

BS EN 13611:2015

Incorporating corrigendum February 2016



BSI Standards Publication

Safety and control devices for burners and appliances burning gaseous and/or liquid fuels — General requirements

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National foreword

This British Standard is the UK implementation of EN 13611:2015, incorporating corrigendum February 2016. It supersedes BS EN 13611:2007+A2:2011 which is withdrawn.

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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Published by BSI Standards Limited 2016

ISBN 978 0 580 92795 9

ICS 23.060.40

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2015.

Amendments/corrigenda issued since publication

Date	Text affected
29 February 2016	Implementation of CEN corrigendum February 2016: Table E1 updated

English Version

Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - General requirements

Équipements auxiliaires pour brûleurs et appareils utilisant
des combustibles gazeux ou liquides - Exigences générales

Sicherheits- und Regeleinrichtungen für Brenner und
Brennstoffgeräte für gasförmige oder flüssige Brennstoffe -
Allgemeine Anforderungen

This European Standard was approved by CEN on 14 February 2015.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 13611:2015) has been prepared by Technical Committee CEN/TC 58 "Safety and control devices for burners and appliances burning gaseous or liquid fuels", 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 December 2015, and conflicting national standards shall be withdrawn at the latest by December 2015.

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 supersedes EN 13611:2007+A2:2011.

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 EU Directive(s).

For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document.

Product specific control standards of CEN/TC 58 make use of this standard by adapting this standard and stating "addition", "modification" or "replacement" in their corresponding clauses.

It should be noted that the following significant changes compared to the previous edition have been incorporated in this European Standard:

- 1) Introduction, new text;
- 2) Clause 1 "Scope" reworded;
- 3) Clause 2 "Normative references" updated;
- 4) Clause 3 "Terms and definitions" updated and inclusion of some new definitions;
- 5) Clause 4 "Classification" new subclause 4.4 "Types of DC supplied controls";
- 6) Clause 5 new title "Test conditions and uncertainty of measurements" updated and inclusion of new subclauses 5.1 "Test conditions" and 5.2 "Uncertainty of measurements";
- 7) Clause 6 new title "Design and construction";
- 8) Subclause 6.1 "General" rewording of general requirements, additional requirements to cover the risk of high pressure;
- 9) Subclause 6.2 "Mechanical parts of the control" reworded and inclusion of new subclauses "Auxiliary canals and orifices" and "Presetting devices";
- 10) Subclause 6.3 "Materials" reworded, renumbered and modified requirements for housing and for zinc alloys, new test for zinc alloys;
- 11) Subclause 6.4 "Gas connections" reworded, updated and modified requirements;
- 12) Subclause 6.5 "Electrical parts of the control" reworded and updated, inclusion of new subclause for switching elements (requirements and test), new subclause for electrical components in the gas way (requirements and test);

- 13) Subclause 6.6 "Protection against internal faults for the purpose of functional safety" reworded and updated, new subclause for lock-out function;
- 14) Subclause 7.1 "General" reworded and new requirements for AC/DC supplied controls;
- 15) Subclause 7.3 „Torsion and bending“ reworded, updated and modified requirements;
- 16) Subclause 7.4 „Rated flow rate“ reworded, updated and modified requirements;
- 17) Subclause 7.5 "Durability" reworded, updated and new requirements for Elastomer/cork and elastomer/cork/synthetic fibre material in contact with gas, new requirements for lubricants in contact with gas;
- 18) Subclause 7.6 "Performance tests for electronic controls" reworded, updated and modified;
- 19) Subclause 7.7 "Long-term performance for electronic controls" reworded, updated and modified;
- 20) New Subclause 7.8 „Data exchange“ new requirements;
- 21) New Clause 8 "Electrical requirements" inclusion of updated requirements of EN 13611:2007+A2:2011, 8.11, inclusion of updated requirements of EN 13611:2007+A2:2011, 6.5.2;
- 22) New Clause 9 "Electromagnetic compatibility (EMC)" inclusion of reworded, updated and modified requirements of EN 13611:2007+A2:2011, Clause 8;
- 23) New Clause 10 "Marking, installation and operating instructions" inclusion of updated requirements of EN 13611:2007+A2:2011, Clause 9;
- 24) Replacement of Annex A (informative) "Gas connections in common use in various countries" by Annex A (informative) "Abbreviations and Symbols";
- 25) Annex E (normative) "Electrical/electronic component fault modes", reworded, updated and modified;
- 26) Annex F (normative) "Additional requirements for safety accessories and pressure accessories" reworded, updated and modified;
- 27) Subclause F.6.3 "Materials" new requirements;
- 28) Annex G (normative) "Materials for pressurized parts" updated;
- 29) Annex H (normative) "Additional materials for pressurized parts" updated;
- 30) Annex I (normative) "Requirements for controls used in DC supplied burners and appliances burning gaseous or liquid fuels" reworded, updated and modified;
- 31) Annex J (normative) "Method for the determination of a Safety integrity level (SIL)" reworded and updated;
- 32) Annex K (normative) "Method for the determination of a Performance Level (PL)" reworded and updated;
- 33) New Annex M (normative) "Reset functions";
- 34) New Annex N (informative) "Guidance document on Environmental Aspects";
- 35) New Annex O (normative) "Seals of elastomer, cork and synthetic fibre mixtures";
- 36) Complete update of the Annexes ZA, ZB and the Bibliography.

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

Introduction

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 burners and appliances burning gaseous and/or liquid fuels and to their testing.

The general requirements for controls are given in this document and methods for classification and assessment for new controls and control functions are given in EN 14459:2007 (see Figure 1). EN 126 (see Figure 1) specifies multifunctional controls combining two or more controls and Application Control Functions, one of which is a mechanical control function. The requirements for controls and Application Control Functions are given in the specific control standard (see Figure 1, control functions).

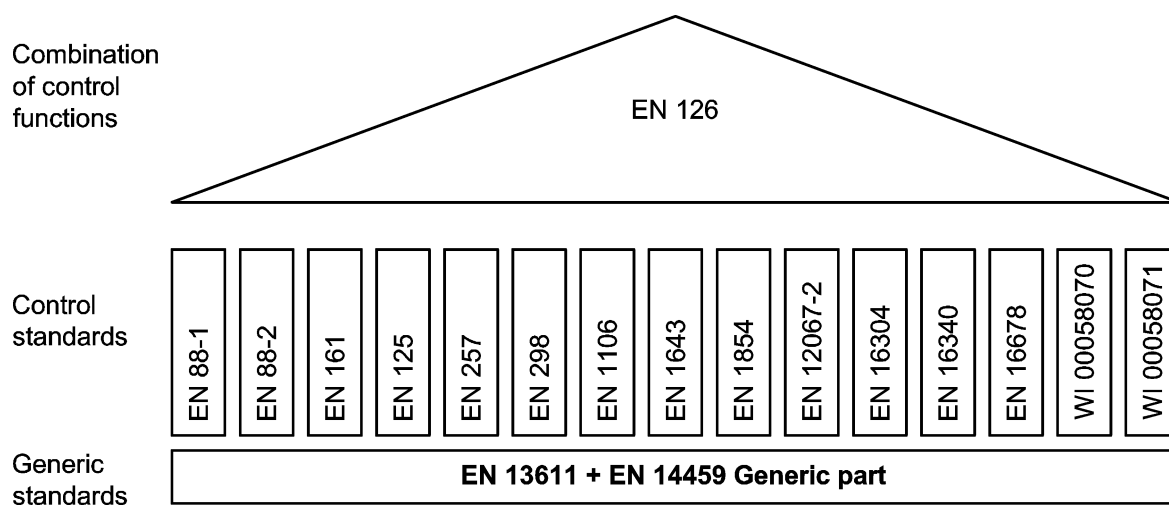


Figure 1 — Interrelation of control standards

This European Standard should be used in conjunction with the specific standard for a specific type of control, (e.g. EN 88-1:2011, EN 88-2:2007, EN 125:2010, EN 126:2012, EN 161:2011+A3:2013, EN 257:2010, EN 298:2012, EN 1106:2010, EN 1643:2014, EN 1854:2010, EN 12067-2:2004, EN 16304:2013 and EN 16340:2014), or for controls for specific applications. This standard can 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 can be necessary. EN 14459:2007 provides assessment methods for new control principles.

