **9.3 Actuation and operation**

373 **9.3.9 Pull-cord actuated control**

374 *Addition:*

375 NOTE 101 The Note is not applicable to **controls** classified as type 1.X or 2.X or type 1.Z or 2.Z.

376 **9.4 Actions**

377 **9.4.3 Type 2 action**

378 *Addition:*

379 Capacitors shall not be connected across the contacts of a thermal cut-out.

380 Constructions requiring a soldering operation to reset thermal cut-outs are not permitted.

381 **9.4.11 Type 1.H or 2.H action (a trip-free mechanism in which the contacts cannot be**
382 **prevented from opening and which can automatically be reset to the "Closed" position).**

position after normal operation conditions have been restored if the reset means is held in the "reset" position)

Replace the compliance criteria by the following:

Compliance is checked by inspection and by the tests as given in 9.4.11.101 to 9.4.11.106 .

Additional subclauses:

9.4.11.101 For this test, the reset mechanism of the **control** will be held in the reset position for the duration of the test from **9.4.11.102** to **9.4.11.104** . The verification of the automatic non-resetting above $-35\text{ }^{\circ}\text{C}$ will be carried out by **9.4.11.105** to **9.4.11.106** . For **SOD**, the verification of the automatic non-resetting above either $+0\text{ }^{\circ}\text{C}$ or $-35\text{ }^{\circ}\text{C}$ will be carried out by **9.4.11.105** to **9.4.11.106** , as declared in item 103 of Table 1.

9.4.11.102 *With the reset mechanism held in the reset position at room temperature, continuity across contacts is observed by a low-energy circuit, 0,05 A maximum.*

9.4.11.103 The **control's sensing element** is then installed in an air circulating chamber or an liquid bath and the **control's switch head** is installed as in 16.5 a). When the whole control is declared as the **sensing element**, the whole control is placed in an air-circulating chamber. The **control** or the **control's sensing element** is adjusted for the maximum set point temperature. The chamber or liquid bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or liquid bath temperature is then raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or liquid bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of **9.4.11.104** .

9.4.11.104 *After the **control** has operated and with the reset mechanism still held in the reset position, the temperature of the chamber or liquid bath is then reduced to determine if the **control** automatically resets. Verification of contact closure is done by applying the method in 9.4.11.102.*

9.4.11.105 The whole **control** or the **control's sensing element** is then installed in an air circulating chamber or liquid bath again and the **control's switch head** (if applicable) is installed as in 16.5 a) with the reset mechanism in its normal condition. The chamber or liquid bath temperature shall be determined by positioning a thermocouple wire adjacent to the control under test. The chamber or liquid bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or liquid bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of **9.4.11.102** .

9.4.11.106 *After the **control** has operated, the temperature of the chamber is allowed to cool down to either $+0\text{ }^{\circ}\text{C}$ or $-35\text{ }^{\circ}\text{C}$. Indication of contact separation is observed by applying the method of 9.4.11.102.*

9.4.12 **Type 1.J or 2.J action (a trip-free mechanism in which the contacts cannot be prevented from opening and the control is not permitted to function as an automatic reset device if the reset means is held in the "reset" or "on" position)**

Replace the compliance criteria by the following:

Compliance is checked by inspection and by the tests as given in 9.4.12.101 to 9.4.12.106 .

9.4.12.101 For this test, the reset mechanism of the **control** will be held in the reset position for the duration of the test from **9.4.12.102** to **9.4.12.104**. The verification of the automatic non-resetting above $-35\text{ }^{\circ}\text{C}$ will be carried out by **9.4.12.105** to **9.4.12.106**. For **SOD**, the verification

of the automatic non-resetting above either +0 °C or –35 °C will be carried out by **9.4.12.105** to **9.4.12.106**, as declared in item 103 of Table 1.

9.4.12.102 With the reset mechanism held in the reset position at room temperature, contact separation is observed by a low-energy circuit, 0,05 A maximum.

9.4.12.103 The **control's sensing element** is then installed in an air circulating chamber or liquid bath and the **control's switch head** is installed as in 16.5. When the whole **control** is declared as the **sensing element**, the whole **control** is placed in an air-circulating chamber. The control or the **control's sensing element** is adjusted for the maximum set point temperature. The chamber or liquid bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or liquid bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or liquid bath temperature is then raised at a rate of not more than 0,5 K per minute until 10 K over the operation temperature. Indication of contact separation is still observed by applying the method of **9.4.12.102**.

