

Safety and control devices for gas burners and gas burning appliances — General requirements

ICS 23.060.40

National foreword

This British Standard is the UK implementation of EN 13611:2007+A2:2011. It supersedes BS EN 13611:2007 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A2 is indicated by A2 A2.

The UK participation in its preparation was entrusted to Technical Committee GSE/22, Safety and control devices for gas and oil burners and gas burning appliances.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2007

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ISBN 978 0 580 70536 6

Amendments/corrigenda issued since publication

Date	Comments
30 November 2011	Implementation of CEN amendment A2:2011

English Version

Safety and control devices for gas burners and gas burning appliances - General requirements

Équipements auxiliaires pour brûleurs à gaz et appareils à gaz - Exigences générales

Sicherheits-, Regel- und Steuereinrichtungen für Gasbrenner und Gasgeräte - Allgemeine Anforderungen

This European Standard was approved by CEN on 7 October 2007 and includes Amendment 1 approved by CEN on 5 June 2011 and Amendment 2 approved by CEN on 29 July 2011.

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Foreword

This document (EN 13611:2007+A2:2011) has been prepared by Technical Committee CEN/TC 58 “Safety and control devices for gas-burners and gas-burning appliances”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2012, and conflicting national standards shall be withdrawn at the latest by April 2012.

This document includes Amendment 1, approved by CEN on 2011-06-05 and Amendment 2, approved by CEN on 2011-07-29.

This document supersedes A2 EN 13611:2007 A2.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1 and A2 A2.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directive(s), see informative Annexes ZA or B, which are an integral part of this document.

For additional requirements for safety accessories and pressure accessories as defined in EU-Directive 97/23/EC see normative Annex F.

For controls used in DC supplied gas burners and gas burning appliances see additional requirements in normative Annex I.

This European Standard covers type testing only.

Tests intended for production testing are not specifically included.

This standard recognizes the safety level specified by CEN/TC 58 and is regarded as a horizontal standard dealing with the safety, construction and performance of controls for gas burners and gas burning appliances and to their testing.

A2 Primarily in industrial applications it is common practice to rate the safety of a plant based on values describing the likelihood of a dangerous failure. These values are being used to determine Safety Integrity Levels or Performance Levels when the system is being assessed in its entirety.

CEN/TC 58 standards for safety relevant controls do go beyond this approach, because for a certain life span for which the product is specified, designed and tested a dangerous failure is not allowed at all. Failure modes are described and assessed in greater detail. Measures to prevent from dangerous situations are defined. Field experience over many decades is reflected in the CEN/TC 58 standards. Requirements of these standards can be considered as proven in practice.

To be able to provide values for the parameters that are needed for Safety Integrity Level or Performance Level system assessment, the Annexes J and K of this document specifies a possible methodology to derive values for the relevant parameters from the requirements of this European Standard.

Only controls that comply with the relevant CEN/TC 58 control standard can be assessed for PL classification according to this amendment.

It cannot be presumed that any Safety Integrity Level or Performance Level assessment alone would imply that requirements of a CEN/TC 58 standard have been met.

For particularly slow and long term cycling controls the test method might result in testing durations which are not feasible. An interim appropriate solution would be to determine suitable service intervals (see also EN ISO 13849-1). The responsible working group of CEN/TC 58 aim to find more representative test methods in the short term for specific scenarios. 

This European Standard should be used in conjunction with the specific standard for a specific type of control, (e. g. EN 88-1, EN 88-2, EN 125, EN 126, EN 161, EN 257, EN 298, EN 1106, EN 1643, EN 1854, EN 12067-1 and EN 12067-2, EN 12078) or for controls for specific applications. This standard may also be applied, so far as reasonable, to controls not mentioned in a specific standard and to controls designed on new principles, in which case additional requirements may be necessary.

Other control standards should make use of this standard by adapting this standard and stating "addition", "modification" or "replacement" in their corresponding clauses.

This 2nd edition of EN 13611 includes EN 13611:2000/A1:2004 and new 6.5 Electric parts of the control and 6.6. Protection against internal faults for the purpose of functional safety. Annex G contains a list of materials which meet the essential requirements of Pressure Equipment Directive (PED).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies safety, construction, and performance requirements and testing of safety control or regulating devices and sub-assemblies or fittings (hereafter referred to as controls) for burners and gas burning appliances using fuel gases of the first, second or third families and to their testing.

Controls to which this European Standard applies include the following:

- automatic shut-off valves;
- automatic burner control systems;
- flame supervision devices;
- gas/air ratio controls;
- pressure regulators;
- manual taps;
- mechanical thermostats;
- multifunctional controls;
- pressure sensing devices;
- valve proving systems;
- zero pressure regulators.

The methods of test given in this standard are intended for product type testing.

For DC supplied controls Annex H applies.

NOTE 1 When no particular control standard exists, the control can be tested according to this standard and further tests taking into account the intended use.

NOTE 2 This European Standard should be used in conjunction with the specific control standard (see Bibliography).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 549, *Rubber materials for seals and diaphragms for gas appliances and gas equipment*

EN 10028-2:2003, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2003, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2003, *Flat products made of steels for pressure purposes — Part 4: Nickel alloy steels with specified low temperature properties*

EN 10028-5:2003, *Flat products made of steels for pressure purposes — Part 5: Weldable fine grain steels, thermomechanically rolled*

EN 10028-6:2003, *Flat products made of steels for pressure purposes — Part 6: Weldable fine grain steels, quenched and tempered*

EN 10028-7:2007, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

EN 10213-3:1995, *Technical delivery conditions for steel castings for pressure purposes — Part 3: Steel grades for use at low temperatures*

EN 10222-1:1998, *Steel forgings for pressure purposes — Part 1: General requirements for open die forgings*

EN 10222-5:1999, *Steel forgings for pressure purposes — Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels*

EN 10272:2000, *Stainless steel bars for pressure purposes*

EN 13906-1, *Cylindrical helical springs made from round wire and bar — Calculation and design — Part 1: Compression springs*

EN 13906-2, *Cylindrical helical springs made from round wire and bar — Calculation and design — Part 2: Extension springs*

EN 60068-2-6, *Environmental testing — Part 2: Tests — Tests Fc: Vibration (sinusoidal) (IEC 60068-2-6:1995 + Corrigendum 1995)*

EN 60127-1, *Miniature fuses — Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links (IEC 60127-1:2006)*

EN 60335-1:2002, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2001, modified)*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 60730-1:2000, *Automatic electrical controls for household and similar use — Part 1: General requirements (IEC 60730-1:1999, modified)*

EN 60947-5-1:2004, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices (IEC 60947-5-1:2003)*

EN 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test — Basic EMC publication (IEC 61000-4-2:1995)*

EN 61000-4-3, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3:2006)*

EN 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test (IEC 61000-4-4:2004)*

EN 61000-4-5, *Electromagnetic compatibility (EMC) — Part 4-5: Testing and measurement techniques — Surge immunity test (IEC 61000-4-5:2005)*

EN 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:2003 + A1:2004 + A2:2006)*

EN 61000-4-8, *Electromagnetic compatibility (EMC); part 4: testing and measurement techniques; section 8: power frequency magnetic field immunity test; basic EMC publication (IEC 61000-4-8:1993)*

EN 61000-4-11, *Electromagnetic compatibility (EMC) — Part 4-11: Testing and measurement techniques — Voltage dips, short interruptions and voltage variations immunity tests (IEC 61000-4-11:2004)*

EN 61000-4-29, *Electromagnetic Compatibility (EMC) — Part 4-29: Testing and measurement techniques; Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests (IEC 61000-4-29:2000)*

EN 61558-2-6, *Safety of power transformers, power supply units and similar — Part 2-6: Particular requirements for safety isolating transformers for general use (IEC 61558-2-6:1997)*

