BS EN 50156-2:2015

BSI Standards Publication

Electrical equipment for furnaces and ancillary equipment

Part 2: Requirements for design, development and type approval of safety devices and subsystems

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/27, Electroheating.

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

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Elektrische Ausrüstung von Feuerungsanlagen - Teil 2: Bestimmungen für den Entwurf, die Entwicklung und die Baumusterprüfung von Sicherheitsbauteilen und Teilsystemen

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European foreword

This document (EN 50156-2:2015) has been prepared by CLC/BTTF 132-2 “Revision of EN 50156 'Electrical equipment for furnaces and ancillary equipment'”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-01-26
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2018-01-26

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This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

This European Standard is the second part of a series of European Standards that specify the requirements for equipment of safety functions for furnaces, especially safety related systems to protect personnel, the furnace with ancillary equipment against hazards related to heat generation, the heated system and to operate reliably during normal conditions, and abnormal conditions that can be foreseen.

EN 50156, *Electrical equipment for furnaces and ancillary equipment*, consists of the following parts:

- Part 1: Requirements for application design and installation;
- Part 2: Requirements for design, development and type approval of safety devices and subsystems;
- Part 3: Requirements for plant-specific tests of safety-related equipment [1)].

This European Standard is based on EN 61508:2010, *Functional safety – Safety-related systems*, Parts 1 to 7 as a basic safety standard.

1) In preparation.

Introduction

This part of EN 50156 sets out the requirements and recommendations for design, development and type approval of safety devices and subsystems to be applied to protect personnel, property and environment against the hazards of furnaces with ancillary equipment and the systems heated by the thermal energy released in the furnace. The operating conditions of the furnace, the hazards of combustion and the safety of the heated system are considered.

The safety requirements for all stages of the life-cycle of a particular plant, proof of fulfilment of the plant-specific safety-requirements, are defined in Part 1 of EN 50156. The requirements for plant specific tests during implementation, operation and maintenance are defined in Part 3 of EN 50156.

The requirements for the application of safety-related systems are specified in EN 50156-1:2015, Clause 10. The rating of necessary safety integrity levels, as specified in EN 50156-1:2015, 10.4, is based on EN 61508-1.

For the plant-specific implementation of safety-related systems, it is necessary to organize management of functional safety and to satisfy safety life-cycle requirements.

1 Scope

This part of EN 50156 applies to the requirements for design, development and approval of safety-relevant equipment for the safety related system for furnaces that are operated with solid, liquid or gaseous fuels and their ancillary equipment.

This part of EN 50156 specifies the requirements for safety-related equipment that is necessary to meet the safety conditions of furnaces, to reduce the hazards of combustion and to protect the heated systems from damage e.g. by overheating. Subsystems and devices of other technologies, which are part of the safety-related system (see EN 50156-1:2015, 3.38), are covered by this part of EN 50156.

This part of EN 50156 sets out special requirements for design, development and approval of safety devices and subsystems to satisfy the requirements of EN 50156-1:2015, Clause 10 “Additional requirements for the application of a safety-related system”.

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 161:2011+A3:2013, *Automatic shut-off valves for gas burners and gas appliances*

EN 267:2009+A1:2011, *Automatic forced draught burners for liquid fuels*

EN 298:2012, *Automatic burner control systems for burners and appliances burning gaseous or liquid fuels*

EN 676:2003+A2:2008, *Automatic forced draught burners for gaseous fuels*

EN 1643:2014, *Safety and control devices for gas burners and gas burning appliances - Valve proving systems for automatic shut-off valves*

EN 1854:2010, *Pressure sensing devices for gas burners and gas burning appliances*

EN 12067-2:2004, *Gas/air ratio controls for gas burners and gas burning appliances - Part 2: Electronic types*

EN 12952-11:2007, *Water-tube boilers and auxiliary installations - Part 11: Requirements for limiting devices of the boiler and accessories*

EN 12953-9:2007, *Shell boilers - Part 9: Requirements for limiting devices of the boiler and accessories*

EN 13611:2007+A2:2011, *Safety and control devices for gas burners and gas burning appliances - General requirements*

EN 16340:2014, *Safety and control devices for burners and appliances burning gaseous or liquid fuels - Combustion product sensing devices*

EN 50156-1:2015, *Electrical equipment for furnaces and ancillary equipment – Part 1: Requirements for application design and installation*

EN 60730-1:2011, *Automatic electrical controls for household and similar use - Part 1: General requirements (IEC 60730-1:2010)*