9.4.12.104 After the **control** has operated and with the reset mechanism still held in the reset position, the temperature of the chamber or liquid bath is then reduced to determine if the control automatically resets. Verification of contact closure is done by applying the method in **9.4.12.102**.

9.4.12.105 The whole **control** or the **control's sensing element** is then installed in an air circulating chamber or liquid bath again and the **control's switch head** (if applicable) is installed as in 16.5. with the reset mechanism in its normal condition. The chamber or liquid bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or liquid bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or liquid bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is *observed* by applying the method of **9.4.12.102**.

9.4.12.106 After the **control** has operated, the temperature of the chamber or liquid bath is allowed to cool down to either +0 °C or –35 °C. Indication of contact separation is observed by applying the method of 9.4.11.102.

9.4.13 Type 1.K or 2.K action (for sensing actions, no increase in the operating value as the result of a breakage in the sensing element, or in parts connecting the sensing element to the switch head)

Additional subclauses:

9.4.13.101 A type 2.K action shall be so designed that in the event of a break in the **sensing element**, or in any other part between the **sensing element** and the **switch head**, the declared disconnection or interruption is provided before the sum of the declared **operating value** and **drift** is exceeded.

Compliance is checked by a), b), and c)

- a) The **sensing element** is broken. Breaking may be achieved by partly cutting or filing through the **sensing element**.
- b) The temperature sensing control is heated to within 10K of the operating temperature.
- c) The temperature is increased at a rate not to exceed 1K/min where the contacts shall open before the sum of the declared operating value plus drift is exceeded.

9.4.13.102 Type 2.K action may also be achieved by compliance with a), b) or c).

- a) Two **sensing elements** operating independently from each other and actuating one switch head.

b) Bimetallic **sensing elements** with

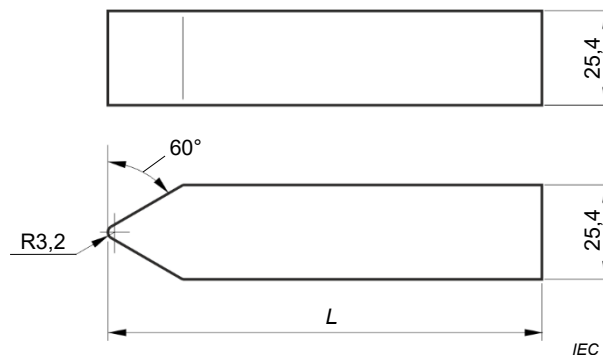
- 1) exposed elements attached with at least double spot welding of the bimetal at both of its ends, or
- 2) elements so located or installed in a **control** of such construction that the bimetal is not likely to be physically damaged during installation and use.

c) If the loss of the fluid fill causes the contacts of the **control** to remain closed or leakage causes upward shift beyond the declared maximum operating temperature, the bulb and capillary of a temperature **sensing control** which is actuated by a change in the pressure of a fluid confined in the bulb and capillary shall conform to the following.

There shall be no damage to the bulb or capillary to the extent which will permit escape of any of the fill when an impact **tool**, as illustrated in Figure 101, is dropped once from a height of 0,60 m so that the tapered end of the **tool** strikes the bulb or capillary in a perpendicular position. For this test, the capillary or the bulb shall be on a concrete surface.

If the capillary is provided with a separate shroud or sleeve, it is to be left in place during the test described above.

Dimensions in millimetres



Material: Steel, CRS, Break all corners

L to be sized to obtain total mass of 0,454 kg

Figure 101 – Impact tool

Additional subclauses:

9.4.101 Type 2.N action (a sensing action in which there is no increase in the operating value as a result of any leakage from the sensing element, or from parts connecting the sensing element to the switch head)

A type 2.N action shall be so designed that in the event of a leak in the **sensing element**, or in any other part between the **sensing element** and the **switch head**, the declared disconnection or interruption is provided before the sum of the declared **operating value** and **drift** is exceeded. *Compliance is checked by a), b), and c):*

- a) *The **operating value** of a type 2.N control is measured under the conditions of Clause 17 of Part 1 with the control set to the highest value (if it has a means for setting).*
- b) *A hole is artificially produced in the **sensing element**.*
- c) *The measurement of the **operating value** is repeated as in a) where no positive drift is allowed above the declared value.*

NOTE 1 The test can be replaced by theoretical computations of the physical mode of operation.