EN 61558-2-17, *Safety of power transformers, power supply units and similar — Part 2-17: Particular requirements for transformers for switch mode power supplies (IEC 61558-2-17:1997)*

EN ISO 228-1:2003, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*

ISO 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 65, *Carbon steel tubes suitable for screwing in accordance with ISO 7-1*

ISO 262, *ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts*

ISO 301, *Zinc alloy ingots intended for casting*

ISO 7005 (all parts), *Metallic flanges*

ISO 7637-2, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

ISO 7637-3, *Road vehicles — Electrical disturbance by conduction and coupling — Part 3: Vehicles with nominal 12 V or 24 V supply voltage — Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines*

IEC 61643-1, *Low-voltage surge protective devices — Part 1: Surge protective devices connected to low-voltage power distribution systems — Requirements and tests*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

control

device which directly or indirectly controls the gas flow and/or provides a safety function within a gas burner or gas-burning appliance

3.2

control function

function providing safe operation of gas burners and gas burning appliances

3.3

closure member

movable part of the control which shuts off the gas flow

3.4

external leak-tightness

leak-tightness of a gas-carrying compartment with respect to atmosphere

3.5

internal leak-tightness

leak-tightness of the closure member (in the closed position) sealing a gas-carrying compartment with respect to another compartment or to the outlet of the control

3.6

inlet pressure

pressure at the inlet of the control

3.7

outlet pressure

pressure at the outlet of the control

3.8

pressure difference

difference between the inlet and outlet pressures

3.9

maximum inlet pressure

highest inlet pressure declared by the manufacturer at which the control may be operated

3.10

minimum inlet pressure

lowest inlet pressure declared by the manufacturer at which the control may be operated

3.11

flow rate

volume flowing through the control in unit time

3.12

rated flow rate

air flow rate at a specified pressure difference declared by the manufacturer, corrected to standard conditions

3.13

maximum ambient temperature

highest temperature of the surrounding air declared by the manufacturer at which the control may be operated

3.14

minimum ambient temperature

lowest temperature of the surrounding air declared by the manufacturer at which the control may be operated

3.15

mounting position

position declared by the manufacturer for mounting the control

3.16

nominal size

DN

numerical designation of size, for reference purposes, loosely related to manufacturing dimensions, common to all components in a piping system

[ISO 6708:1995]

3.17

apparatus

single piece of equipment with (a) direct function(s) intended for final use

3.18

system

combination of apparatus and/or active components constituting a single functional unit and intended to be installed and operated to perform (a) specific task(s)

3.19

installation

combination of apparatuses, components and systems assembled and/or erected (individually) in a given area

NOTE For physical reasons (e. g. long distances between individual items) it is in many cases not possible to test an installation as a unit.

3.20

fault tolerating time

time between the occurrence of a fault and the shut down of the burner, which is tolerated by the application without creating a hazardous situation

NOTE Actions other than shut down of a burner are possible if they can show prevention of hazardous situations.

3.21

fault reaction time

time for a control function, within the fault tolerating time, to react on a fault and initiate a shut down

3.22

normal operation

use of the control or its associated equipment for the purpose for which it was made and in the manner intended by the manufacturer under the conditions as specified

3.23

defined state

state of a control with the following characterisation:

- a) control passively assumes a state in which the output terminals ensure a safe situation under all circumstances. When the cause of the transition to defined state is lifted the application starts up only in accordance with the appropriate requirements or
- b) control actively executes a protective action, within the time as specified for the specific control standard, causing it to shut down and/or lock-out or
- c) control remains in operation, continuing to satisfy all safety related functional requirements.

3.24

complex electronics

denote assemblies which use electronic components with the following characteristics:

- a) Component provides more than one functional output.
- b) It is impractical or impossible to represent the failure mode of such a component by stuck-at and cross-links at the pins or by other failure modes which are described in Annex E.

3.25

reset

action which provides reset from lock-out to allow the system to attempt a restart

3.26

failure

termination of the ability of an item to perform a required function

[191-14-01 of IEC 60050-191:1990]

3.27

degradation

undesired departure in the operational performance of any device, equipment or system from its intended performance

[161-11-19 of IEC 60050-161:1990]

NOTE The term "degradation" can apply to temporary or permanent failure.

3.28

fault

state of an item characterised by its inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

NOTE 1 „Failure“ is an event, as distinguished from „fault“, which is a state.

NOTE 2 After failure the item has a fault.

NOTE 3 This concept as defined does not apply to items consisting of software only.

NOTE 4 A fault is often the result of a failure of the item itself, but may exist without prior failure.

[IEC 60191-1]

3.29

harm

physical injury and/or damage to health or property

[ISO/IEC Guide 51:1999]

3.30

hazard

potential source of harm

[ISO/IEC Guide 51:1999]

3.31

risk

probable rate of occurrence of a hazard causing harm and the degree of severity of the harm

[ISO/IEC Guide 51:1999]

3.32

functional safety

safety related to the application which depends on the correct functioning of the safety-related control

3.33

program

sequence of control operations

NOTE It may consist of switching on, starting up, supervising and switching off, safety shut down or lock out.

3.34

breather hole

orifice which allows atmospheric pressure to be maintained within a compartment of variable volume

4 Classification

4.1 Classes of control

Where appropriate, controls are classified by application (e. g. sealing force, performance characteristics, number of operations during their working life). For classification of controls, see also the specific control standard.

4.2 Groups of control

Controls are grouped according to the bending stresses which they are required to withstand (see Table 4).

Group 1 controls

- Controls for use in an appliance or installation where they are not subjected to bending stresses imposed by installation pipework (e. g. by the use of rigid adjacent supports).

Group 2 controls

- Controls for use in any situation, either internal or external to the appliance, typically without support.

NOTE Controls which meet the requirements of a group 2 control also meet the requirements of a group 1 control.

4.3 Classes of control functions

For the evaluation of protective measures for fault tolerance and avoidance of hazards it is necessary to classify control functions with regard to their fault behaviour.

At the classification of control functions their integration into the complete safety concept of the appliance shall be taken into account.

For the purpose of evaluating the design of a control function, present requirements recognise three distinct classes:

Class A: Control functions which are not intended to be relied upon for the safety of the application,

NOTE Examples are: room thermostats, temperature control.

Class B: Control functions which are intended to prevent an unsafe state of the appliance. Failure of the control function will not lead directly to a hazardous situation,

NOTE Examples are: thermal limiter, pressure limiter.

Class C: Control functions which are intended to prevent special hazards such as explosion or whose failure could directly cause a hazard in the appliance.

NOTE Examples are: burner control systems, thermal cut-outs for closed water systems (without vent protection).

5 Units of measurement and test conditions

5.1 Dimensions

Dimensions are given in millimetres.

5.2 Pressures

Pressures are static pressures relative to atmospheric pressure and are given in Pa or kPa (millibars or bars)¹⁾.

5.3 Bending moments and torques

Bending moments and torques are given in Newton metres.

5.4 Test conditions and measurement tolerances

Tests are carried out with air at $(20 \pm 5) ^\circ\text{C}$.

All measured values are corrected to the standard conditions:

15 °C, 101,325 kPa (1013,25 mbar) dry.

Controls which can be converted to another gas family by exchanging components are additionally tested with the conversion components.

Tests are carried out in the mounting position declared by the manufacturer. Where there are several mounting positions, tests are carried out in the least favourable position.

Where possible those tests already covered by other standards (e. g. EN 60730-series) shall be combined.

Further test conditions are:

- rated voltage or rated voltage range;
- rated frequency;
- ambient temperature at $(20 \pm 5) ^\circ\text{C}$.