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 the determination of a Safety Integrity Level or of a Performance Level, Annex J and Annex 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 conform to 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.

1 Scope

This European Standard specifies the general safety, design, construction, and performance requirements and testing for safety, control or regulating devices (hereafter referred to as controls) for burners and appliances burning one or more gaseous fuels or liquid fuels. This European Standard is applicable to controls with declared maximum inlet pressure up to and including 500 kPa of nominal connection sizes up to and including DN 250.

This European standard specifies general product requirements for the following controls:

- 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;
- automatic vent valves.

This European standard applies for control functions that are not covered by a specific control standard for burners and appliances burning one or more gaseous fuels or liquid fuels.

This European Standard applies also for safety accessories and pressure accessories with a product of the maximum allowable pressure PS and the volume V of less than $600\,000\text{ kPa} \cdot \text{dm}^3$ ($6\,000\text{ bar} \cdot \text{litres}$) or with a product of PS and DN of less than $300\,000\text{ kPa}$ ($3\,000\text{ bar}$).

This European Standard applies for *AC* and *DC* supplied controls (for controls supplied by stand-alone battery system, battery systems for mobile applications or systems which are intended to be connected to *DC* supply networks controls see Annex I).

This European Standard is applicable to reset functions used for reset from lockout, e.g. due to ignition failure or temperature cut-out in burners and appliances (see Annex M).

This European Standard establishes methodologies for the determination of a Safety Integrity Level (SIL) and the determination of a Performance Level (PL) (see Annex J, Annex K and Annex L).

This European Standard gives guidelines for environmental aspects (see Annex N).

This European Standard does not apply to mechanical controls for use with liquid fuels.

The protection against environmental impact in open air (i.e. capable of withstanding UV radiation, wind, rain, snow, dirt deposits, condensation, ice and hoar frost (see IEV 441-11-05:2005), earthquake and external fire) is not covered by this standard.

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

2 Normative references

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

EN 485-2:2013, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties*

EN 549:1994, *Rubber materials for seals and diaphragms for gas appliances and gas equipment*

EN 586-2:1994, *Aluminium and aluminium alloys - Forgings - Part 2: Mechanical properties and additional property requirements*

EN 754-2:2013, *Aluminium and aluminium alloys - Cold drawn rod/bar and tube - Part 2: Mechanical properties*

EN 755-2:2013, *Aluminium and aluminium alloys - Extruded rod/bar, tube and profiles - Part 2: Mechanical properties*

EN 1057:2006+A1:2010, *Copper and copper alloys - Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 1563:2011, *Founding - Spheroidal graphite cast irons*

EN 1559-1:2011, *Founding - Technical conditions of delivery - Part 1: General*

EN 1652:1997, *Copper and copper alloys - Plate, sheet, strip and circles for general purposes*

EN 1706:2010, *Aluminium and aluminium alloys - Castings - Chemical composition and mechanical properties*

EN 1774:1997, *Zinc and zinc alloys - Alloys for foundry purposes - Ingot and liquid*

EN 1982:2008, *Copper and copper alloys - Ingots and castings*

EN 10025-1:2004, *Hot rolled products of structural steels - Part 1: General technical delivery conditions*

EN 10028-2:2009, *Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2009, *Flat products made of steels for pressure purposes - Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2009, *Flat products made of steels for pressure purposes - Part 4: Nickel alloy steels with specified low temperature properties*

EN 10028-5:2009, *Flat products made of steels for pressure purposes - Part 5: Weldable fine grain steels, thermomechanically rolled*

EN 10028-6:2009, *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 10083-1:2006, *Steels for quenching and tempering - Part 1: General technical delivery conditions*

EN 10083-2:2006, *Steels for quenching and tempering - Part 2: Technical delivery conditions for non alloy steels*

EN 10087:1998, *Free-cutting steels - Technical delivery conditions for semi-finished products, hot-rolled bars and rods*

EN 10088-1:2014, *Stainless steels — Part 1: List of stainless steels*

EN 10088-3:2014, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN 10111:2008, *Continuously hot rolled low carbon steel sheet and strip for cold forming - Technical delivery conditions*

EN 10130:2006, *Cold rolled low carbon steel flat products for cold forming - Technical delivery conditions*

EN 10213:2007, *Steel castings for pressure purposes*

EN 10216-1:2013, *Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10216-5:2013, *Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 5: Stainless steel tubes*

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 10226-1:2004, *Pipe threads where pressure tight joints are made on the threads - Part 1: Taper external threads and parallel internal threads - Dimensions, tolerances and designation*

EN 10226-2:2005, *Pipe threads where pressure tight joints are made on the threads - Part 2: Taper external threads and taper internal threads - Dimensions, tolerances and designation*

EN 10250-1:1999, *Open die steel forgings for general engineering purposes - Part 1: General requirements*

EN 10250-2:1999, *Open die steel forgings for general engineering purposes - Part 2: Non-alloy quality and special steels*

EN 10250-4:1999, *Open die steel forgings for general engineering purposes - Part 4: Stainless steels*

EN 10255:2004+A1:2007, *Non-Alloy steel tubes suitable for welding and threading - Technical delivery conditions*

EN 10272:2007, *Stainless steel bars for pressure purposes*

EN 10277-3:2008, *Bright steel products - Technical delivery conditions - Part 3: Free-cutting steels*

EN 10293:2015, *Steel castings for general engineering uses*

EN 10297-1:2003, *Seamless circular steel tubes for mechanical and general engineering purposes - Technical delivery conditions - Part 1: Non-alloy and alloy steel tubes*

EN 10305-1:2010, *Steel tubes for precision applications - Technical delivery conditions - Part 1: Seamless cold drawn tubes*

EN 10305-4:2011, *Steel tubes for precision applications - Technical delivery conditions - Part 4: Seamless cold drawn tubes for hydraulic and pneumatic power systems*

EN 10346:2009, *Continuously hot-dip coated steel flat products - Technical delivery conditions*

EN 12164:2011, *Copper and copper alloys - Rod for free machining purposes*

EN 12165:2011, *Copper and copper alloys - Wrought and unwrought forging stock*

EN 12186:2014, *Gas supply systems — Gas pressure regulating stations for transmission and distribution — Functional requirements*

EN 12279:2000, *Gas supply systems - Gas pressure regulating installations on service lines - Functional requirements*

EN 12516-1:2014, *Industrial valves — Shell design strength — Part 1: Tabulation method for steel valve shells*

EN 13445-4:2014, *Unfired pressure vessels — Part 4: Fabrication*

EN 13555:2014, *Flanges and their joints - Gasket parameters and test procedures relevant to the design rules for gasketed circular flange connections*

EN 13906-1:2013, *Cylindrical helical springs made from round wire and bar - Calculation and design - Part 1 : Compression springs*

EN 13906-2:2013, *Cylindrical helical springs made from round wire and bar - Calculation and design - Part 2: Extension springs*

EN 50159:2010, *Railway applications - Communication, signalling and processing systems - Safety-related communication in transmission systems*

EN 60068-2-6:2008, *Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:2007)*

EN 60384-14:2013, *Fixed capacitors for use in electronic equipment - Part 14: Sectional specification - Fixed capacitors for electromagnetic interference suppression and connection to the supply mains (IEC 60384-14:2010)*

EN 60384-16:2005, *Fixed capacitors for use in electronic equipment - Part 16: Sectional specification: Fixed metallized polypropylene film dielectric d.c. capacitors (IEC 60384-16:2004)*

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

prEN 60730-1:2013, *Automatic electrical controls — Part 1: General requirements (IEC 60730-1:2013)*¹

EN 60747-5-2:2001, *Discrete semiconductor devices and integrated circuits - Part 5-2: Optoelectronic devices - Essential ratings and characteristics (IEC 60747-5-2:1997)*

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 61000-4-29:2000, *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 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements (IEC 61508-1:2010)*

¹ To be published.

