

Safety of machinery — Electro-sensitive protective equipment —

Part 1: General requirements and tests

The European Standard EN 61496-1:1997 has the status of a
British Standard

ICS 13.110

National foreword

This British Standard is the English language version of EN 61496-1:1997. It is identical with IEC 61496-1:1997. Together with BS IEC 61496-2:1997 (published September 1999) it superseded BS 6491-1:1984 and BS 6491-2:1987, which were withdrawn in September 1999.

The UK participation in its preparation was entrusted to Technical Committee GEL/44, Safety of machinery — Electrotechnical aspects, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 52, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 August 1998

© BSI 12-1999

ISBN 0 580 30249 0

Amendments issued since publication

Amd. No.	Date	Comments
10817 Corrigendum	December 1999	Supersession details added to national foreword (paragraph 1)

ICS 13.110

Descriptors: Electrical equipment, machines, control and operation requirements, testing, definitions, electrical safety requirements, electro-sensitive protective equipment

English version

**Safety of machinery - Electro-sensitive protective equipment
Part 1: General requirements and tests
(IEC 61496-1:1997)**

Sécurité des machines - Equipements
de protection électro-sensibles
Partie 1: Prescriptions générales et
essais
(CEI 61496-1:1997)

Sicherheit von Maschinen
Berührungslos wirkende
Schutzeinrichtungen
Teil 1: Allgemeine Anforderungen
und Prüfungen
(IEC 61496-1:1997)

This European Standard was approved by CENELEC on 1997-10-01. CENELEC 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 Central Secretariat or to any CENELEC 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 CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

© 1997 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Ref. No. EN 61496-1:1997 E

Foreword

The text of documents 44/206/FDIS and 44/206A/FDIS, future edition 1 of IEC 61496-1, prepared by IEC TC 44, Safety of machinery: Electrotechnical aspects, in collaboration with CENELEC TC 44X, Safety of machinery: Electrotechnical aspects, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61496-1 on 1997-10-01.

This standard has been prepared as a specification of general requirements for electro-sensitive protective equipment (ESPE) specifically related to machinery safety and has been developed to meet the needs of the equipment suppliers, the machine users and safety enforcement authorities.

This standard has been prepared under a mandate given to CEN/CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of the following EC Directives:

- Electromagnetic compatibility (89/336/EEC);
- Machinery Directive (89/392/EEC).

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 1998-07-01
- latest date by which national standards conflicting
with the EN have to be withdrawn (dow) 1998-07-01

NOTE: Within CENELEC the subject of this standard was originally submitted to the enquiry procedure with reference prEN 50100-1. Any reference made to prEN 50100-1 in whatever document should henceforth be understood as referring to this EN 61496-1.

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B and ZA are normative and annex C is informative.

Annex ZA has been added by CENELEC.

This standard has the status of a product family standard (type B2 in CEN) and may be used as a normative reference in the preparation of product family standards or dedicated product standards (type C in CEN as defined in EN 414:1992, 3.1) for machines.

Endorsement notice

The text of the International Standard IEC 61496-1:1997 was approved by CENELEC as a European Standard without any modification.

In the official version, for annex C, Bibliography, the following notes have to be added for the standards indicated:

IEC 60812	NOTE: Harmonized as HD 485 S1:1987 (not modified).
IEC 61025	NOTE: Harmonized as HD 617 S1:1992 (not modified).
ISO 9000-3	NOTE: Harmonized as EN 29000-3:1993 (not modified).

CONTENTS

	Page
INTRODUCTION	5
 Clause	
1 Scope	6
2 Normative references	6
3 Definitions	8
4 Functional, design and environmental requirements	11
4.1 Functional requirements	11
4.2 Design requirements	12
4.3 Environmental requirements	17
5 Testing	20
5.1 General	20
5.2 Functional tests	22
5.3 Performance testing under fault conditions	24
5.4 Environmental tests	25
5.5 Validation of programmable or complex integrated circuits	28
6 Marking for identification and safe use	29
6.1 General	29
6.2 ESPE supplied from a dedicated power supply	30
6.3 ESPE supplied from an internal electrical power source	30
6.4 Adjustment	30
6.5 Enclosures	30
6.6 Control devices	30
6.7 Terminal markings	31
6.8 Marking durability	31
7 Accompanying documents	31
 Annexes	
A Optional functions of the ESPE	34
B Catalogue of single faults affecting the electrical equipment of the ESPE, to be applied as specified in 5.3	43
C Bibliography	48
 Index	 49
 Annex ZA Normative references to international publications with their corresponding European publications	 51

INTRODUCTION

An electro-sensitive protective equipment (ESPE) is applied to machinery presenting a risk of personal injury. It provides protection by causing the machine to revert to a safe condition before a person can be placed in a hazardous situation.

This part of IEC 61496 provides general design and performance requirements of ESPEs for use over a broad range of applications. Essential features of equipment meeting the requirements of this standard are the appropriate level of safety-related performance provided and the built-in periodic functional checks/self-checks that are specified to ensure that this level of performance is maintained.