The error of measurement shall not exceed:

- for time measurements: $\pm 0,1 \text{ s}$;
- for temperature measurements: $\pm 1 \text{ K}$;
- for supply frequency measurements: $\pm 0,1 \text{ Hz}$;
- for electrical supply measurements: $\pm 0,5 \%$.

All measurements shall be made after stable temperature conditions have been achieved.

¹⁾ 1 mbar = 100 N/m² = 100 Pa

6 Construction requirements

6.1 General

Controls shall be designed, manufactured, and assembled so that the various functions operate correctly when installed and used according to the manufacturer's instructions.

All pressurized parts of a control shall withstand the mechanical and thermal stresses to which it is subjected without any deformation affecting safety.

In general conformity with the requirements given in this standard is verified by the methods of test given in this standard or the specific control standard.

6.2 Mechanical parts of the control

6.2.1 Appearance

Controls shall be free from sharp edges and corners which could cause damage, injury or incorrect operation. All parts shall be clean internally and externally.

6.2.2 Holes

Holes for screws, pins, etc., used for the assembly of parts of the control or for mounting, shall not penetrate gas ways. The wall thickness between these holes and gas ways shall be at least 1 mm.

Holes necessary for manufacture which connect gas ways to atmosphere but which do not affect the operation of the control shall be permanently sealed by metallic means. Suitable jointing compounds may additionally be used.

6.2.3 Breather holes

Breather holes in controls with diaphragms, which are not provided with a connection for a vent pipe, shall be designed in such a way that when the diaphragm is damaged, air does not escape at a rate of more than 70 dm³/h at the maximum inlet pressure.

Conformity shall be verified by the method given in 6.2.4

For maximum inlet pressures below 3 kPa (30 mbar), this requirement is deemed to be met if the diameter of the breather hole does not exceed 0,7 mm.

If a leakage rate limiter is used, it shall be able to withstand three times the maximum inlet pressure. If a safety diaphragm is used as a leakage rate limiter, it shall not take the place of the working diaphragm if there is a fault.

Breather holes shall be protected against blockage or they shall be located such that they do not easily become blocked. They shall be positioned in such a way that the diaphragm cannot be damaged by a sharp device inserted through the breather hole.

6.2.4 Test for leakage of breather holes

Rupture the dynamic part of the working diaphragm. Ensure all closure members of the control, if any, are in the open position. Pressurize all gas-carrying compartments to the maximum inlet pressure and measure the leakage rate.

6.2.5 Screwed fastenings

Screwed fastenings which may be removed for service or adjustment shall have metric threads that conform to ISO 262 unless a different thread is essential for the correct operation or adjustment of the control.

Self-tapping screws which cut a thread and produce swarf shall not be used for connecting gas-carrying parts or parts which may be removed for service.

Self-tapping screws which form a thread and do not produce swarf may be used provided that they can be replaced by metric machine screws conforming to ISO 262.

6.2.6 Jointing

Jointing compounds for permanent assemblies shall remain effective under normal operating conditions.

Soldering or other processes where the jointing material has a melting point below 450 °C after application shall not be used for connecting gas-carrying parts except for additional sealing.

6.2.7 Moving parts

The operation of moving parts (e. g. diaphragms, bellows) shall not be impaired by other parts. There shall be no exposed moving parts which could adversely affect the operation of controls.

6.2.8 Sealing caps

Sealing caps shall be capable of being removed and replaced with commonly available tools and sealed (e. g. by lacquer). A sealing cap shall not hinder adjustment within the whole range declared by the manufacturer.

6.2.9 Dismantling and reassembly

Parts which need to be dismantled for service or adjustment shall be capable of being dismantled and reassembled using commonly available tools. They shall be constructed or marked in such a way that incorrect assembly is impossible when following the manufacturer's instructions.

Closure parts, including those of measuring and test points, which may be dismantled for service or adjustment shall be constructed such that leak-tightness is achieved by mechanical means (e. g. metal-to-metal joints, O-rings) without using jointing compounds such as liquids, pastes or tapes.

Closure parts not intended to be dismantled shall be sealed by means which will show evidence of interference (e. g. lacquer).

6.3 Materials

6.3.1 General material requirements

The quality of materials, the dimensions used and the method of assembling the various parts shall be such that construction and performance characteristics are safe. Performance characteristics shall not alter significantly during a reasonable life when installed and used according to the manufacturer's instructions. Under these circumstances, all components shall withstand any mechanical, chemical, and thermal conditions to which they may be subjected during service.

6.3.2 Housing

Parts of the housing which directly or indirectly separate a gas-carrying compartment from atmosphere shall either:

— be made from metallic materials, or

- on removal or fracture of non-metallic parts other than O-rings, gaskets and sealing parts of diaphragms, no more than 30 dm³/h of air escapes at the maximum inlet pressure.

When inside the housing a diaphragm separates the gas-carrying compartment from atmosphere than this is considered to be indirectly separated.

6.3.3 Test for leakage of housing after removal of non-metallic parts

Remove all non-metallic parts of the housing which separate a gas-carrying compartment from atmosphere, excluding O-rings, gaskets and sealing part of diaphragms. Pressurize the inlet and outlet(s) of the control to the maximum inlet pressure and measure the leakage rate.

6.3.4 Zinc alloys

Zinc alloys shall only be used for gas-carrying parts of controls up to DN 50 with maximum working pressures up to 20 kP (200 mbar) and of quality ZnAl4 that conforms to ISO 301 where the parts do not exceed a temperature of 80 °C. Where the main inlet or outlet threaded connections are made of zinc alloys, threads shall be external and conform to EN ISO 228-1.

6.3.5 Springs providing closing and/or sealing force

Closing force and sealing force shall be provided by spring action.

Springs providing the sealing and/or closing force for any closure member of the control shall be made of corrosion-resistant materials and shall be designed for static and dynamic loading according to EN 13906-1 or EN 13906-2.

Springs with wire diameter up to and including 2,5 mm shall be made from corrosion-resistant materials.

Springs with wire diameter above 2,5 mm shall either be made from corrosion-resistant materials or shall be protected against corrosion.

6.3.6 Resistance to corrosion and surface protection

All parts in contact with gas or atmosphere and springs other than those covered by 6.3.5, shall either be made from corrosion-resistant materials or shall be suitably protected. The corrosion protection for springs and other moving parts shall not be impaired by any movement.

6.3.7 Impregnation

Where impregnation is part of the manufacturing process, it shall be carried out using an appropriate procedure, (e. g. vacuum or internal pressure, using appropriate sealing materials).

6.3.8 Seals for glands for moving parts

Seals for moving parts which pass through the body to atmosphere and seals for closure members shall be made only of solid, mechanically stable material of a type which does not deform permanently. Sealing paste shall not be used.

Manually adjustable packing glands shall not be used for sealing moving parts.

NOTE An adjustable gland set by the manufacturer and protected against further adjustment is considered to be non-adjustable.

Bellows shall not be used as the sole sealing element against atmosphere.

6.4 Gas connections

6.4.1 Making connections

It shall be possible to make all gas connections using commonly available tools, e. g. by the provision of suitable spanner flats.

6.4.2 Connection sizes

Equivalent connection sizes are given in Table 1.

Table 1 — Connection sizes

Thread or flange nominal size DN	Thread or flange designation inches	Compression fitting tube outside diameter range mm
6	1/8	2 to 5
8	1/4	6 to 8
10	3/8	10 to 12
15	1/2	14 to 16
20	3/4	18 to 22
25	1	25 to 28
32	1 1/4	30 to 32
40	1 1/2	35 to 40
50	2	42 to 50
65	2 1/2	—
80	3	—
100	4	—
125	5	—
150	6	—
200	8	—
250	10	—

Controls above DN 80 shall be flanged to ISO 7005.

NOTE In some countries there is a requirement for flanged connections above DN 50.