- EN 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems (IEC 61508-2:2010)*
- EN 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements (IEC 61508-3:2010)*
- EN 61508-4:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations (IEC 61508-4:2010)*
- EN 61508-6:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3 (IEC 61508-6:2010)*
- EN 61508-7:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures (IEC 61508-7:2010)*
- EN 61558-2-6:2009, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V - Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers (IEC 61558-2-6:2009)*
- EN 61558-2-16:2009, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V - Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units (IEC 61558-2-16:2009)*
- EN 61643-11:2012, *Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods (IEC 61643-11:2011, modified)*
- EN 61810-1:2008, *Electromechanical elementary relays - Part 1: General requirements (IEC 61810-1:2008)*
- EN 62061:2005, *Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005)*
- 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)*
- EN ISO 898-1:2013, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1:2013)*
- EN ISO 898-2:2012, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread (ISO 898-2:2012)*
- EN ISO 3506-1:2009, *Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs (ISO 3506-1:2009)*
- EN ISO 3506-2:2009, *Mechanical properties of corrosion-resistant stainless steel fasteners - Part 2: Nuts (ISO 3506-2:2009)*
- EN ISO 3506-3:2009, *Mechanical properties of corrosion-resistant stainless steel fasteners - Part 3: Set screws and similar fasteners not under tensile stress (ISO 3506-3:2009)*
- EN ISO 8434-1:2007, *Metallic tube connections for fluid power and general use - Part 1: 24 degree cone connectors (ISO 8434-1:2007)*
- EN ISO 9606-1:2013, *Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1:2012 including Cor 1:2012)*
- EN ISO 9606-2:2004, *Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)*

EN ISO 9606-3:1999, *Approval testing of welders - Fusion welding - Part 3: Copper and copper alloys (ISO 9606-3:1999)*

EN ISO 9606-4:1999, *Approval testing of welders - Fusion welding - Part 4: Nickel and nickel alloys (ISO 9606-4:1999)*

EN ISO 9712:2012, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012)*

EN ISO 13849-1:2008, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2006)*

EN ISO 14732:2013, *Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732:2013)*

EN ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607:2003)*

EN ISO 15609-1:2004, *Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15610:2003, *Specification and qualification of welding procedures for metallic materials - Qualification based on tested welding consumables (ISO 15610:2003)*

EN ISO 15611:2003, *Specification and qualification of welding procedures for metallic materials - Qualification based on previous welding experience (ISO 15611:2003)*

EN ISO 15612:2004, *Specification and qualification of welding procedures for metallic materials - Qualification by adoption of a standard welding procedure (ISO 15612:2004)*

EN ISO 15613:2004, *Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613:2004)*

EN ISO 15614-1:2004, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

EN ISO 15614-2:2005, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005)*

EN ISO 17637:2011, *Non-destructive testing of welds - Visual testing of fusion-welded joints (ISO 17637:2003)*

ISO 37:2011, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 262:1998, *ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts*

ISO 301:2006, *Zinc alloy ingots intended for castings*

ISO 815-1:2008, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 1083:2004, *Spheroidal graphite cast irons - Classification*

ISO 1817:2011, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 7637-2:2011, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

ISO 7637-3:2007, *Road vehicles — Electrical disturbances from conduction and coupling — Part 3: Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines*

ISO 23529:2010, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

API SPEC 5L:2012, *Specification for Line Pipe*

ASTM A 106/A 106 M:2013, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

ASTM A 193/A 193M:2013, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A 194/A 194M:2013, *Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A 213/A 213M:2014, *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*

ASTM A 269:2013, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

ASTM A 312/A 312 M:2014, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*

ASTM A 320/A 320M:2011, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

ASTM A 333/A 333M:2013, *Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service*

ASTM A 395/A 395M:1999, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*

ASTM A 420/A 420M:2013, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service*

ASTM A 536:1984, *Standard Specification for Ductile Iron Castings*

ASTM A 874/A 874M:1998, *Standard Specification for Ferritic Ductile Iron Castings Suitable for Low-Temperature Service*

ASTM B 85/B 85M:2013, *Standard Specification for Aluminum-Alloy Die Castings*

ASTM B 283/B 283M:2014, *Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)*

ASTM B 584:2013, *Standard Specification for Copper Alloy Sand Castings for General Applications*

ASTM F 593:2013, *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*

ASTM F 594:2009, *Standard Specification for Stainless Steel Nuts*

MSS SP-55:2011, *Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components — Visual Method for Evaluation of Surface Irregularities (ANSI-approved American National Standard)*

SAE J429:2014, *Mechanical and Material Requirements for Externally Threaded Fasteners*

SAE J995:2012, *Mechanical and Material Requirements for Steel Nuts*

3 Terms and definitions

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

- 3.1**
control
device which provides functionality as specified in the specific control standard
- 3.2**
control function
function providing safe operation of burners and appliances burning gaseous or liquid fuels
- 3.3**
closure member
movable part of the control which shuts off the gas flow
- 3.4**
breather hole
orifice which allows atmospheric pressure to be maintained within a compartment of variable volume
- 3.5**
external leak-tightness
leak-tightness of a gas-carrying compartment with respect to atmosphere
- 3.6**
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
- 3.7**
inlet pressure
pressure at the inlet of the control
- 3.8**
outlet pressure
pressure at the outlet of the control
- 3.9**
pressure difference
difference between the inlet and outlet pressures
- 3.10**
maximum inlet pressure
highest inlet pressure as stated in the installation and operating instructions at which the control can be operated
- Note 1 to entry: The Definition of “*maximum inlet pressure*” in this document corresponds to the definition of “*maximum allowable pressure*” in the PED.
- 3.11**
minimum inlet pressure
lowest inlet pressure as stated in the installation and operating instructions at which the control can be operated
- 3.12**
flow rate
volume flowing through the control in unit time

3.13

rated flow rate

air flow rate at a specified pressure difference, corrected to standard conditions

3.14

maximum ambient temperature

highest temperature of the surrounding air as stated in the installation and operating instructions at which the control can be operated

3.15

minimum ambient temperature

lowest temperature of the surrounding air as stated in the installation and operating instructions at which the control can be operated

3.16

mounting position

position as stated in the installation and operating instructions for mounting the control

3.17

nominal size

DN

numerical designation of size, for reference purposes

3.18

apparatus

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

3.19

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)

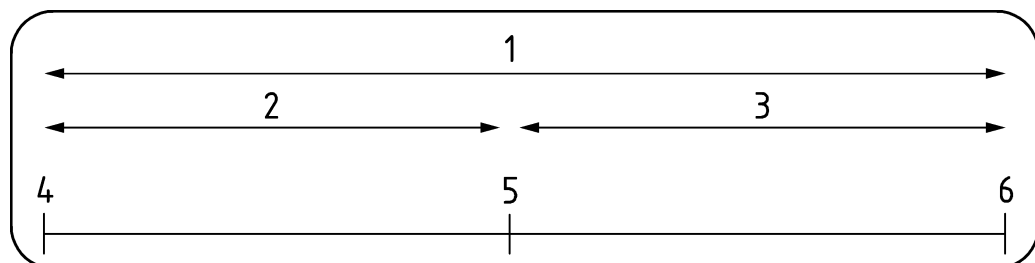
3.20

fault tolerating time

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

Note 1 to entry: Actions other than shutdown of a burner are possible if they can show prevention of hazardous situations.

Note 2 to entry: For illustration see Figure 2.



Key

1	fault tolerating time	4	fault occurs
2	fault detection time	5	fault flagged
3	max. fault reaction time	6	shutdown

Figure 2 — Fault tolerating time

3.21

fault reaction time

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

3.22

normal operation

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

3.23

safety shutdown

process which is effected immediately following the response of a protection device or the detection of a fault in the control system and assumes a state in which the output terminals ensure a safe situation

3.24

reset

action releasing the control from lock-out

3.25

lock-out

safety-shutdown condition of the system, where a release from this condition can be accomplished by a reset

3.26

failure

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

[SOURCE: IEC 60050-191:1990, 191-04-01]

3.27

degradation

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

Note 1 to entry: The term “degradation” can apply to temporary or permanent failure.

[SOURCE: IEC 60050-161:1990, 161-01-19]

3.28

fault

state of an item characterized 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 to entry: “Failure” is an event, as distinguished from “fault”, which is a state.