NOTE 2 A separate shroud or sleeve may be employed for protection of the bulb and capillary to achieve conformance with Clause 11

9.4.102 Type 2.P action (an action which operates after a declared thermal cycling test)

A type 2.P action shall be so designed that it operates in its intended manner after a thermal cycling test.

Compliance is checked by the test of 19.101.

NOTE In general, **thermal cut-outs** for specific applications, such as pressurized water heating systems, may be classified as having Type 2.P action.

9.4.103 Bimetallic single-operation device

A **bimetallic single-operation device** shall be so designed that it does not reset above the reset value declared in Table 1, requirement 103.

Compliance is checked by the test of 19.15.107.

9.4.104 Type 1.X or 2.X (an action which is initiated only after a push-and-turn actuation or pull-and-turn actuation and in which only rotation is required to return the actuating member to the OFF position or rest position)

A type 1.X or 2.X action shall be so designed that a turn action can only be accomplished after the completion of a push-action or a pull-action. Only rotation shall be required to return the **actuating member** of the **control** to the **OFF position** or rest position.

Compliance is checked by the tests of 20.101.

9.4.105 Type 1.Z or 2.Z (an action which is initiated only after a push-and-turn actuation or pull-and-turn actuation)

A type 1.Z or 2.Z action shall be so designed that a turn action can only be accomplished after the completion of a push-action or a pull-action.

Compliance is checked by the tests of 20.101.

9.4.106 Type 1.AK or 2.AK (an action which cannot be reset under electrically loaded conditions)

A **voltage maintained thermal cut-out** shall be so designed that it does not reset above the reset value declared in Table 1, requirement 111.

Compliance is checked by the tests of 19.15.106.

9.4.107 Type 1.AM or 2.AM (an action which operates after declared agricultural environmental exposures)

A type 1.AM or 2.AM action shall be so designed that it operates in its intended manner after the declared agricultural environmental exposures.

Compliance is checked by the tests of Annex DD.

9.6 Mounting of controls

9.6.3 Mounting of independently mounted controls

Additional subclause:

9.6.3.101 For agricultural thermostats declared in Table 1, requirement 117, the mounting method shall be such that the integrity of the protection by the enclosure is not compromised.

Additional subclause:

9.101 Time factor

If a **time factor** is declared, this shall be checked by one of the applicable determining methods as indicated in Annex BB. The determined value shall not exceed the rated values. See Table BB.1.

NOTE In Germany, for temperature **sensing controls** intended to control boiler water or flue gas temperature in heat generating systems, the maximum values of **time factor** given in Table BB.1 shall not be exceeded.

10 Threaded parts and connections

This clause of Part 1 is applicable.

11 Creepage distances, clearances and distances through solid insulation

This clause of Part 1 is applicable.

12 Components

This clause of Part 1 is applicable.

13 Fault assessment on electronic circuits

This clause of Part 1 is applicable except as follows:

13.1 Fault assessment for inherent safety

13.1.3 Component fault assessment

13.1.3.8 Compliance criteria

This clause of Part 1 is applicable except item c).

14 Moisture and dust resistance

This clause of Part 1 is applicable except as follows.

Additional subclauses:

14.101 Refrigeration controls

14.101.1 Controls which have the **switch head** and **sensing element** mounted in the evaporator of refrigeration or similar equipment, producing conditions of over temperature and of freezing and melting, shall maintain insulation integrity.

Compliance is checked by the tests of 14.101.2 to 14.101.6.

14.101.2 Controls which use a potting compound are given a softening test. Two samples are heated in a heating chamber at 15 K above the maximum declared operating temperature for 16 h with the potting surface in the most unfavourable position. The potting material shall not unduly soften or distort, crack or deteriorate.