6.4.3 Threads

Inlet and outlet threads shall be according to ISO 7-1 or to EN ISO 228-1 and shall be chosen from the series given in Table 1.

NOTE Additional information on the use of these threads is given in Annex A.

6.4.4 Union joints

Where connections are made with union joints either the joints shall be included with the control or full details shall be supplied if the threads do not conform to ISO 7-1 or EN ISO 228-1.

6.4.5 Flanges

Where flanges are used on controls above DN 50, they shall be suitable for connection to flanges to ISO 7005, PN 6 or PN 16.

Where flanges are used on controls up to and including DN 50 which are not suitable for connection to flanges to ISO 7005, either suitable adapters shall be supplied to enable connection to standard flanges and threads, or full details of mating parts shall be supplied.

6.4.6 Compression fittings

If compression fittings are used, it shall not be necessary to form the tubes before making connections. Olives shall be appropriate to the tubes for which they are intended. Non-symmetrical olives may be used provided they cannot be fitted incorrectly.

6.4.7 Nipples for pressure test

Pressure test nipples shall have an external diameter of $9^{+0}_{-0.5}$ mm and a useful length of at least 10 mm for connection to tubing. The equivalent diameter of the bore shall not exceed 1 mm.

6.4.8 Strainers

Where an inlet strainer is fitted the maximum strainer hole dimension shall not exceed 1,5 mm and it shall prevent the passage of a 1 mm diameter pin gauge.

Where an inlet strainer is not fitted, the installation instructions shall include relevant information on the use and installation of a strainer conforming to the above requirements, to prevent the ingress of foreign matter.

6.5 Electronic parts of the control

6.5.1 General

The electrical components shall be designed for their intended use.

The quality of the materials, the design, and structure of the components used shall be such that the system will operate safely and in accordance with the requirements of this standard for a reasonable period of time (service life). That shall continue under the mechanical, chemical, thermal and environmental conditions normally expected, even in the event of such carelessness as may occur in normal use. This is provided that compliance with the manufacturer's instructions for installation, adjustment, operation and maintenance is assured. Compliance is checked by carrying out the tests specified in this standard.

The system shall be designed such that changes in critical circuit component values (such as those affecting timing or sequence) within the component manufacturer's declared worst case tolerances, including the long term stability, shall result in the system continuing to function in accordance with this standard. Compliance shall be checked by worst case analysis.

For class C control functions the system shall include at least two operating elements to directly de-energize the safety related output terminals to ensure a safe situation under all circumstances.

NOTE A single relay switching two independent contacts is considered to be only one operating element.

6.5.2 Protection provided by the enclosure

The degree of protection for systems with their own enclosure shall be a minimum of EN 60529 IP 40 or protection shall be provided by the appliance in which it is installed. For systems for use in the open air the protection shall conform to at least EN 60529 IP 54.

6.5.3 Electrical components

6.5.3.1 Performance of electrical components

The electrical components shall be designed for their intended use.

Components shall be dimensioned on the basis of the worst-case conditions which can arise in the control, as stated by the manufacturer.

6.5.3.2 Test

An examination of the circuit shall be carried out according to the requirements of 6.6 and Annex E.

6.5.3.3 Sensing element

Sensing elements shall remain suitable and reliable during the product's lifetime with respect to its intended purpose (e.g. the surface of a temperature sensing element shall remain suitable and reliable during the product's lifetime with respect to heat transfer).

Interchange of wiring and changing of polarity of wiring shall be prevented or the effect shall be controlled whenever interchange can lead to a hazard. Connectors with a polarity key are considered to be a preventative measure.

The physical value as detected by the sensing element shall not be influenced significantly by the measurement method compared to the declared deviation according to the specific control standard.

6.6 Protection against internal faults for the purpose of functional safety

6.6.1 Design and construction requirements

6.6.1.1 Fault avoidance and fault tolerance

Controls shall be designed in accordance with 6.6 (taking into account the failure modes of Annex E) and in accordance with EN 60730-1:2000, Annex H.11.12 for complex electronics.

Failures of complex electronics can be caused by either systematic errors (built into the design) or by random faults (component faults). Therefore, the system shall be designed in such a way that systematic errors are avoided and random faults shall be dealt with by a proper system configuration.

The design of the software and hardware shall be based on the functional analysis of the application resulting in a structured design explicitly incorporating the control flow, data flow and time related functions required by the application. In the case of custom-chips special attention is required with regard to measures taken to minimize systematic errors.

The result shall be a system configuration which is either inherently fail safe or in which components with direct safety-critical functions (e. g. gas valve drivers, microprocessors with their associated circuits, etc.) are guarded by safeguards (in accordance to EN 60730-1:2000, Annex H, Software class B or C). These safeguards shall be built into hardware (e. g. watch-dog, supply voltage supervision) and can be supplemented by software (e. g. ROM-test, RAM-test, etc.). It is important that these safeguards can cause a completely independent safety-shut-down. Reaction times of these safeguards shall be equal or smaller than the relevant fault tolerating time.

If time slot monitoring is used, it shall be sensitive to both an upper and a lower limit of the time interval. Faults resulting in shift of the upper and/or lower limit shall be taken into account.

In case of a control that is classified as class C, if a single fault in a primary safeguard can render the safeguard inoperative, a secondary safeguard shall be provided. The reaction time of the secondary safeguard shall be in accordance with 6.6.4

NOTE 1 The secondary guarding can be realised by:

- a) a physically separate circuit monitoring the primary safeguard; or
- b) mutual action between the circuit being safeguarded and the primary safeguard (e. g. a watch-dog guarded by the microprocessor); or
- c) action between primary safeguards (e. g. a ROM-test guarding a RAM-test).

For lock-out function with a mechanical actuator a test up to, but not including the switching contacts, is sufficient. If the test of the lock-out function fails, the system shall proceed to safety shut-down. Frequency of test is given in the specific control standard. Internal faults on components of the checking circuit are not considered.

Components shall be dimensioned on the basis of the worst-case conditions which can arise in the control, as stated by the manufacturer.

NOTE 2 A component failure could cause a degradation of safety critical insulation. This should be considered when making assessment against this clause.

6.6.1.2 Reset device

The system shall be so constructed that a restart attempt following non-volatile lock-out shall only be possible following a manual reset, e. g. with an integrally or remotely mounted reset button.

Misuse or tampering with the reset device, whether integrally or remotely mounted (e. g. continuous pressing of the manual reset button or an internal fault of the reset device) or shorting of the connecting cables to the reset device, or between the connecting cables and earth, shall not cause the system to operate outside the requirements of this standard or prevent it from going to shut-down or lock-out.

Acceptable means for resetting from lock-out others than a reset button on the appliance shall be described in the specific control standard.

6.6.1.3 Documentation

The functional analysis of the control and the safety related programs under its control shall be documented in a clear hierarchical way in accordance with the safety philosophy and the programme requirements.

As a minimum the following documentation shall be provided with any system submitted for assessment:

- a) description of the system philosophy, the control flow, data flow and timings;
- b) clear description of the safety philosophy of the system with all safeguards and safety functions clearly indicated. Sufficient design information shall be provided to enable the safety functions or safeguards to be assessed;
- c) Documentation for any software within the system.

A documentation of design programming shall be supplied in a programming language declared by the manufacturer.

Safety related data and safety related segments of the operating sequence shall be identified and classified according to EN 60730-1:2000, Annex H.

There shall be a clear relationship between the various parts of the documentation, for example the interconnections of process, hardware and the labelling used in software documentation.

If a manufacturer provides documentation of the analytical measures taken during the development stage of the hardware and software, this documentation shall be used by the test authority as part of the assessment procedure.

6.6.2 Class A

Fault assessment is not applicable.

NOTE The requirements of electrical safety as described in 8.11 are applicable.