Note 2 to entry: After failure the item has a fault.

Note 3 to entry: This concept as defined does not apply to items consisting of software only.

Note 4 to entry: A fault is often the result of a failure of the item itself, but can exist without prior failure.

[SOURCE: IEC 60191-1:2007, 191-05-01]

3.29

harm

physical injury and/or damage to health or property

[SOURCE: ISO/IEC Guide 51:1999]

3.30

hazard

potential source of harm

[SOURCE: 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

[SOURCE: 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

[SOURCE: prEN 60730-1:2013, H.2.23.13]

3.33

program

sequence of control operations

Note 1 to entry: It can consist of switching on, starting up, supervising and switching off, safety shutdown or lock out.

3.34

presetting device

device for adjusting an intended operating condition

3.35

reset function

function that provides reset from lock-out allowing the system to attempt a restart

Note 1 to entry: The reset function can be performed by various electric/electronic (mobile) devices.

3.36

rated voltage

voltage as stated in the installation and operating instructions at which the control can be operated

3.37

rated current

current as stated in the installation and operating instructions at which the control can be operated

3.38

jointing compound

sealing material between two pipes or tubes that are to be joined

3.39

union joint

connection of pipe with union head having a male screw thread and a pipe by means of a union tail piece and a union nut

3.40

common cause failure

failures of different items, resulting from a single event, where these failures are not consequences of each other

Note 1 to entry: Common cause failures should not be confused with common mode failures.

[SOURCE: IEC 60050-101:2004]

3.41

non-permanent operation

operation in the running position for less than 24 h

3.42

permanent operation

operation in the running position for more than 24 h

3.43

terms and definitions for a Method to determine safety integrity level (SIL)

see J.3

3.44

terms and definitions for a Method to determine performance level (PL)

see K.3

3.45

terms and definitions for seals of elastomer, cork and synthetic fibre mixtures

see O.3

4 Classification

4.1 Classes of control

For classification of controls, see 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 with connection sizes up to and including DN 20, for use in an appliance where they are not subjected to bending stresses imposed by installation pipe work or in an installation if used with 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 recognize three distinct classes:

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

NOTE 1 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 2 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 3 Examples are: burner control systems, thermal cut-outs for closed water systems (without vent protection).

4.4 Types of *DC* supplied controls

DC supplied controls according to Annex I will fall into one of the three following types:

Type A: Stand-alone battery systems;

Type B: Battery systems for mobile applications;

Type C: Systems which are intended to be connected to *DC* supply networks.

5 Test conditions and uncertainty of measurements

5.1 Test conditions

Except where otherwise stated, the tests shall be carried out

- with air at $(20 \pm 5) ^\circ\text{C}$,
- at ambient temperature $(20 \pm 5) ^\circ\text{C}$.

All measured values shall be corrected to standard conditions:

15 °C, 101,325 kPa (1 013,25 mbar) dry.

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

Tests shall be carried out in the mounting position as stated in the installation and operating instructions. Where there are several mounting positions, tests shall be carried out in the least favourable position. Where possible those tests already covered by other standards (e.g. by relevant parts of prEN 60730-1:2013) shall be combined.

All measurements shall be made after stable conditions have been reached.

5.2 Uncertainty of measurements

Except where otherwise stated in the particular clauses, measurements shall be carried out with the maximum uncertainties indicated below:

- Absolute pressures $\pm 500 \text{ Pa}$ or $\pm 4 \%$, whichever is greater;
- Relative pressures $\pm 50 \text{ Pa}$ or $\pm 2 \%$ of the measured value, whichever is greater (e.g. gauge pressures or differential pressures);
- Flow rate $\pm 3 \%$ of the measured value;
- Leakage rate $\pm 10 \text{ cm}^3/\text{h}$ (The apparatus shown schematically in Annex C or another device giving equivalent results is used.);

- Time $\pm 0,1$ % or $\pm 0,2$ s, whichever is greater;
- Temperatures ± 1 K;
- Torque ± 10 %;
- Force ± 10 %;
- Current ± 1 %;
- Voltage ± 1 %;
- Electrical Power ± 2 %;
- Supply frequency $\pm 0,1$ Hz.

The full range of the measuring apparatus is chosen to be suitable for maximum anticipated value.

The measurement uncertainties as listed above concern individual measurements. For measurements requiring a combination of individual measurements (e.g. efficiency measurements), lower uncertainties for the individual measurements can be necessary to limit the total uncertainty.

6 Design and construction

6.1 General

Controls shall be designed, so that the various functions operate correctly when installed and used as stated in the installation and operating instructions.

Mechanical controls shall be designed such that access to internal parts requires the use of tools. For other controls access to internal parts shall only be possible by the use of tools. All pressurized parts of a control shall withstand the mechanical and thermal stresses to which it is subjected without any deformation affecting safety.

Safety accessories and pressure accessories with a product of the maximum allowable pressure PS and the volume V of less than $600\,000\text{ kPa} \times \text{dm}^3$ ($6\,000\text{ bar} \times \text{l}$) or with a product of PS and DN of less than $300\,000\text{ kPa}$ ($3\,000\text{ bar}$) shall conform to the requirements in Annex F, Annex G and Annex H.

If a control system consists of one apparatus and provides two or more different control functions, the system shall provide the same overall safety level as the independent control functions provide for the complete application.

Any interference between individual control functions shall be assessed with respect to both the functional condition and any fault conditions.

Failures in any function shall not affect safe operation of the control function. Each individual function shall be assessed in accordance with the requirements of this standard.

Control functions, integrated into a multifunctional system, shall be able to withstand the same long-term performance requirements as required for independent controls.

Compliance to these requirements is covered by the tests given in Clause 6, Clause 7, Clause 8 and Clause 9

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.

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.

NOTE Suitable jointing compounds can additionally be used.

6.2.3 Breather holes

6.2.3.1 Requirements

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 6.2.3.2

If a leakage rate limiter is used, it shall be able to withstand 3 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.

6.2.3.2 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.

6.2.4 Screwed fastenings

Screwed fastenings which can be removed for service or adjustment shall have metric threads that conform to ISO 262:1998 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 that can fall into the gas carrying compartment shall not be used.

Self-tapping screws which form a thread and do not produce swarf can be used provided that they can be replaced by metric machine screws conforming to ISO 262:1998, e.g. for service purposes.

6.2.5 Jointing

Jointing compounds for permanent assemblies shall provide a leak-tight connection under normal (intended/specified/designated) operating conditions. Sealing materials for metallic threaded joints in contact with gas shall conform to EN 751-1:1996, EN 751-2:1996 or EN 751-3:1996. For other sealing materials for metallic threaded joints, not covered by EN 751 (all parts), evidence shall be provided in the technical documentation that this material is suitable for its application.

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.

6.2.6 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.

6.2.7 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 as stated in the installation and operating instructions.

6.2.8 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 installation and operating instructions.

Closure parts, including those of measuring and test points, which can be dismantled for service or adjustment shall be constructed such that leak-tightness is achieved by mechanical means (e.g. metal-to-metal joints or 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).

6.2.9 Auxiliary canals and orifices

Blockage of auxiliary canals and orifices used for safe functioning shall not lead to a situation where the specific control comes in an unsafe operating condition, otherwise they shall be protected against blockage.

6.2.10 Presetting device

A presetting device shall only be adjustable by use of a tool. The means of adjustment shall be easily accessible and shall not change of its own accord. Interference with the means of adjustment other than authorized in the installation and operating instructions shall be visible e.g. use of a sealing (lacquer).

A presetting device that connects a gas-carrying part to atmosphere shall be made sound by a means which shall not seal on the thread of the presetting means, e.g. use of an O-ring seal.

The presetting device shall not be able to fall off. If an O-ring or equivalent gasket provides a seal against the atmosphere, then when the presetting device is completely unscrewed it shall not be able to be pushed out by gas pressure and shall remain tight at the maximum inlet pressure.

If a presetting device is used for different gas families it shall have a fixed minimum orifice. A cover of any presetting device shall require a tool for removal and replacement and it shall not interfere with other settings.

NOTE Example of presetting devices are flow rate adjusters.