14.101.3 The two samples used for the softening tests and one untested sample (three total) are placed in water maintained between $T_{\max}$ (maximum declared **switch head** ambient temperature) and either $(T_{\max} + 5) ^\circ\text{C}$ or 1,05 times $T_{\max}$, whichever is greater for 2 h. The three samples are then immediately transferred to water at a temperature of below $5 ^\circ\text{C}$ for 2 h and then frozen in a small, flexible container at a temperature between $T_{\min}$ (minimum declared switch head ambient temperature) and $(T_{\min} - 5) ^\circ\text{C}$ for 2 h. Ten heating-freezing cycles are required.

14.101.4 The tested samples shall be left in water at room temperature overnight after each completed heating-freezing cycle.

14.101.5 After the last freezing test, the samples are thawed to approximately room temperature in water and the insulation resistance is measured from current-carrying parts to grounded parts and to the surface of potting and/or insulating material; the direct current voltmeter method is used. Insulation resistance shall be at least 50 000 Ω .

14.101.6 While the samples are still moist, a voltage equal to $(2 \times V_R) + 1\,000\text{ V}$ is applied at rated frequency for 1 min between current-carrying parts and grounded parts and the surface of the potting and/or insulating material. No flashover or breakdown of insulation shall occur during the test.

15 Electric strength and insulation resistance

This clause of Part 1 is applicable

16 Heating

This clause of Part 1 is applicable except as follows.

16.4 Additional subclauses

16.4.101 For a **voltage maintained thermal cut-out**, the heating test of 16.4.c)1) is completed, after which the temperature of the **sensing element** is raised until the contacts open. At this time, the ambient temperature surrounding the **sensing element** is reduced to $T_{\max.1}$ (Table 1 req 109) in time period t_1 (Table 1 req 110), at a uniform rate. The test of 16.5.a) is then completed.

16.4.102 Where the whole **control** has been declared as the **sensing element** (see Table 1, requirement 41), the heating test, at the request of the manufacturer, need not be conducted until the successful completion of the tests in Clause 19.

Additional subclauses:

16.101 Controls used in or on cooking appliances, ovens of the self-cleaning type, or food-handling appliances only: As a means of complying with Note i) of Table 17, if the temperature of insulating parts exceeds that permitted in Table 17, the test of 19.15.101 may be conducted after the conditioning of a) or b).

a) An unenergized previously untested sample of the control is conditioned for 1 000 h in an oven maintained at a temperature between $1,02 T_1 + 20 \text{ K}$ and 1,05 times that temperature, where T_1 is the maximum measured temperature on the insulating part during the test of Clause 16.

b) In lieu of a), if the elevated temperature is localized, such as at or near a terminal, an unenergized control is conditioned for 1 000 h in an oven maintained at a temperature between $T_{\max}$ and $T_{\max} + 5 \%$ for normal conditions, but with the contacts closed and non-cycling. If necessary, the contacts may be forced closed to provide the most arduous temperature conditions. A bimetal heater across the mains is energized at 1,1 times rated voltage. A series bimetal heater shall conduct at 1,1 times rated current

17 Manufacturing deviation and drift

This clause of Part 1 is applicable.

18 Environmental stress

This clause of Part 1 is applicable except as follows:

Addition:

This clause is not applicable for **bimetallic SOD**.

19 Endurance

This clause of Part 1 is applicable except as follows:

19.3.1 Addition:

- for temperature **sensing controls** in which the whole **control** is declared as the **sensing element** and for which the minimum operating temperature declared in Table 1, requirement 48, is less than $0 \text{ }^{\circ}\text{C}$, the test of 19.8 is carried out on a further set of three samples at the minimum declared operating temperature with a tolerance of $+5 \text{ K}$, -0 K , the number of cycles being 5 % of the number declared in Table 1, requirement 20.

19.8.4 Additional subclause:

19.8.4.101 The number of automatic and manual cycles for independently mounted and in-line cord controls shall be as indicated in Clause CC.1, unless a higher number is declared by the manufacturer.

19.15 Test for particular purpose controls

Additional subclauses:

19.15.101 Thermostats

- 19.1 to 19.5 inclusive are applicable.
- 19.6 is applicable to actions classified as type 1.M or type 2.M, the value of "X" being $(5 \pm 1) \text{ K}$ or $\pm 5 \%$ of the original **activating quantity**, whichever is greater.
- 19.7 is applicable.
- 19.8 is applicable.
- 19.9 is applicable, but only to slow-make, slow-break **automatic actions**.