Each type of machine presents its own particular hazards and it is not the purpose of this standard to recommend the manner of application of the ESPE to any particular machine. The application of the ESPE should be a matter for agreement between the equipment supplier, the machine user and the enforcing authority, and in this context attention is drawn to the relevant guidance established internationally, for example ISO TR-12100.

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT –

Part 1: General requirements and tests

1 Scope

This part of IEC 61496 specifies general requirements for the design, construction and testing of electro-sensitive protective equipment (ESPE) for the safeguarding of machinery. Special attention is directed to functional and design requirements that ensure an appropriate safety-related performance is achieved. An ESPE may include optional safety-related functions, the requirements for which are given in annex A.

The particular requirements for specific types of sensing function are given in other parts of this standard.

This standard does not specify the dimensions or configuration of the detection zone and its disposition in relation to hazards in any particular application, nor what constitutes a hazardous state of any machine. It is restricted to the functioning of the ESPE and how it interfaces with the machine.

This standard may be relevant to applications other than those for the protection of persons, for example for the protection of machinery or products from mechanical damage. In those applications additional requirements may be necessary, for example when the materials that have to be recognized by the sensing function have different properties from those of persons.

This standard does not deal with electromagnetic compatibility (EMC) emission requirements.

This part of IEC 61496 provides general requirements for ESPEs of various types employing different methods of sensing. The particular requirements for specific types of sensing function will be covered in subsequent parts of this standard. The requirements for ESPEs using active opto-electric protective devices, e.g. light curtains, are contained in part 2.

This part refers to the technical suitability of the electro-sensitive protective equipment. Its application may require the use of substances and/or test procedures that could be injurious to health unless adequate precautions were taken. Conformance with this standard in no way absolves either the supplier or the user from statutory obligations relating to the safety and health of persons during the use of the equipment covered by this standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61496. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61496 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(191):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-29:1987, *Environmental testing – Part 2: Tests – Test Eb and guidance: Bump*

IEC 60204-1, — *Safety of machinery – Electrical equipment of machines – Part 1: General requirements¹⁾*

IEC 60249-2, *Base materials for printed circuits – Part 2: Specifications*

IEC 60439-1:1992, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

IEC 60445:1988, *Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

IEC 60447:1993, *Man-machine interface (MMI) – Actuating principles*

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

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60742:1983, *Isolating transformers and safety isolating transformers – Requirements*

IEC 60947-5-1:1990, *Low-voltage switchgear and controlgear – Part 5: Control circuit devices and switching elements – Section One: Electromechanical control circuit devices*

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

IEC 61000-4-3:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test – Basic EMC publication*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test – Basic EMC publication*

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity tests*

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields – Basic EMC publication*

IEC 61310-1:1995, *Safety of machinery – Indication, marketing and actuation – Part 1: Requirements for visual, auditory and tactile signals*

¹⁾ To be published.

ISO 9001:1994, *Quality systems – Model for quality assurance in design, development, production, installation and servicing*

ISO/TR 12100-1:1992, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology*

ISO/TR 12100-2:1992, *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles and specifications*

3 Definitions

NOTE – The index lists, in alphabetical order, the terms and acronyms defined in this clause and indicates where they are used in the text of this part.

For the purpose of this part of IEC 61496, the following definitions apply.

3.1 electro-sensitive protective equipment (ESPE): An assembly of devices and/or components working together for protective tripping or presence-sensing purposes and comprising as a minimum:

- a sensing device;
- controlling/monitoring devices;
- output signal switching devices.

NOTE – The safety-related control system associated with the ESPE, or the ESPE itself, may further include a secondary switching device, muting functions, stopping performance monitor, etc. (see annex A). In order to assist in the understanding of the inter-relationship of the various major elements of the ESPE and the associated safety-related control systems, block schematic diagrams are included as figures A.1 and A.2.

3.2 controlling/monitoring device: The part of the electro-sensitive protective equipment (ESPE) that:

- receives and processes information from the sensing device and provides signals to the output signal switching devices (OSSDs);
- monitors the sensing device and the OSSDs.

3.3 defined signal range: The permissible signal range within which the safety-related signal threshold values have been set and are detected by the sensing device.

3.4 detection capability: The sensing function parameter limit specified by the supplier that will cause actuation of the electro-sensitive protective equipment (ESPE).

3.5 detection zone: The zone within which a specified test piece will be detected by the electro-sensitive protective equipment (ESPE).

3.6 external device monitoring (EDM): A means by which the electro-sensitive protective equipment (ESPE) monitors the state of control devices which are external to the ESPE.

3.7 failure: The termination of the ability of an item to perform a required function.
[IEV 191-04-01]

NOTES

- 1 After failure the item has a fault.
- 2 "Failure" is an event, as distinguished from "fault", which is a state.
- 3 This concept as defined does not apply to items consisting of software only.
- 4 In practice the terms fault and failure are often used synonymously.