6.6.3 Class B

6.6.3.1 Design and construction requirements

A class B control function shall be designed such that under single fault conditions it remains in or proceeds to the defined state. A second independent fault is not considered.

Software shall conform to software class B of EN 60730-1.

The assessment shall be performed according to 6.6.3.2 and 6.6.3.3 and under the test conditions and criteria of 6.6.5.

6.6.3.2 First fault

Any first fault (see Annex E) in any one component or any one fault together with any other fault arising from that first fault shall result in either:

- a) the control becoming inoperative with all safety related output terminals de-energized or assuming a status in which they ensure a safe situation;
- b) the control reacting within the fault reaction time by proceeding to safety shut-down, or to lock-out, provided that subsequent reset from the lock-out condition under the same fault condition results in the system returning to the lock-out condition;
- c) the control continuing to operate, the fault being identified during the next start-up sequence, the result being a) or b);
- d) the control remaining operational in accordance with the safety related functional requirements of the specific control standard.

The specific control standard specifies the fault reaction time as well as the applicability of c).

6.6.3.3 Fault introduced during lock-out or safety- shut-down

Whenever the control is in lock-out or in safety shut down without an internal fault, the following requirements shall apply.

Any first fault (together with any other fault arising from that fault) in any one component (see Annex E), induced while the control is staying in the safety-shut-down or lock-out position, shall result in either:

- a) the control remaining in safety-shut-down or lock-out, safety related output terminals remaining de-energized;
- b) the control becoming inoperative with all safety related output terminals remaining de-energized;
- c) the control comes into operation again resulting in a) or b) as mentioned in this clause under the condition that the safety related output terminals are energized not longer than the fault reaction time. If the cause

of the original safety shut-down or lock-out condition no longer remains and the control comes again in operation it shall operate in accordance with the safety related functional requirements of the specific control standard.

The specific control standard specifies the fault reaction time.

NOTE Safety related output terminals are terminals which are safety related even in the safety shut-down or lock-out position, e. g. gas valve terminal, but not a terminal for an actuator driving the controlling element of a gas air ratio control (see EN 12067-2).

6.6.4 Class C

6.6.4.1 Design and construction requirements

A class C control function shall be designed such that under first and second fault conditions it remains in or proceeds to the defined state. A third independent fault is not considered.

Software shall conform to software class C of EN 60730-1.

The assessment shall be performed according to 6.6.4.2, 6.6.4.3 and 6.6.4.4 and under the test conditions and criteria of 6.6.5

6.6.4.2 First fault

Any first fault (see Annex E) in any one component or any one fault together with any other fault arising from that first fault shall result in either:

- a) the control becoming inoperative with all safety related output terminals de-energized or assuming a status in which they ensure a safe situation;
- b) the control reacting within the fault reaction time by proceeding to safety shut-down, or to lock-out, provided that subsequent reset from the lock-out condition under the same fault condition results in the system returning to the lock-out condition;
- c) the control continuing to operate, the fault being identified during the next start-up sequence, the result being a) or b);
- d) the control remaining operational in accordance with the safety related functional requirements of the specific control standard.

The specific control standard specifies the fault reaction time as well as the applicability of c).

6.6.4.3 Second fault

If the assessment of the first fault results in the control remaining operational in accordance with the safety related functional requirements of the specific control standard (see 6.6.4.2 d), any further independent fault considered together with the first fault shall result in either 6.6.4.2 a), b), c) or d).

During assessment, the second fault shall only be considered to occur:

- a) Either when a start-up sequence has been performed between the first and the second fault, or
- b) 24 h after the first fault.

The specific control standard specifies the applicability of a) or b) and the fault reaction time.

It may also specify a different time span in which the second fault does not occur, if different from 24 h.

6.6.4.4 Faults during lock-out or safety- shut-down

6.6.4.4.1 General

Whenever the control is in lock-out or safety shut down without an internal fault, an assessment according to 6.6.4.4.2 and 6.6.4.4.3 shall be performed.

Whenever the control is inoperative with all safety related output terminals de-energized or in a status in which they ensure a safe situation, in lock-out or in safety shut down with an internal fault, an additional single fault assessment according to 6.6.4.4.3 shall be performed.

NOTE Safety related output terminal as used in 6.6.4.4.2 and 6.6.4.4.3 are terminals which are safety related even in the safety shut-down or lock-out position, e. g. gas valve terminals, but not a terminal for an actuator driving the controlling element of a gas air ratio control (see EN 12067-2).

6.6.4.4.2 First fault introduced during lock-out or safety- shut-down

Any first fault (together with any other fault arising from that fault) in any one component (see Annex E), induced while the control is staying in the safety-shut-down or lock-out position, shall result in either:

- a) the control remaining in safety-shut-down or lock-out, safety related output terminals remaining de-energized or in a status in which they ensure a safe situation;
- b) the control becoming inoperative with all safety related output terminals remaining de-energized or assuming a status in which they ensure a safe situation;
- c) the control comes into operation again resulting in a) or b) as mentioned in this clause under the condition that the safety related output terminals are energized not longer than the fault reaction time. If the cause of the original safety shut-down or lock-out condition no longer remains and the control comes again in operation, it shall operate in accordance with the safety related functional requirements of the specific control standard and the second fault assessment shall be carried out in accordance with 6.6.4.3.

6.6.4.4.3 Second fault introduced during lock-out or safety- shut-down

Any second fault (together with any other fault arising from that fault) in any one component (see Annex E), induced while the control is staying in the safety shut-down or lock-out position, shall result in either 6.6.4.4.2 a), b) or c).

During assessment, the second fault shall not be considered to occur within 24 h after the first fault.

The specific control standard specifies the fault reaction time.

It may also specify a different time span in which the second fault does not occur, if different from 24 h.

6.6.5 Circuit and construction evaluation

6.6.5.1 Test conditions

The effect of internal faults shall be assessed by simulation and/or by an examination of the circuit design.

The fault shall be considered to have occurred at any stage in the control programme sequence.

The control shall be operated or considered to operate under the following conditions:

- a) at the most unfavourable voltage in the range 85 % to 110 % of the rated supply voltage;
- b) loaded with the most unfavourable load declared by the manufacturer;

- c) in an ambient temperature of $(20 \pm 5) ^\circ\text{C}$, unless there are significant reasons for conducting the test at another temperature within the manufacturer's declared range;
- d) with any actuating member placed in the most unfavourable position;
- e) with tissue paper placed on the supporting surface(s) of the control;
- f) with sparks of about 3 mm in length and having an energy of not less than 0,5 J applied to those components which are likely to liberate flammable gases during the test.

6.6.5.2 Test criteria

During the appraisal, it shall be verified that under the conditions described in 6.6.5.1, the following criteria are satisfied.

- a) the control shall not emit flames, hot metal or hot plastics, the tissue paper shall not ignite, no explosion shall result from the liberation of flammable gases and any flame produced shall not continue to burn for more than 10 s after switching off the spark generator. When a control is incorporated with any appliance, any enclosure afforded by the appliance is taken into consideration.
- b) if the control continues to function, it shall conform to Clauses 8 and 13 of EN 60730-1:2000 or Clauses 8 and 13 of the relevant part 2 of EN 60730. If it ceases to function, it shall still continue to conform to Clause 8 of EN 60730-1:2000 or Clause 8 of the relevant part 2 of EN 60730.

After the tests there shall be no deterioration of the various parts of the control that would result in failure to comply with Clause 20 of EN 60730-1:2000 or Clause 20 of the relevant part 2 of EN 60730.

NOTE Heating elements consisting of wire-wound resistors are considered to be short-circuit proof (see Annex E).