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 lifetime when installed and used as stated in the installation and operating instructions. Under these circumstances, all components shall withstand any mechanical, chemical, and thermal conditions to which they can be subjected during service.

6.3.2 Housing

6.3.2.1 Requirements

Parts of the housing which directly or indirectly separate a gas-carrying compartment from atmosphere shall be made from metallic materials that:

- a) have a melting point (solidus temperature) of at least 427 °C, or
- b) conform to 6.3.3.

For housings according a), the external leakage after removal or fracture of non-metallic parts other than O-rings, gaskets and sealing parts of diaphragms, should be no more than 30 dm³/h of air escapes at the maximum inlet pressure, when tested according to 6.3.2.2.

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

6.3.2.2 Test

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. Any breather holes shall be blocked. Pressurize the inlet and outlet(s) of the control to the maximum inlet pressure and measure the leakage rate.

6.3.3 Zinc alloys

6.3.3.1 Requirements

Zinc alloys (ZnAl4) for gas carrying parts shall conform to the following:

- DN size shall be ≤ DN 50;
- The maximum inlet pressure shall be ≤ 20 kPa (200 mbar);
- The maximum ambient temperature shall be 80 °C;
- Quality of ZnAl4 shall conform to ISO 301:2006;

with the following restriction:

Where zinc alloy parts are used in the part upstream of the closure member of automatic shut-off valves (stand-alone or as part of a multifunctional control) which are in contact with gas, this housing upstream of the closure member, including the inlet connection, shall conform to 6.3.2.1 a) and upon removal of those Zinc Alloy parts in the housing upstream of the closure member, the external leakage rate shall be less than 30 dm³/h at maximum inlet pressure when measured according to 6.3.3.2. If the housing of the automatic shut-off valve contains, in addition to zinc alloy parts upstream of the closure member, also non-metallic parts in contact with gas, these parts shall also be removed for this test.

Parts made of Zinc alloy can be used inside the housing of the gas control.

6.3.3.2 Test

Remove all non-metallic parts and zinc alloy parts of the housing upstream of the closure member which separate a gas-carrying compartment from atmosphere, excluding O-rings, gaskets and sealing part of diaphragms. Any breather holes shall be blocked.

Pressurize the inlet and the outlet of the control to the maximum inlet pressure and measure the leakage rate.

6.3.4 Springs

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 13906-1:2013 or EN 13906-2:2013.

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.

6.3.5 Resistance to corrosion and surface protection

All parts in contact with gas or atmosphere and springs other than those covered by 6.3.4, 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.

6.3.6 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).

6.3.7 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 Adjusted glands protected against further adjustment are 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 and Table 2.

Table 1 — Gas connection sizes for Group 1

External thread pipe size or internal thread size flange / control	Nominal size	For compression fittings, fiber seal and flare connections ^{a)}					
		compression fitting		fiber seal connection		Flare connection	
	DN	union / tubing nut	tube size ≤	union nut	tube size ≤	union / tubing nut	tube size ≤
inch		Spanner size mm	mm	Spanner size mm	mm	Spanner size mm	mm
1/8	6	13	6	13	6	13	6
1/4	8	16	8	16	8	16	8
3/8	10	19	12	19	12	19	12
1/2	15	24	16	24	16	24	16
3/4	20	32	22	32	22	32	22
1	25	39	28	39	28	39	28

^{a)} For illustration refer to Figure 3.

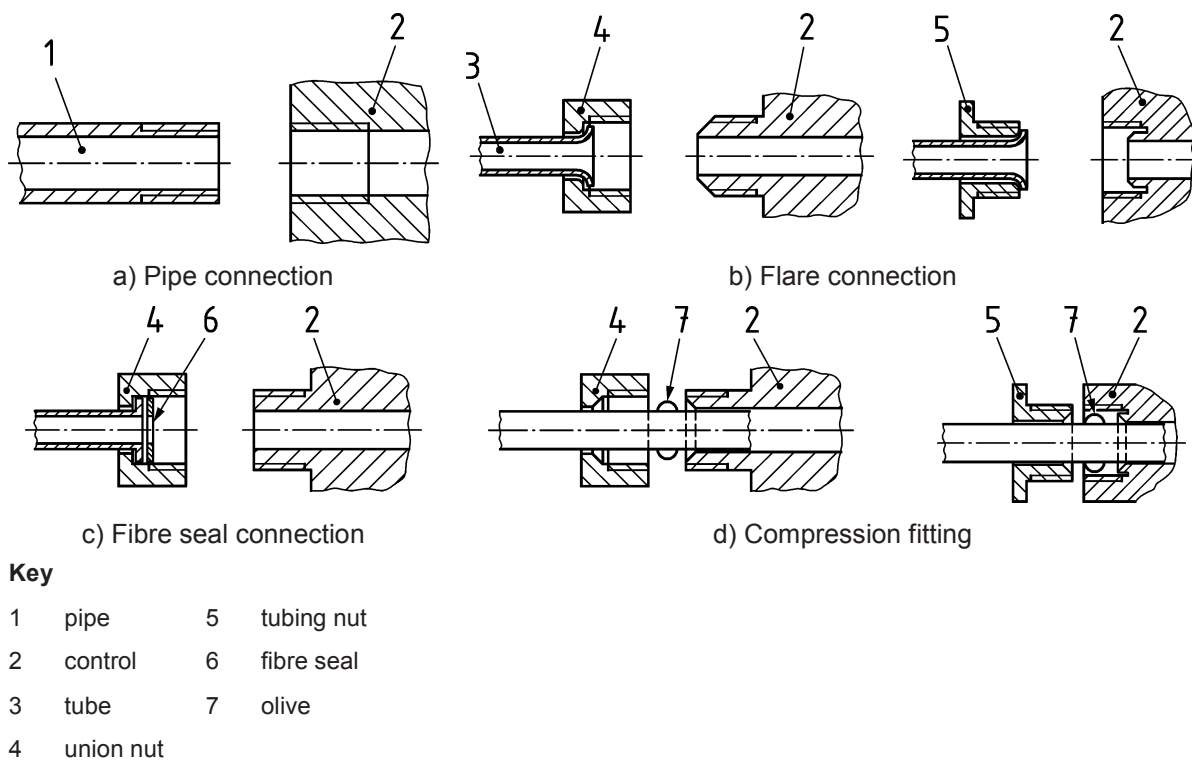


Figure 3 — Types of connections

Table 2 — Gas connection sizes for Group 2

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 according to EN 1092-1:2007+A1:2013, EN 1092-2:1997, EN 1092-3:2003, EN 1092-4:2002, EN 1759-1:2004, EN 1759-3:2003 and EN 1759-4:2003.

6.4.3 Threads

Inlet and outlet threads shall be according to EN 10226-1:2004, EN 10226-2:2005 or to EN ISO 228-1:2003 and shall be chosen from the series given in Table 1 and Table 2.

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 EN 10226-2:2005 or EN ISO 228-1:2003.

6.4.5 Flanges

Where flanges are used on controls, they shall be suitable for connection to flanges according to EN 1092-1:2007+A1:2013, EN 1092-2:1997, EN 1092-3:2003, EN 1092-4:2002, EN 1759-1:2004, EN 1759-3:2003 and EN 1759-4:2003., PN 6 or PN 16. Alternatively suitable adapters shall be supplied to enable connection to these flanges or to threads according to 6.4.3, or full details of mating parts shall be supplied.

Alternatively it is recommended to use suitable adapters to enable connection to these flanges or to threads according to 6.4.3, or full details of mating parts should be supplied.

NOTE EN 1092-1:2007+A1:2013 has a different flange hole arrangement for DN 65 with PN 16. The 4-hole arrangement of the previous edition has changed into an 8-hole arrangement.

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 can 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. Strainers fitted to controls of DN 25 and above shall be accessible for cleaning or replacement without the need to remove the control body by dismantling threaded or welded pipe work.

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

6.5 Electrical 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 control will operate safely and in accordance with the requirements of this standard for a reasonable life time. That shall continue under the mechanical, chemical, thermal and environmental conditions normally expected, even in the event of such carelessness as can occur in normal use. This is provided that compliance with the installation and operating instructions is ensured. Compliance is checked by carrying out the tests specified in this standard.