EN 60812:2006, *Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA) (IEC 60812:2006)*

EN 60947-2:2006, *Low-voltage switchgear and controlgear - Part 2: Circuit-breakers (IEC 60947-2:2006)*

EN 61010-1:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements (IEC 61010-1:2010+corr 2011)*

EN 61131-2:2007, *Programmable controllers - Part 2: Equipment requirements and tests (IEC 61131-2:2007)*

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

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 61508-5:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 5: Examples of methods for the determination of safety integrity levels (IEC 61508-5:2010)*

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 61800-5-2:2007, *Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional (IEC 61800-5-2:2007)*

EN ISO 23553-1:2014, *Safety and control devices for oil burners and oil-burning appliances - Particular requirements - Part 1: Automatic and semi-automatic valves (ISO 23553-1:2014)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 50156-1:2015 apply.

4 Requirements for safety devices and subsystems of safety-related systems

4.1 General

The qualification and conformity for subsystems or devices as E/E/PES is defined in 4.2 and for subsystems and devices of other technology in 4.3

Safety functions of the safety related system, such as flame monitoring, pre-purge, air-gas ratio control, fuel safety shut-off-valves etc. shall fulfil the requirements of the relevant product standards (see 4.2.2 and 4.3.2). When thereof are deviations (e.g. concerning process technical reasons,

operational reasons), the safety and reliability levels shall not be reduced. The deviations have to be described in the safety manual according to EN 61508-4:2010.

For subsystems and devices in accordance to the relevant product standards a quantitative determination of SIL is not required.

4.2 Requirements for safety devices and subsystems in electrical/electronic/ programmable electronic systems

4.2.1 General

If product standard exists for subsystems and devices continue according 4.2.2, if no applicable standard exists continue 4.2.3.

4.2.2 Type approval in accordance with product standards

Safety devices or subsystems shall be used which have been tested in accordance with a product standard as per the following list, if they are in the scope of these standards:

EN 298:2012, EN 1643:2014, EN 1854:2010, EN 12952-11:2007, EN 12953-9:2007, EN 12067-2:2004, EN 13611:2007+A2:2011, EN 16340:2014 and EN 61800-5-2:2007, EN ISO 23552-1:2014.

Products that combine several functions shall satisfy all the standards relevant for the functions. The product standards allow a range of subsystems with different level of functional safety. The requirements of the safety relevant systems according to the application standards have to be taken in account (e.g. EN 12952-8:2002, 6.3.3)

NOTE Some of the product standards are based on fault-exclusion models similar to the approach in EN 50156–1:2015, Figures 11 to 13 and Table 2. By using these safety devices or subsystems in safety-related systems this may require special measures during the design and safety validation.

4.2.3 Type approval following the requirements of EN 61508

4.2.3.1 General

Functional safety in accordance to EN 61508 (all parts) shall be proven for electrical/electronic/ programmable electronic systems within the safety function.

Additionally the following requirements shall be fulfilled.

4.2.3.2 Safety requirement and functional specification: A specification describing the desired function of the device has to be provided. This specification shall describe the required safety function of the device as well the operational behaviour.

4.2.3.3 Safety management: A safety management system shall be present for all lifecycle phases during development e.g. safety plan, Verification&Validation plan.

4.2.3.4 Preventing and managing systematic faults (systematic capability): The measures for preventing and managing systematic faults shall correspond to the required SIL according to **EN 61508,** in particular Parts 2 and 3.

4.2.3.5 Architecture: The architectural requirements shall be satisfied in accordance with route 1H according to **EN 61508-2:2010.**

4.2.3.6 Safety parameters: The parameters HFT, SFF, PFD/PFH and proof test interval in accordance to **EN 61508** shall be determined. For an example of documentation for the data, see Annex C.

4.2.3.7 Environment / Electrical safety: Evidence shall be provided at least of the requirements of one of the following European Standards:

EN 61131-2:2007, EN 60730-1:2011, EN 61010-1:2010.

Stricter requirements may apply in the case of sensors and actuators depending on the installation location.

4.2.3.8 EMC: The requirements shall be according to part 1 of this standard in 4.2.2.

4.2.3.9 Operating and maintenance instructions: The operating instructions as the safety manual describe all the framework condition for application, installation, operation and maintenance. Moreover, all the safety parameters that are necessary to determine the required SIL shall be indicated.