6.6.5.3 Assessment

A thorough appraisal of the circuit shall be carried out to determine its performance under the specified fault conditions. This appraisal shall take the form of a theoretical analysis and a component failure simulation test. Fault simulations may also be carried out to simulate faults within complex devices, e. g. EPROM emulation tests.

Only the safety related software (Software class B and C) as identified according to 6.6.1.3 shall be subjected to further assessment. For the identification, a fault tree analysis may be used.

7 Performance

7.1 General

Controls shall operate correctly under all combinations of the following:

- full range of inlet pressures;
- ambient temperature range from $0 ^\circ\text{C}$ to $60 ^\circ\text{C}$ or wider limits, if declared by the manufacturer;
- in all mounting positions declared by the manufacturer;
- voltage or current range from 85 % to 110 % of the rated supply value or from 85 % of the minimum rated value to 110 % of the maximum rated value.

7.2 Leak-tightness

Controls shall be leak tight, in accordance with the leakage rates given in Table 2.

Table 2 — Maximum leakage rates

Nominal inlet size DN	Maximum leakage rates cm ³ /h of air	
	Internal leak-tightness	External leak-tightness
DN < 10	20	20
10 ≤ DN ≤ 25	40	40
25 < DN ≤ 80	60	60
80 < DN ≤ 150	100	60
150 < DN < 250	150	60

Closure parts shall remain leak-tight after dismantling and reassembly.

7.3 Test for leak-tightness

7.3.1 General

The limits of error of the apparatus used shall be $\pm 1 \text{ cm}^3$ and 10 Pa ($\pm 0,1 \text{ mbar}$).

The uncertainty of measurement of leakage rates shall be within $\pm 5 \text{ cm}^3/\text{h}$.

For internal leakage of closure members carry out the tests with an initial test pressure of 0,6 kPa (6 mbar) then for both internal and external leakage repeat the tests at 1,5 times the maximum inlet pressure or 15 kPa (150 mbar), whichever is greater.

Where the control is suitable for use with third family gases with nominal inlet pressures of 11,2 kPa (112 mbar) or 14,8 kPa (148 mbar), use a test pressure of at least 22 kPa (220 mbar).

Use a method which gives reproducible results. Examples of such methods are shown in:

- Annex B (volumetric method) for test pressures up to and including 15 kPa (150 mbar);
- Annex C (pressure loss method) for test pressures above 15 kPa (150) mbar.

The equation for conversion from the pressure loss method to the volumetric method is given in Annex D.

7.3.2 External leak-tightness

Pressurize the inlet and outlet(s) of the control to the test pressures given in 7.3.1 and measure the leakage rate.

Dismantle and reassemble closure parts five times according to the manufacturer's instructions and repeat the test.

7.3.3 Internal leak-tightness

With any closure member in the closed position, pressurize the inlet of the control in the direction of gas flow indicated, to the test pressures given in 7.3.1 and measure the leakage rate.

7.4 Torsion and bending

7.4.1 General

Controls shall be constructed in such a way that they have adequate strength to withstand likely mechanical stress to which they may be subjected during installation and service.

After testing, there shall be no permanent deformation and any leakage shall not exceed the values specified in Table 2 or in the specific control standard.

7.4.2 Torsion

Controls shall withstand the torque given in Table 4 when tested to 7.5.2 or 7.5.3.

7.4.3 Bending moment

Controls shall withstand the bending moment given in Table 4 when tested to 7.5.4. Group 1 controls shall additionally be tested to 7.5.5.

7.5 Torsion and bending tests

7.5.1 General

Use pipes according to ISO 65, medium series with a length of:

- at least $40 \times \text{DN}$ for controls up to and including DN 50;
- at least 300 mm for controls above DN 50.

Use only non-hardening sealing paste on connections.

Determine the appropriate tightening torque to be applied to flange bolts to ISO 7005 from the values in Table 3.

Table 3 — Tightening torque for flange bolts

DN	6	8	10	15	20	25	32	40	50	65	80	100	125	≥150
Torque N·m	20	20	30	30	30	30	50	50	50	50	50	80	160	160

Test the control for external leak-tightness to 7.3.2 and internal leak-tightness to 7.3.3 where applicable, before carrying out torsion and bending tests.

If the inlet and outlet connections are not on a common axis, repeat the tests with the connections reversed.

If the inlet and outlet connections are not of the same nominal size, clamp the body of the control and apply the torque and bending moment appropriate to each connection in turn.

Controls with compression fittings shall be subjected to the bending moment test by means of an adapter on the union threads.

NOTE 1 Torsion tests are not applicable to controls with flanged connections if these are the only means of connection.

NOTE 2 Bending moment tests are not applicable for controls with flanged or saddle-clamp inlet connections for attachment to cooking appliance manifolds.

7.5.2 Ten second torsion test – group 1 and group 2 controls with threaded connections

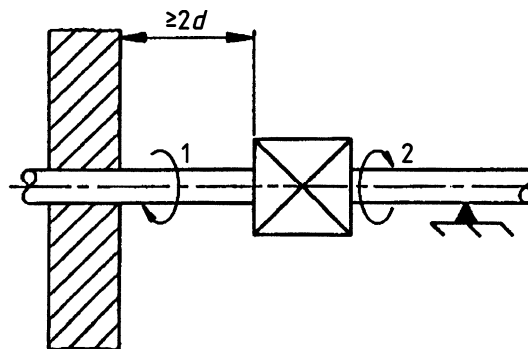
Screw pipe 1 into the control with a torque not exceeding the values given in Table 4. Clamp pipe 1 at a distance at least $2d$ from the control (see Figure 1).

Screw pipe 2 into the control with a torque not exceeding the values given in Table 4. Ensure that all joints are leak-tight.

Support pipe 2 such that no bending moment is applied to the control.

Progressively apply the appropriate torque to pipe 2 for 10 s without exceeding the values given in Table 4. Apply the last 10 % of the torque over a period not exceeding 1 min.

Remove the torque and visually inspect the control for any deformation, then test the control for external leak-tightness to 7.3.2 and internal leak-tightness to 7.3.3 where applicable.



Key

d = external diameter

Figure 1 — Torsion test assembly

7.5.3 Ten second torsion test – group 1 and group 2 controls with compression joints

7.5.3.1 Olive-type compression joints

Use a steel tube with a new brass olive of the appropriate size.

Clamp the control body rigidly and apply the test torque given in Table 4 to every tubing nut in turn for 10 s.

Visually inspect the control for deformation, discounting any deformation of the olive seating or mating surfaces consistent with the applied torque. Test the control for external leak-tightness to 7.3.2 and internal leak-tightness to 7.3.3 where applicable.

7.5.3.2 Flared compression joints

Use a short length of steel tube with a flared end and follow the method given in 7.5.3.1, discounting any deformation of the cone seating or mating surfaces consistent with the applied torque.

7.5.3.3 Flanged or saddle-clamp inlet connections for attachment to cooking appliance gas manifolds

Attach the control to a manifold as recommended by the manufacturer and tighten the fixing screws to the recommended torque. Connect the olive or flared type compression coupling and tighten to the specified torque, given in parentheses in column 2 of Table 4, in accordance with the procedures given in 7.5.3.1 or 7.5.3.2, as appropriate.

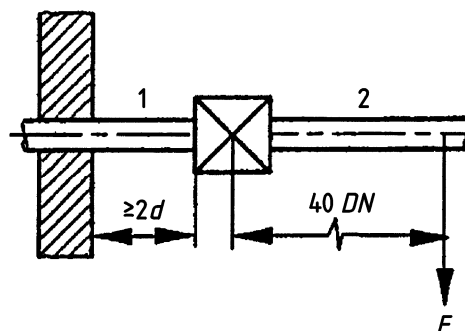
7.5.4 Ten second bending moment test – group 1 and group 2 controls

Use the same control as for the torsion test and the assembly as shown in Figure 2.