The control shall be designed such that changes in critical circuit component values (such as those affecting timing or sequence) within the worst case specifications of the components, including the long-term stability, shall result in the control continuing to function in accordance with this standard. Compliance shall be checked by worst case analysis.

6.5.2 Switching elements

6.5.2.1 Requirements

For Class C control functions the control shall include at least two switching 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 switching element.

Measures shall be taken to protect against failure of two (or more) switching elements, due to a common cause, by an external short circuit that would prevent the control from performing a safety shutdown.

Acceptable methods are current limitation, overcurrent protection device or internal fault detecting functions.

When tested according to 6.5.2.2 either

— the capability to interrupt the energization of the safety related output terminals by means of at least one switching element shall be maintained

or

— a non-replaceable overcurrent protection device shall have interrupted.

6.5.2.2 Test of protecting measures against failure of switching elements

The safety related output terminals of the control are connected to a switch that is intended to switch the short circuit current. With this switch opened, the control is connected as described in prEN 60730-1:2013, H.27.1.1.2 with the outputs energized to simulate normal operation (contacts of the internal switching elements closed).

Where overcurrent protection devices are used as the protective measure the power supply to the control shall have the capability of supplying an inrush current of at least 500 A. Where current limitation techniques are used the power supply to the control shall not limit the current.

A short-circuit is applied between output terminals of the control by closing the switch.

The test is terminated if there is no current flow through the switch, or after 1 h.

If an overcurrent protection device is replaceable and operated during the test it shall be replaced and the test is repeated two more times by attempting to restart the control keeping the switch closed.

A second test procedure is conducted in the same way, with the switch closed prior to the first start-up sequence; a second test sample can be used for this second test procedure.

If an internal fault detecting function of the control either opens the switching elements or initiates a safety shutdown the test is repeated 2 times while maintaining the external short circuit by attempting to restart the control.

Compliance is checked in accordance with prEN 60730-1:2013, H.27.1.1.3 and Clause 15.

After the test at least one switching element of the control shall be able to de-energize the safety related output terminals, or a non-replaceable overcurrent protection device permanently interrupted the supply to the safety related output terminals.

Designs where at least two relays are used as switching elements with independent contacts and in series with a non-replaceable fuse (see Table E.1, h) with $I_N < 0,6 * I_e$, are considered to conform to the requirements for prevention of common cause failure, without further testing.

NOTE I_N : values for the fuse (see EN 60127-1:2006, 3.16).

I_e : rated operational current of the contact (see EN 60947-1:2007, 4.3.2.3).

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.

6.5.3.2 Tests

An examination of the circuit shall be carried out in accordance with 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 unless the effect is controlled and does not 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 in accordance with the specific control standard.

6.5.3.4 Gas controls employing electrical components in the gas way

6.5.3.4.1 Requirements

Gas controls employing electrical components in the gas way shall either meet the leakage requirements of 7.2 after the test of 6.5.3.4.2 or shall not represent an ignition source if tested according to 6.5.3.4.3.

NOTE The use of open electricity in the gas way of a gas controls represents a risk of explosion in case an explosive gas/air mixture is present in the gas way. Such a mixture can be the result of air diffusing into the gas way of the control.

6.5.3.4.2 Test by ignition trial

Ignition test shall be performed by ignition trial from those points where un-insulated electrical parts are in contact with gas, which might require a special preparation of the test sample.

The ignition test shall be done by making use of a sparking transformer with spark energy of at least 10 μ As.

Straight piping of 1,5 m shall be attached to both the inlet and outlet connections of the sample with a manual valve attached to each end of the straight piping. Piping diameter shall be equal to valve connections.

Test sequence:

- The test sample shall be activated to open position, if applicable.
- The two manual valves shall be opened.
- A gas-air test mixture comprised of 5 % propane and 95 % air (by volume) shall be introduced into the inlet end of the piping system.
- When a sufficient volume of the test mixture has been introduced to ensure a uniform distribution of the test mixture throughout the piping system and the gas way of the test sample, the inlet manual valve shall be closed.
- The outlet manual valve shall be closed immediately thereafter.
- The test sample shall remain opened, if applicable and the sparking transformer activated ensuring that there is sparking on the ignition electrodes.
- After ignition of the gas-air test mixture or if no ignition occurs after 10 seconds of sparking, the test is repeated with the test sample closed if applicable.

In addition for controls with a closure member the following test shall be performed:

- After refilling the piping system and the gas way of the test sample with the test mixture, the inlet manual valve shall be closed, and immediately thereafter the test sample shall be closed.
- The outlet manual valve shall remain opened and the gas-air test mixture ignited.

These two tests shall be performed 3 times on each of two test samples. If no ignition could be accomplished, the requirements are met.

If ignition could be accomplished, test samples that are operable shall be cycled 5 times.

After that all test samples, whether operable or not, shall be tested according the leakage tests of 7.2.2.

6.5.3.4.3 Test of ignition source

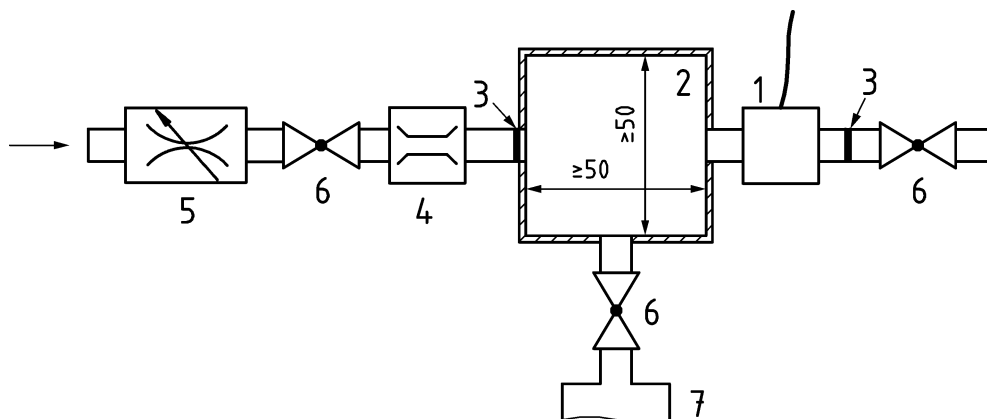
The electrical components in the gas way shall be analysed with regard to EN 1127-1:2011 as possible ignition sources in relation to the relevant gas compartment. For the assessment Class B according to 6.6.3 shall be applicable.

NOTE For electrical components representing an ignition source measures for avoidance by proper design or protective measures are specified in EN 1127-1:2011.

The experimental test setup is shown in Figure 4. The test chamber for explosion testing of the gas controls shall have a minimum volume of at least 1 dm³ and shall withstand by choice of proper materials and design the changes of pressure and temperature during testing. The distance of opposite test chamber walls shall be at least 50 mm to avoid wall effects and to ensure in case of ignition, a proper ignition of the whole internal volume with the test gas.

- The test gas shall consist of a mixture of $5,2 \pm 0,5$ Vol.-% propane and $94,8 \pm 0,5$ Vol.-% air.
- The absolute pressure inside the test chamber shall be $101 \text{ kPa} \pm 10 \%$.
- The gas temperature inside the test chamber shall be at least $20 \text{ }^{\circ}\text{C}$.

The gas control shall be adapted to the test chamber, the tapering of the cross section of the connection to the test chamber shall be kept minimal. Alternatively that part of the control that might be a possible ignition source is placed inside the test chamber. During the testing the test chamber and the adapted gas control (if applicable) shall be gas tight. In case of a continuous flow the test gas shall pass the gas control, or the test chamber and an appropriate flame retarding device at the exit. The test gas composition shall be ensured by measuring the gas concentration at the exit port of the test chamber. Inadmissible pressure increases in case of continuous flow mode and an ignition shall be avoided by use of burst discs or comparable means. The pressure relief of the burned gases and the exhaust gas of the test chamber shall be handled safely.