4.2.3.10 Documentation: The result of the approval shall document the achievable safety integrity level and the safety manual of the equipment shall describe all conditions and restrictions for the use of the safety-relevant equipment. Satisfaction of the requirements for application as specified in the qualification documentation shall be documented and verified.

4.2.3.11 Quality assurance

Type and scope of quality assurance is defined by Pressure Equipment Directive 97/23/EC [1]. An independent organization shall also be involved for applications that do not fall within the scope of the Pressure Equipment Directive in order to evaluate the component.

NOTE The requirements in relation to the testing organization are derived from the legal requirements (e.g. Directive 97/23/EC [1], Directive 2006/42/EC [2], Directive 2009/142/EC [3]).

4.3 Requirements for safety devices and subsystems of other technologies

4.3.1 General

Mechanical, hydraulic, or pneumatic components connected to electrical systems within safety relevant systems are referred to as components of other technology.

4.3.2 Type approval by product standards

Components shall be used which have been tested in accordance with a product standard according to the following list, if they are in the scope of these standards:

EN 161:2011+A3:2013, EN 267:2009+A1:2011, EN 676:2003+A2:2008, EN 1854:2010, EN ISO 23553-1:2014, EN 12952-11:2007, EN 12953-9:2007, EN 13611:2007+A2:2011, EN 60947-2:2006.

Products that combine several functions shall satisfy all the standards relevant for the functions.

4.3.3 Type approval by fault assessment

4.3.3.1 General

If subsystems or devices are not in the scope of the product standards in accordance to 4.3.2, the safety related requirements of product standards shall be taken into account as far as possible.

This shall be supplemented by the use of a fault assessment in accordance to Figure 11 in part 1 of this standard in combination with an FMEA in accordance to EN 60812:2006 (see e.g. Annex B).

NOTE 1 A qualitative FMEA in accordance to EN 60812:2006 may be sufficient, if all faults are detected.

NOTE 2 The annexes of EN ISO 13849-2:2012 [6] may be used for the FMEA in accordance to EN 60812:2006.

4.3.3.2 Safety requirement and functional specification: See 4.2.3.2.

4.3.3.3 Environment / Electrical safety: See 4.2.3.7.

4.3.3.4 EMC: See 4.2.3.8.

4.3.3.5 Operating and maintenance instructions: The operating instructions as the safety manual in accordance to EN 61508-4:2010 describe all the framework condition for application, installation, operation and maintenance.

4.3.3.6 Documentation: The result of the approval shall document the satisfaction of the requirements and shall describe all conditions and restrictions for the use of the safety-relevant equipment.

4.3.4 Quality assurance

See 4.2.3.11.

4.3.5 Quantification

If quantification is required for evaluating the safety function on the basis of further requirements (e.g. legal provisions) or the risk analysis method used, this shall be carried out on the data based on the product standards according to 4.2.2. Annex A shall be used only for components not covered by product standards.

For less complex systems, the fault assessment according to EN 50156-1:2015, Figure 11 can be used. Suitability for these systems shall be ascertained by FMEA in accordance to EN 60812:2006. Quantification is not possible in this case.

A lower degree of complexity cannot be clearly defined. In principle, it is necessary that, in the case of a fault assessment according to EN 50156–1:2015, Figure 11, all hazardous influences are identified either by proof test or by comprehensive architectural analysis in the context of component evaluation. In case of doubt, the test intervals for the required tests shall be reduced.

4.3.6 Recurring functional testing

If quantification is not possible, the proof test interval cannot be determined by calculation. In this case, required diagnostics or other measures (e.g. Proof Test Intervall) to ensure the required SIL shall be specified based on a fault assessment.

The types of tests and test intervals can only be specified by evaluating the damaging influences and the intended mode of operation (e.g. admissible ambient conditions, provided requirement rate, interactions at the interfaces) in agreement with an independent organization.

4.3.7 Operating instructions

Operating instructions shall include the requirements for inspections, maintenance and functional tests that are required to ensure the safety integrity over the entire life cycle. If the relevant product standard does not include any detailed requirements, an FMEA in accordance to EN 60812:2006 shall be conducted. The measures derived from the FMEA in accordance to EN 60812:2006 shall be documented in the operating instructions.

Annex A
(normative)

Proven in use for subsystems and devices of other technologies

Proof of suitability of a component of other technologies by proven in use is described below.

1) The manufacturer conducts an FMEA in accordance to EN 60812:2006 for the component under analyse. The technical documents comprise:

   – material certificates/reports;

   – design drawings;

   – parts lists;

   – technical description of the component;

   – operating and maintenance instructions.