- 19.10 to 19.13 inclusive are applicable, but only to those **thermostats** which have a **manual action** (including an **actuating means** providing **setting by the user**).
- 19.14 is applicable for all temperature **sensing controls**. In addition to the criteria stated in 19.14, temperature **sensing controls** specified under 16.4.c)5) shall comply with the requirements of Clause 16.

19.15.102 Temperature limiters

- 19.1 to 19.5 inclusive are applicable.
- 19.6 is applicable to actions classified as type 1.M or type 2.M, the value of "X" being (5 ± 1) K, or ± 5 % of the original **activating quantity**, whichever is greater.
- 19.7 and 19.8 are applicable, except that, where necessary, the reset **operation**, if required, is obtained by **actuation**. This **actuation** shall be as specified in 19.4 for accelerated speed, as soon as permitted by the mechanism, or as declared by the manufacturer in Table 1, requirement 31.
- 19.9 is applicable, but only to **temperature limiters** with slow-make, slow-break **automatic actions**, the same conditions for manual reset as specified above for 19.7 and 19.8 being used.
- 19.10 to 19.13 inclusive do not apply to the normal reset **manual action**, which is tested during the automatic tests of 19.7 to 19.9 inclusive. If the **temperature limiter** has other **manual actions** which are not tested during the automatic tests, then these subclauses are applicable.
- 19.14 is applicable for all temperature **sensing controls**. In addition to the criteria stated in 19.14, temperature **sensing controls** specified under 16.4.c)1) shall comply with the requirements of Clause 16.

19.15.103 Thermal cut-outs

- 19.1 to 19.5 inclusive are applicable.
- 19.6 is applicable to actions classified as type 2.M, the value of "X" being (5 ± 1) K, or ± 5 % of the original **activating quantity**, whichever is greater.
- 19.7 and 19.8 are applicable, except that, where necessary, the reset **operation**, if required, is obtained by **actuation**.
- This **actuation** shall be as specified in 19.4 for accelerated speed, as soon as permitted by the mechanism, or as declared by the manufacturer in Table 1, requirement 31.
- 19.9 is applicable, but only to **thermal cut-outs** with slow-make, slow-break **automatic actions**, the same conditions for manual reset as specified above for 19.7 and 19.8 being used.
- 19.10 to 19.13 inclusive do not apply to the normal reset **manual action**, which is tested during the automatic tests of 19.7 to 19.9 inclusive. If the **thermal cut-out** has other **manual actions** which are not tested during the automatic tests, then these subclauses are applicable.
- 19.14 is applicable for all **controls**. In addition to the criteria stated in 19.14, **controls** specified under 16.4.c)1), shall comply with the requirements of Clause 16.

– 19.15.106 is applicable to voltage maintained thermal cut-outs

19.15.104 Evaluation of materials

The **control** shall comply with 19.5 after being subjected to the tests of 19.7 for 50 **operations** and 19.8 for 1000 **operations** under the conditions as indicated in 16.101 a).

19.15.105 Over-temperature test of sensing element

For **controls** declared under Table 1, requirement 105, the **control** shall comply with 19.14 after the **sensing element** portion of a previously untested sample is exposed to 250 thermal cycles.

- The test ambient temperature is varied between 40 °C and T_e where T_e is declared in Table 1 requirement 105.

- The maximum rate of temperature change is declared in Table 1, requirement 31.

- The extremes of temperature are maintained for 30 min.

19.15.106 Voltage maintained thermal cut-out

Six untested **voltage maintained thermal cut-outs** are conditioned for 7 h at a temperature of -20 °C (or lower, if declared in Table 1 req 111).

During and at the conclusion of the conditioning, none of the six samples shall have operated.

Operation of the **voltage maintained thermal cut-outs** shall be detected as indicated in H.17.5.3.107.

These requirements apply to a **voltage maintained thermal cut-out** in the operated condition with the voltage across it.