Key

1	test sample	5	restrictor
2	test chamber	6	valve
3	flame retarding device	7	burst disc
4	flow meter		

Figure 4 — Experimental setup for ignition testing

For the ignition testing with regard to the probability of ignition the gas control shall be adapted to the test chamber as described by the manufacturer's installation manual, which comprises the pneumatical and electrical connections, power and control lines. Alternatively that part of the control that might be a possible

ignition source is placed inside the test chamber. Exposed to the test gas the gas control or the possible ignition source is operated such that each operating state is reached, but at least 10 times.

The control or the possible ignition source shall be operated under the following electrical conditions:

- a) for AC supplied controls at the most unfavourable voltage in the range 85 % to 110 % of the rated supply voltage as stated in the installation and operating instructions (unfavourable in the sense of power input or a possible spark formation, e.g. in case of relay contacts);
- b) for DC supplied controls within the scope of Annex I a tolerance of 20 % to the minimum and the maximum rated voltage applies. For DC supplies of other types the tolerance shall be stated in the installation and operating instructions;
- c) if a heat up of any actuating member does occur equilibrium shall be achieved (hottest surface temperatures).

These tests shall be performed on each of two test samples. If no ignition is accomplished, the controls are not representing an ignition source and the requirements are met.

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

6.6.1.1.1 General

Controls shall be designed in accordance with 6.6 (taking into account the fault modes of Annex E) and in accordance with prEN 60730-1:2013, H.11.12 for complex electronics being assemblies which use electronic components with the following characteristics:

- a) The 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.

Components shall be dimensioned on the basis of the worst-case conditions which can arise in the control.

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

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

6.6.1.1.2 Design

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 design configuration which is either inherently fail safe or in which components with direct safety-critical functions (e.g. shut-off valve drivers, microprocessors with their associated circuits, etc.) are guarded by safeguards (in accordance to prEN 60730-1:2013, 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 shutdown. 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 The secondary safeguard can be realized 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).

6.6.1.2 Lock-out function

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 control shall proceed to safety shutdown. Frequency of test is given in the specific control standard. Internal faults on components of the checking circuit are not considered.

6.6.1.3 Reset device

The control 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 control to operate outside the requirements of this standard or prevent it from going to shutdown or lock-out.

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

Detailed requirements are given in Annex M.

6.6.1.4 Documentation

The functional analysis of the control and the safety related programs under its control shall be documented, resulting in a specification of all functional requirements and of all safety requirements for the control.

The documentation shall be expressed and structured in such way that it is clear, precise, unambiguous, verifiable, testable, maintainable and feasible.

As a minimum the following design documentation shall be available:

- a) a specification of functional requirements and of safety requirements including the following aspects:
 - 1) The requirements specification shall be expressed in natural or formal language and/or logic, sequence or cause and effect diagrams that define the necessary safety functions with each safety function being individually defined.
 - 2) The requirements specification shall be structured with a hierarchical separation into sub requirements; refined down to functional level.

- 3) The specification of safety requirements shall include a description of all safety-related control functions and their control function class.
 - 4) The specification of safety requirements shall include appropriate requirements to consider
 - the boundary of the appliance and possible hazards (from process, environment, etc.);
 - operation, functions, interfaces, special safety regulations and environment of the appliance;
 - all hazards or hazardous events of the appliance, and all potential hazards for the application arising from the control itself;
 - safety requirements, safety-related control functions requirements and safety integrity requirements, dealing with the necessary constraints on the system architecture that ensure sufficient fault tolerance for the control.
 - 5) The interfaces between safety-related control functions and non-safety-related control functions shall be well-defined. Safety-related control functions and non-safety-related control functions as well as safety-related control functions with different control function classes shall be implemented sufficiently independent, otherwise they shall be implemented with the highest class associated to a control function.
- b) a specification of the system architecture including the following aspects:
- 1) Partitioning into modules / subsystems with a description of the modules / subsystems and a description of the interfaces between modules / subsystems.
 - 2) The allocation of control functions to modules / subsystems.
- c) a software documentation (for controls using software) in accordance with prEN 60730-1:2013, H.11.12.

There shall be a consistent relationship between the various parts of the documentation. It shall be possible to trace requirements from their definition to design / implementation and assessment / verification / validation.

6.6.2 Class A

Fault assessment is not applicable.

NOTE The requirements of electrical safety as described in Clause 8 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 complies with 6.6.3.2 and 6.6.3.3. A second independent fault is not considered. Software shall conform to software Class B of prEN 60730-1:2013.

Under the test conditions and criteria of 6.6.5, 6.6.3.2 and 6.6.3.3 are applicable.

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 shutdown, or to lock-out, provided that subsequent reset from the lock-out condition under the same fault condition results in the control 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- shutdown

Whenever the control is in lock-out or in safety shutdown 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 shutdown or lock-out position, shall result in either:

- a) The control remaining in safety shutdown 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 shutdown 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 shutdown or lock-out position, e.g. shut-off valve terminal, but not a terminal for an actuator driving the controlling element of a gas air ratio control (see EN 12067-2:2004).

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 complies with 6.6.4.2, 6.6.4.3 and 6.6.4.4. A third independent fault is not considered.

Software shall conform to software Class C of prEN 60730-1:2013.

Under the test conditions and criteria of 6.6.5, 6.6.4.2, 6.6.4.3 and 6.6.4.4 are applicable.

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 shutdown, or to lock-out, provided that subsequent reset from the lock-out condition under the same fault condition results in the control 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 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).

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 can 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- shutdown

6.6.4.4.1 General

Whenever the control is in lock-out or safety shutdown without an internal fault, 6.6.4.4.2 and 6.6.4.4.3 are applicable.

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 shutdown with an internal fault, in addition 6.6.4.4.3 is applicable.

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 shutdown or lock-out position, e.g. shut-off valve terminals, but not a terminal for an actuator driving the controlling element of a gas air ratio control (see EN 12067-2:2004).

6.6.4.4.2 First fault introduced during lock-out or safety- shutdown

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 shutdown or lock-out position, shall result in either:

- a) the control remaining in safety shutdown 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 shutdown 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- shutdown

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 shutdown or lock-out position, shall result in either 6.6.4.4.2 a), b) or c).

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.

While conducting this test, the second fault can be applied at any time during the lock-out or safety-shutdown condition. It is not necessary to wait 24 h before applying the second fault. If the second fault was applied before 24 h and unacceptable results were obtained, the initial fault should be applied and then 24 h should pass before the second fault is applied.

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 program sequence.

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

- a) for AC supplied controls at the most unfavourable voltage in the range 85 % to 110 % of the rated supply voltage as stated in the installation and operating instructions;
- b) for DC supplied controls within the scope of Annex I a tolerance of 20 % to the minimum and the maximum rated voltage applies. For DC supplies of other types the tolerance shall be stated in the installation and operating instructions;
- c) loaded with the most unfavourable load as stated in the installation and operating instructions;
- d) 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 range as stated in the installation and operating instructions;
- e) with any actuating member placed in the most unfavourable position;
- f) with tissue paper placed on the supporting surface(s) of the control;
- g) 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 assessment, 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 prEN 60730-1:2013, Clause 8 and Clause 13. If it ceases to function, it shall still continue to conform to prEN 60730-1:2013, Clause 8.

After the test there shall be no deterioration of the various parts of the control that would result in failure to conform to prEN 60730-1:2013, Clause 20.

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 assessment of the circuit shall be carried out to determine its performance under the specified fault conditions.

A failure mode and effect analysis (FMEA) shall be performed to determine the effect of each failure mode of each component or group of components in the element under consideration of diagnostic tests (self-tests).

The FMEA shall take the form of a theoretical analysis in combination with component fault insertion tests. Fault simulations can also be carried out to assess faults within complex devices, e.g. EPROM emulation tests.

In order to undertake this analysis the following information is required:

- a detailed block diagram of the control describing the element together with the interconnections for those parts of the control which will affect the safety function(s) under consideration;
- the hardware schematics of the element describing each component or group of components and the interconnections between components;
- the failure modes and rates of each component according to Annex E.

Only the safety related software (Software Class B and C) as identified according to 6.6.1.4 shall be subjected to further assessment.