Apply the force for the required bending moment for a group 1 or group 2 control given in Table 4 for 10 s, taking the mass of the pipe into consideration. Apply the force:

- for controls up to and including DN 50, $40 \times \text{DN}$ from the centre of the control;
- for controls above DN 50, at least 300 mm from the control connection.

Remove the force and visually inspect the control for any deformation, then test the control for external leak-tightness to 7.3.2 and internal leak-tightness to 7.3.3 where applicable.



Key

d = external diameter

Figure 2 — Bending moment test assembly

7.5.5 900 second bending moment test – group 1 controls only

Use the same control as for the torsion test and the assembly as shown in Figure 2.

Apply the force for the required bending moment for a group 1 control given in Table 4 for 900 s, taking the mass of the pipe into consideration. Apply the force:

- for controls up to and including DN 50, $40 \times \text{DN}$ from the centre of the control;
- for controls above DN 50, at least 300 mm from the control connection.

With the force still applied, test the control for external leak-tightness to 7.3.2 and for internal leak-tightness to 7.3.3 where applicable.

Table 4 — Torque and bending moment

Nominal size DN ^a	Torque ^b N·m	Bending moment N·m		
	Group 1 and 2	Group 1		Group 2
		10 s	900 s	10 s
6	15 (7)	15	7	25
8	20 (10)	20	10	35
10	35 (15)	35	20	70
15	50 (15)	70	40	105
20	85	90	50	225
25	125	160	80	340
32	160	260	130	475
40	200	350	175	610
50	250	520	260	1100
65	325	630	315	1600
80	400	780	390	2400
100	-	950	475	5000
125	-	1000	500	6000
≥ 150	-	1100	550	7600

^a Equivalent connection sizes are given in Table 1.

^b Values in parentheses are for controls with flanged or saddle-clamp inlet connections on cooking appliances.

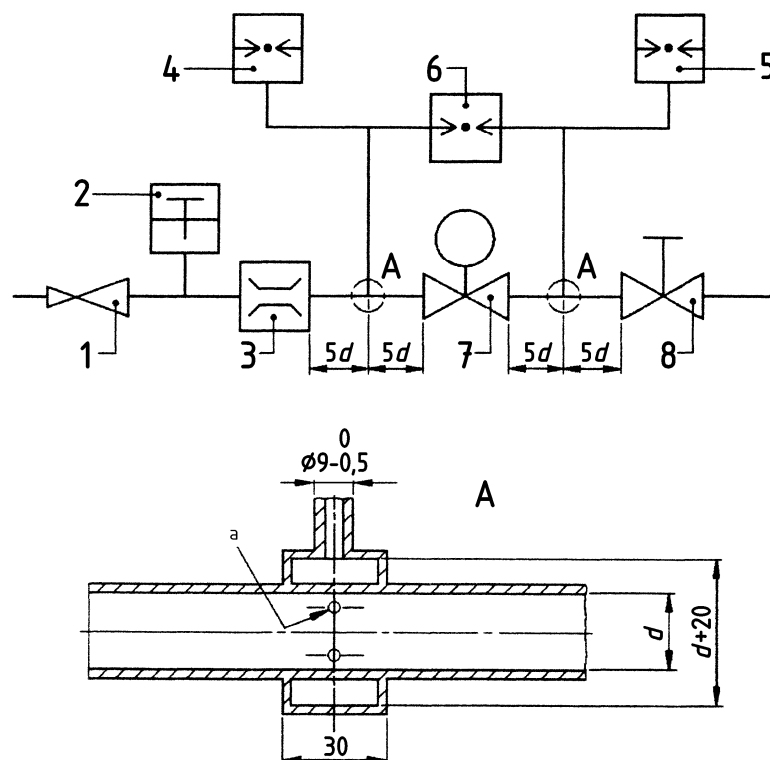
7.6 Rated flow rate

The maximum flow rate when measured according to 7.7 shall be at least 0,95 times the rated flow rate.

7.7 Test for rated flow rate

7.7.1 Apparatus

Carry out the test using the apparatus shown in Figure 3. The uncertainty of measurement shall not exceed 2 %.



Nominal size DN	Internal diameter <i>d</i> mm	Nominal size DN	Internal diameter <i>d</i> mm
6	6	50	52
8	9	65	67
10	13	80	80
15	16	100	106
20	22	125	131
25	28	150	159
32	35	200	209
40	41	250	260

Key

- 1 adjustable regulator for inlet pressure
- 2 thermometer
- 3 flow meter
- 4 inlet pressure gauge
- 5 outlet pressure gauge
- 6 differential pressure gauge
- 7 control under test
- 8 manual control tap

Figure 3 — Flow rate test apparatus

7.7.2 Test procedure

Operate and adjust the control according to the manufacturer's instructions.

Adjust the air flow rate, keeping the inlet pressure constant to provide the manufacturer's declared pressure difference.

7.7.3 Conversion of air flow rate

Use the following equation for conversion of flow rate to standard conditions:

$$q_n = q \left[\frac{p_a + p}{101,325} \times \frac{288,15}{273,15 + t} \right]^{\frac{1}{2}}$$

where

q_n is the corrected air flow rate at reference conditions in m³/h;

q is the measured air flow rate in m³/h;

p is the test pressure in kPa (mbar · 10⁻¹);

p_a is the atmospheric pressure in kPa (mbar · 10⁻¹);

t is the air temperature in °C.

7.8 Durability

7.8.1 Elastomers in contact with gas

Elastomers in contact with gas (e. g. valve pads, O-rings, diaphragms and lip seals) shall comply with requirements and tests given in EN 549.

7.8.2 Marking

Adhesive labels and all marking shall be tested for resistance to abrasion, humidity and temperature. They shall neither lift nor discolour such that the marking becomes illegible.

In specific, markings on knobs shall survive the continual handling and rubbing resulting from manual operation.

7.8.3 Tests for marking

Marking shall be tested in accordance with the methods given in EN 60730-1:2000, Annex A.

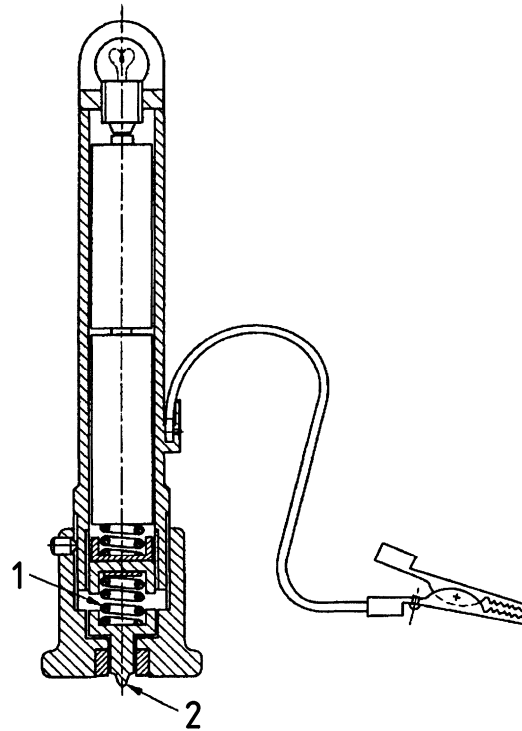
7.8.4 Resistance to scratching

Surfaces exclusively protected with paint shall withstand the scratch test before and after the humidity test without the ball penetrating the protective coating to expose bare metal.

7.8.5 Scratch test

Draw a 1 mm diameter fixed steel ball across the surface of the control at a speed of 30 mm/s to 40 mm/s with a contact force of 10 N (see Figure 4).

Repeat the scratch test after the humidity test of 7.8.7.