2) An independent organization shall assess the FMEA in accordance to EN 60812:2006.

3) Operational testing data of components used in the case of operators or comparatively comprehensive field tests shall be recorded and evaluated. The type and scope of the data are apparent from the following list:

   – based on field data;

   – type of component (type coding);

   – number of components used;

   – period of operation;

   – evidence of consistently documented faults/failures;

   – classification of the faults, at least however description of the fault;

   – description of application (ambient conditions, charges).

   NOTE 1 A larger number of observed components and number of different applications increase the informative value of the determined data.

   NOTE 2 The faults should be recorded in a detailed and consistent manner.

4) The manufacturer shall identify failure date on the basis of his quality system. This includes

   – number of supplied components;

   – failures recorded.

5) This failure data shall be compared with the results of operational test (see 3) above) and the FMEA in accordance to EN 60812:2006 (see 2 above). The deviations shall be analysed and where necessary the FMEA in accordance to EN 60812:2006 shall be revised.

6) The MTBF values are determined on the basis of the analysed data of operational performance.

7) The MTBF values and their determination shall be documented in a report. The report shall contain information on the origin of the data, the data sets on which it is based and the manner of determination.

Annex B
(informative)

Aspects with influence on functional safety

Where technically applicable, only equipment according to the product standards may be used. The equipment may not perform other tasks unless their safety-relevant functions cannot be impaired as a result.

A clear safety position of the equipment shall be defined. The following points should be considered and evaluated in the context of a FMEA in accordance to EN 60812:2006:

– energy;

– actuating force reserve;

– medium influence;

– corrosion, erosion, imperviousness, cementing;

– foreign particles;

– ambient influences;

– stability of the structure;

– aging;

– manufacturing influences;

– installation conditions;

– taking into account incorrect operation in the design;

– leakage;

– sufficient cross-section.

The above list makes no claim of being complete.

Annex C
(informative)

Summary of the characteristic data for use of a subsystem or device in safety-related systems

C.1 Classification of the product

Product:

Company:

C.2 Characteristic data according to EN 61508, Parts 1 to 7:

C.2.1 Data for use of the product as a subsystem or device in safety functions

	Value	Remark
Safety Integrity Level	**SIL SC**	**Systematic capability, max. achievable SIL**
PFH [1/h]		**corresponds to XX % of SIL X**
PFD		
Proof Test Interval T		

NOTE 1 The values of PFH and/or PFD avg. depending on the claimed operation mode

NOTE 2 At a PFH value that is < 1 % of the allowed SIL-threshold, the performance of special Proof Tests within the mission time of the product is regarded as not necessary.

C.2.2 Additional data for use of the product as a component in safety functions

	Value	Remark
Dangerous failure rate λ_d		**1/h or FIT**
Dangerous undetected failure rate λ_{du}		**1/h or FIT**
Diagnostic Coverage DC		
Common Cause Factor β		
Diagnostic Test Interval T_D		
Proof Test Interval T		
HFT		

The calculation of these values is based on the following assumptions.

– Besides this summary of the characteristic data, the information provided in the product documents of the manufacturer has always to be considered;

– Source of failure rate data: IEC/TR 62380, as far as no data from the component manufacturer was available;

– Max. average ambient temperature: __ °C.

Bibliography

[1] *Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment*, OJ L 181, 9.7.1997, p. 1–55, available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1997:181:0001:0055:EN:PDF

[2] *Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)*, OJ L 157, 9.6.2006, p. 24–86, available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:157:0024:0086:EN:PDF

[3] *Directive 2009/142/EC of the European Parliament and of the Council of 30 November 2009 relating to appliances burning gaseous fuels*, OJ L 330, 16.12.2009, p. 10–27, available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:330:0010:0027:EN:PDF

[4] EN 334:2005+A1:2009, *Gas pressure regulators for inlet pressures up to 100 bar*

[5] EN 12952-8:2002, *Water-tube boilers and auxiliary installations - Part 8: Requirements for firing systems for liquid and gaseous fuels for the boiler*

[6] EN ISO 13849-2:2012, *Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2:2012)*

[7] EN 14597:2012, *Temperature control devices and temperature limiters for heat generating systems*

[8] 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)*

[9] EN 61511-1, *Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and software requirements (IEC 61511-1)*

[10] EN 61326-3-1:2008, *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications (IEC 61326-3-1:2008)*

[11] IEC/TR 62380, *Reliability data handbook – Universal model for reliability prediction of electronics components, PCBs and equipment*

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