7 Performance

7.1 General

Controls shall operate correctly under all combinations of the following:

- the full range of inlet pressures, as stated in the installation and operating instructions;
- the ambient temperature range from 0 °C to 60 °C or wider limits, if stated in the installation and operating instructions ;
- in all mounting positions as stated in the installation and operating instructions; where there are several mounting positions, tests are carried out in the least favourable position;
- for AC supplied controls: 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 and at rated frequency;
- for DC supplied controls (types A, B, and C as classified in 4.4) a tolerance of 20 % to the minimum and the maximum rated voltage applies (see Annex I). For DC supplied controls of other types the tolerance shall be stated in the installation and operating instructions.

7.2 Leak-tightness

7.2.1 Requirements

Gas controls shall be leak tight, in accordance with the leakage rates given in Table 3.

Table 3 — 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.

7.2.2 Tests

7.2.2.1 General

The external and internal leakage tests shall be carried out at the minimum temperature, at the maximum temperature and at (20 ± 5) °C.

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 gas 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.

NOTE 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 formula for conversion from the pressure loss method to the volumetric method is given in Annex D.

7.2.2.2 External leak-tightness

Pressurize the inlet and outlet(s) of the gas control to the test pressures given in 7.2.2.1 and measure the leakage rate.

Dismantle and reassemble closure parts 5 times as stated in the installation and operating instructions and repeat the test.

7.2.2.3 Internal leak-tightness

With any closure member in the closed position, pressurize the inlet of the gas control in the direction of gas flow indicated, to the test pressures given in 7.2.2.1 and measure the leakage rate.

7.3 Torsion and bending

7.3.1 General

Gas controls shall be constructed in such a way that they have adequate strength to withstand likely mechanical stress to which they can 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 3 or in the specific control standard.

7.3.2 Torsion and bending moments

7.3.2.1 Requirements

Gas controls shall withstand the torque given in Table 4/Table 5 when tested to 7.3.2.2.2 or 7.3.2.2.3.

Gas controls shall withstand the bending moment given in Table 4/Table 5 when tested to 7.3.2.2.4. Group 1 gas controls shall additionally be tested to 7.3.2.2.5.

Table 4 — Torque and bending moment for Group 1

Internal thread ^a			Nominal size DN	Internal or external thread	
For steel pipe connections				For compression fittings / fiber seal / flare connections	
Torque Nm	Bending Nm			Torque ^a Nm	Bending Nm
	10 s	900 s			900 s
15	15	7	6	10 (7)	7
20	20	10	8	15 (10)	10
35	35	20	10	25 (15)	17
50	70	40	15	40 (15)	35
85	90	50	20	50	45
125	160	80	25	75	80
^a Values in parentheses are for gas controls with flanged or saddle-clamp inlet connections on cooking appliances.					

Table 5 — Torque and bending moments for Group 2

Nominal size DN ^a	Torque N·m	Bending moment N·m
	10 s	10 s
6	15	25
8	20	35
10	35	70
15	50	105
20	85	225
25	125	340
32	160	475
40	200	610
50	250	1 100
65	325	1 600
80	400	2 400
100	-	5 000
125 > 150	-	6 000
≤ 150	-	7 600

^a Equivalent connection sizes are given in Table 1 and Table 2.

7.3.2.2 Tests

7.3.2.2.1 General

Use pipes in accordance with EN 10255:2004+A1:2007, medium series with a length of:

- at least 40 × DN for gas controls up to and including DN 50;
- at least 300 mm for gas controls above DN 50.

Use only non-hardening sealing paste on connections.

Determine the appropriate tightening torque to be applied to flange bolts to EN 1092 and EN 1759 from the values in Table 6.

Table 6 — 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 gas control for external leak-tightness to 7.2.2.2 and internal leak-tightness to 7.2.2.3 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 gas control and apply the torque and bending moment appropriate to each connection in turn.

Gas controls with compression fittings shall be subjected to the bending moment tests by means of an adapter on the union threads.

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

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

7.3.2.2.2 10 second torsion test – Group 1 and Group 2 gas controls with threaded connections

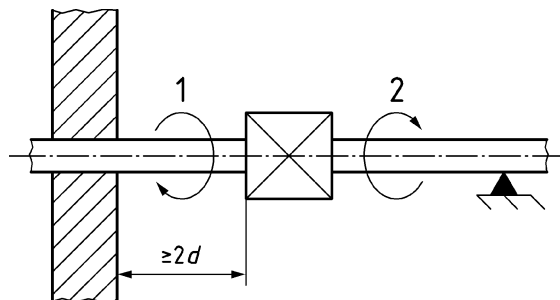
Screw pipe 1 into the gas control with a torque not exceeding the values given in Table 4/Table 5. Clamp pipe 1 at a distance at least $2d$ from the gas control (see Figure 5).

Screw pipe 2 into the gas control with a torque not exceeding the values given in Table 3. Ensure that all joints are leak-tight.

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

Progressively apply the appropriate torque to pipe 2 for 10 s without exceeding the values given in Table 4/Table 5. Apply the last 10 % of the torque over a period not exceeding 1 min.

After removal of the load, visually inspect the gas control for any deformation, then test the gas control for external leak-tightness to 7.2.2.2 and internal leak-tightness to 7.2.2.3 where applicable.



Key

d external diameter

Figure 5 — Torsion test assembly

7.3.2.2.3 10 second torsion test – Group 1 and Group 2 gas controls with compression joints

7.3.2.2.3.1 Olive-type compression joints

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

Clamp the gas control body rigidly and apply the test torque given in Table 3 to every tubing nut in turn for 10 s.

Visually inspect the gas control for deformation, discounting any deformation of the olive seating or mating surfaces consistent with the applied torque. Test the gas control for external leak-tightness to 7.2.2.2 and internal leak-tightness to 7.2.2.3 where applicable.

7.3.2.2.3.2 Flare and fibre seal compression joints

For the test use a short length of steel tube with a conical flared end for flare connections, or a flat flared end for fibre seal connections, and follow the method given in 7.3.2.2.3.1, discounting any deformation of the cone seating or mating surfaces consistent with the applied torque.

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

Attach the gas control to a manifold as stated in the installation and operating instructions and tighten the fixing screws to the recommended torque. Connect the olive or flared type compression coupling, as appropriate, and tighten to the torque, given in parentheses in Column 2 of Table 3, in accordance with the procedures given in 7.3.2.2.3.1 or 7.3.2.2.3.2.

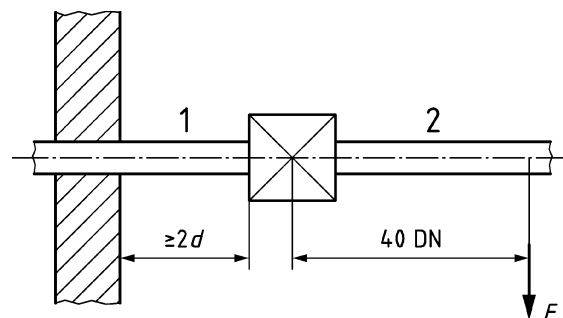
7.3.2.2.4 10 second bending moment test – Group 1 and Group 2 gas controls

Use the same gas control as for the torsion tests and the assembly as shown in Figure 6.

Apply the force for the required bending moment for Group 2 gas controls given in Table 4/Table 5 for 10 s, taking the mass of the pipe into consideration. Apply the force:

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

Remove the force and visually inspect the gas control for any deformation, then test the gas control for external leak-tightness to 7.2.2.2 and internal leak-tightness to 7.2.2.3 where applicable.



Key

d external diameter

Figure 6 — Bending moment test assembly

7.3.2.2.5 900 second bending moment test – Group 1 gas controls only

Use the same gas control as for the torsion tests and the assembly as shown in Figure 6.

Apply the force for the required bending moment for a Group 1 gas control given in Table 4/Table 5 for 900 s, taking the mass of the pipe into consideration. Apply the force:

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

With the force still applied, test the gas control for external leak-tightness to 7.2.2.2 and for internal leak-tightness to 7.2.2.3 where applicable.

7.4 Rated flow rate

7.4.1 Requirement

The maximum flow rate when measured according to 7.4.2 shall be at least 0,95 times the rated flow rate.

7.4.2 Test

Operate and adjust the gas control as stated in the installation and operating instructions.

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

Carry out the test using the test apparatus shown in Figure 7.