Key

- 1 spring loading = 10N
- 2 scratching point ($\varnothing$ 1 mm steel ball)

Figure 4 — Scratch test apparatus

7.8.6 Resistance to humidity

All parts including those with protected surfaces, (e. g. coated with paint or plating) shall withstand the humidity test without any signs of undue corrosion, lifting or blistering visible with the naked eye.

Where evidence of minor corrosion of a control part exists, the part shall be substantial enough to ensure an adequate margin for the safety of the control.

Nevertheless, parts of the control, the corrosion of which could adversely affect the continued safe working of the control, shall not show any signs of corrosion.

7.8.7 Humidity test

Place the control in a chamber at an ambient temperature of $(40 \pm 2) ^\circ\text{C}$ with a relative humidity exceeding 95 % for 48 h. Remove the control from the chamber and examine it with the naked eye for signs of corrosion, lifting or blistering of the coated surface. Leave the control for a further 24 h at $(20 \pm 5) ^\circ\text{C}$ and carry out another examination.

7.9 Performance tests for electronic controls

7.9.1 At ambient temperature

The safety related functions (e. g. switching times and sequence of a complete programme) shall be measured in the delivered state. The system is connected and installed according to the manufacturer's instructions.

These tests shall be performed under test conditions (see 5.4):

- at the manufacturer's declared rated voltage(s), or if this is a range, at the lowest and highest rated voltages;
- at 85 % of the lowest declared rated voltage;
- at 110 % of the highest declared rated voltage.

The results of the above measured safety related functions shall comply with the specific control standard.

7.9.2 At low temperature

The tests according to 7.9.1 shall be repeated at 0 °C or at the lowest declared ambient temperature where this is lower than 0 °C.

7.9.3 At high temperature

The tests according to 7.9.1 shall be repeated at 60 °C or at the highest declared ambient temperature where this is higher than 60 °C.

7.10 Long-term performance for electronic controls

7.10.1 General

All components of the control shall be able to withstand the tests as detailed in 7.10.2 and 7.10.3. If the Control function is an integral part of an apparatus the long-term performance tests can be combined. The test of 7.10.2 and the test of 7.10.3 shall not be carried out on the same test sample.

In the case of the control not having a clear operating cycle, the long-term performance test shall be carried out for the minimum specified amount of time.

7.10.2 Stress test [by the test laboratory]

7.10.2.1 Thermal stress test

The thermal stress test shall be carried out with the terminals loaded with the loads and power factors as declared by the manufacturer.

The purpose of the test is to expose the electronic components of the control to temperature cycles between limits likely to be reached in normal use owing to fluctuations in ambient temperature, temperature variations in the component itself, power supply fluctuation and temperature changes like from standby to operation and vice versa.

The control shall be tested as listed below:

- a) 14 days at the following electrical and thermal conditions and rate of operation:

- Electrical conditions: The system is loaded according to the ratings declared by the manufacturer, the voltage then being increased to 110 % of maximum declared rated voltage except that for 30 min during each 24 h period of the test the voltage is reduced to 90 % of minimum declared rated voltage. The change of voltage shall not be synchronised with the change of temperature. Each 24 h period shall also include at least one period in the order of 30 s during which the supply voltage is switched off.
- Thermal conditions: The ambient temperature and/or the mounting surface temperature are varied between the maximum declared ambient temperature or 60 °C, whichever is higher, and the minimum declared ambient temperature or 0 °C, whichever is lower, to cause the temperature of the components of the electronic circuit to be cycled between the resulting extremes. The rate of ambient and/or mounting surface temperature change shall be in the order of 1 °K/min and the extremes of temperature maintained for approximately 1 h.

NOTE 1 Care should be taken to avoid the occurrence of condensation during this test.

- Rate of operation: During the test the control shall be cycled through all of its normal operational modes (e. g. stand-by, start-up, running) up to a maximum of six cycles/min. The number of cycles completed during this test shall be recorded and if this number is less than 45 000 the remaining cycles shall be executed at the declared rated voltage and at ambient temperature.
- b) 2 500 cycles performed, but at least 24 h through all of its normal operational modes (e. g. stand-by, start-up, running) at the maximum declared ambient temperature or 60 °C whichever is higher, and at 110 % of the maximum declared rated voltage.
- c) 2 500 cycles performed, but at least 24 h through all of its normal operational modes (e. g. stand-by, start-up, running) at the minimum declared ambient temperature or 0 °C whichever is lower, and at 85% of the minimum declared rated voltage.
- d) If a control is provided with a safety relevant function that on the basis of a sensor or switch is able to initiate a safety action, 5 000 cycles of such safety actions or the number as specified in the specific control standard shall be performed for each safety relevant function individually at the ambient temperature and nominal rated voltage, by simulating the sensor or switch to initiate such safety action.

NOTE 2 Where possible the testing of the safety relevant functions may be combined.

During the tests a), b), c) and d) as described above, the system shall be operated in such a way that the normal start-up sequence is performed. The time that the system is held in the running position and the time that the control loop is interrupted before the cycle is repeated shall be agreed between the manufacturer and the test authority.

NOTE 3 By agreement between the manufacturer and the test authority any safety relevant times used during the above tests may be chosen to be as short as practicable so that the thermal stress test is not unnecessarily prolonged.

On completion of the thermal stress test, the test of 7.9.1 shall be repeated at rated voltage only.

7.10.2.2 Vibration test

When resistance to vibration is declared by the manufacturer, the sinusoidal vibration test, as described below, shall be carried out.

The object of the test is to demonstrate the ability of the control to withstand the long-term effects of vibration at levels declared by the manufacturer.

During the exposures the control shall be mounted on a rigid fixture by means of the specified fastening arrangement.

The test shall be performed in accordance with EN 60068-2-6, test Fc.

The test is performed at least with the following severity conditions:

- Acceleration amplitude: 1,0 g or higher if declared by the manufacturer
- Frequency range: 10 Hz to 150 Hz
- Sweep rate: 1 octave per minute
- Number of sweep cycles: 10
- Number of axes: 3, mutually perpendicular

A visual inspection shall be carried out after the termination of the exposure. No mechanical damage shall be found and the control shall comply with the construction requirements as specified in the specific control standard. On completion of the vibration test, the test of 7.9.1 shall be repeated at rated voltage only.

7.10.3 Long term performance test [by the manufacturer]

The manufacturer shall declare that the control has completed the required duration as specified in the specific control standard or a minimum of 250 000 cycles performed through all of its normal operational modes (e. g. stand-by, start-up, running), with the terminals loaded with the loads and power factors as declared, without failure.

The control shall have been tested under the following conditions:

- a) 90 % of the total number of cycles or duration of time shall be performed at the declared rated voltage and at ambient temperature.
- b) 5 % of the total number of cycles or duration of time shall be performed at the maximum declared ambient temperature or 60 °C, whichever is higher, and at 110 % of the maximum declared rated voltage.
- c) 5 % of the total number of cycles or duration of time shall be performed at the minimum declared ambient temperature or 0 °C, whichever is lower, and at 85 % of the minimum declared rated voltage.

On completion of this test, the test sample shall still comply with EN 60730-1:2000, 13.2.2 through 13.2.4.

8 EMC/Electrical requirements

8.1 Protection against environmental influences

Any components which are specifically intended for protection against EMC disturbances failing during any of these tests, will lead to non compliance with this standard.

Assessment Criterion I:

When tested at the severity levels given in 8.2 to 8.10, the control shall continue to function in accordance with the relevant requirements of the specific control standard.

Assessment Criterion II:

When tested at the severity levels given in 8.2 to 8.10 the control shall maintain a defined state or behave as specified in the specific control standard or, for severity level 4 where in addition to level 3 testing is required, with the relevant requirements of the specific application standard.

NOTE In the basic EMC publications EN 61000-4 series "control" is commonly referred to EUT (Equipment under test).