19.15.107 Single operation devices**19.15.107.1 Bimetallic single operation devices.**

19.15.107.1.1 Bimetallic single operation devices are subject to the following tests:

19.15.107.1.2 After the appropriate tests of Clause H.17, the same six samples shall be maintained at -35 °C or 0 °C as declared in Table 1, requirement 103, for 7 h. The devices shall not reset during this period, which is determined by the test of H.17.5.3.109.

19.15.107.1.3 Six untested bimetallic single operation devices are conditioned for 720h at 90% of the declared operating value in °C (+/- 1K) or 7K +/- 1K below the declared operating value, whichever is lower. The devices must comply with both a) and b):

- a) During conditioning the SOD's shall not operate as indicated in H.17.5.3.107

- b) Following conditioning, the appropriate tests of H.17 shall be repeated on all six SOD's, where the temperature measured shall be within the declared deviation limits.

19.15.107.1.4 For **bimetallic single operation devices** with a declared reset temperature of -35 °C, six untested samples shall be subjected to an over-voltage test for one cycle under the electrical conditions of Table 18 or Table 19 as appropriate, and then the test of H.17.5.3.109 shall be repeated.

19.15.107.1.5 For **bimetallic single operation devices** with a declared reset temperature of 0 °C, one sample shall be subjected to an over-voltage test of 50 cycles under the electrical conditions of Table 18 or Table 19, as appropriate.

- a) One sample shall be subjected to an over-voltage test of 50 cycles under the electrical conditions of Table 18 or Table 19 as appropriate

b) The sample from a) is subjected to the number of cycles declared in Table 1 requirement 104, at rated current and voltage

c) The sample from b) shall comply with the appropriate tests of H.17 where the temperature measured shall be within the declared deviation limits.

*Note: The purpose of the tests of 19.15.107.1.5 is to evaluate the device under unintended **operation** caused by exposure to temperatures below 0 °C. In order to achieve cycling, it is suggested that the test be conducted in a test chamber which permits decrease of the ambient temperature to the declared reset value and increase of the ambient temperature to the normal **operating value**.*

19.15.107.2 Non-bimetallic SODs

19.15.107.2.1 For a **non-bimetallic SOD**, automatic temperature sensing functions except those for the non-bimetallic part of the **control** (such as **thermostat**, **temperature limiter** and/or the **thermal-cut-out**), shall comply with 19.15.101, 19.15.102 and 19.15.103 respectively where the tests of each clause may be conducted on separate samples.

19.15.107.2.2 Six untested samples shall be mounted in a suitable apparatus and the thermal **sensing elements** are conditioned for an ageing period equal to either 750 h or the result of the specified number of cycles declared by the end product application divided by 4 (calculation value is the number of hours), whichever is greater, at the temperature declared in Table 1, requirement 115, – 5 K.

a) During the ageing period, the **SODs** shall not operate as indicated in H.17.5.3.107.

b) At the end of the ageing period, the samples are removed from the apparatus and the appropriate tests of Clause H.17 shall be conducted on the six samples plus an additional six untested samples. The temperatures measured shall be within the declared deviation limits, with the electrical conditions of the test V_{Rmax} and I_{Rmax} .

c) For **non-bimetallic SODs** where the **sensing element** has a declared reset temperature, the **SODs** shall be held at the temperature declared in Table 1 and the test will continue for 7 h. The device shall not reset during this period as indicated in H.17.5.3.109.

d) All samples shall then be subjected to the test of Clause H.15, carried out at the temperature limits declared in Table 1, requirement 30.

NOTE: The apparatus used for the tests of 19.15.107.2.2 should be constructed so that heat can be applied to the thermal **sensing element** of the **SOD** whilst taking care that other parts of the **control** are protected from exposure to temperatures in excess of their intended use.

Additional subclauses:

19.101 Type 2.P cycling test

19.101.1 Thermal Cycling

Following the appropriate tests of 19.15 and the evaluation of 19.14, the **control** is subjected to a thermal cycling test of 50 000 cycles at a temperature maintained between 50 % and 90 % of the switch-off temperature recorded in 19.14. During this test, the **switch head** is maintained at $(20 \pm 5) ^\circ\text{C}$.

The manufacturer shall declare whether the method of 19.101.2 or 19.101.3 is to be used.

The test shall be carried out in accordance with the manufacturer's declaration in Table 1, requirement 112.