3.8 failure to danger: A failure which prevents or delays all output signal switching devices (OSSDs) going to, and/or remaining in the OFF-state in response to a condition which, in normal operation, would result in their so doing.

3.9 fault: The state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources.

NOTES

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

2 In English the term "fault" and its definition are identical with those given in IEC 191-05-01. In the field of machinery, the French term "défaut" and the German term "Fehler" are used rather than the terms "panne" and "Fehlzustand" that appear with this definition.

3.10 final switching device (FSD): The component of the machine's safety-related control system that interrupts the circuit to the machine primary control element (MPCE) when the output signal switching device (OSSD) goes to the OFF-state (see figures A.1 and A.2).

3.11 integrated circuit – complex or programmable: A monolithic, hybrid or module circuit, where the internal connections are not accessible, which satisfies one or more of the criteria below:

- a) more than 1 000 gates are used in the digital mode;
- b) more than 24 functionally different external electrical connections are available for use;
- c) the functions can be programmed.

NOTES

1 Examples include ASICs, ROMs, PROMs, EPROMs, PALs, CPUs, PLAs, and PLDs.

2 The circuits may function in the analogue mode, in the digital mode, or in a combination of the two modes.

3.12 integrated circuit – simple: A monolithic, hybrid or module circuit, where the internal connections are not accessible, and which satisfies none of the criteria in 3.11.

NOTES

1 Examples are SSI or MSI logic ICs, comparators.

2 The circuits may function in the analogue mode, in the digital mode, or in a combination of the two modes.

3.13 lock-out condition: A condition, initiated by a fault, preventing normal operation of the electro-sensitive protective equipment (ESPE) which is automatically attained when all output signal switching devices (OSSDs) and, where applicable, all final switching devices (FSDs) and secondary switching devices (SSDs) are signalled to go to the OFF-state.

3.14 machine primary control element (MPCE): The electrically powered element that directly controls the normal operation of a machine in such a way that it is the last element (in time) to function when machine operation is to be initiated or arrested.

NOTE – This element can be, for example, a mains contactor, a magnetic clutch or an electrically operated hydraulic valve.

3.15 machine secondary control element (MSCE): A machine control element, independent of the machine primary control element(s), that is capable of removing the source of power from the prime mover of the relevant hazardous parts.

NOTES

- 1 When fitted, the MSCE is normally controlled by the secondary switching device.
- 2 This element can be, for example, a mains contactor, a magnetic clutch or an electrically operated hydraulic valve.

3.16 muting: A temporary automatic suspension of a safety function(s) by safety-related parts of the control system.

NOTE – For ESPE-muting see A.7.

3.17 OFF-state: The state in which the output circuit is interrupted and does not permit the flow of current.

3.18 ON-state: The state in which the output circuit is complete and permits the flow of current.

3.19 output signal switching device (OSSD): The component of the electro-sensitive protective equipment (ESPE) connected to the control system of the machine which, when the sensing device is actuated during normal operation, responds by going to the OFF-state.

3.20 overall system stopping performance: The time interval resulting from the sum of the electro-sensitive protective equipment (ESPE) response time and the time to the cessation of hazardous machine operation.

3.21 response time: The maximum time between the occurrence of the event leading to the actuation of the sensing device and the output signal switching devices (OSSDs) achieving the OFF-state.

3.22 restart interlock: A means of preventing automatic restarting of a machine after actuation of the sensing device during a hazardous part of the operating cycle of the machine, after a change in mode of operation of the machine, and after a change in the means of start control of the machine.

NOTE – Modes of operation include inch, single stroke, automatic. Means of start control include foot switch, two-hand control, and single or double actuation of the electro-sensitive protective equipment (ESPE) sensing device.

3.23 safety-related part of a control system: A part or subpart(s) of a control system which respond(s) to input signals and generate(s) safety-related output signals. The combined safety-related parts of a control system start at the points where the safety-related signals are initiated and end at the output of the power control elements (see also ISO/TR 12100-1, annex A). This also includes monitoring systems.

3.24 secondary switching device (SSD): A device which, in a lock-out condition, performs a back-up safety function by going to the OFF-state and initiating an appropriate machine control action, e.g. de-energizing the machine secondary control element (MSCE).

3.25 sensing device: That part of the electro-sensitive protective equipment (ESPE) which uses electro-sensitive means to determine the event or state that the ESPE is intended to detect, for example in an opto-electronic device the sensing function would detect an opaque object entering the detection zone.

3.26 start interlock: A means which prevents an automatic machine start when the electrical supply to the electro-sensitive protective equipment (ESPE) is switched on, or is interrupted and restored.

3.27 start test: A manual or automatic test which is performed after the electro-sensitive protective equipment (ESPE) has been switched on in order to test its complete safety-related control system before normal machine operation is initiated.

3.28 stopping performance monitor (SPM): A monitoring means to determine whether or not the overall system stopping performance is within the preset limit(s).

3.29 supplier: An entity (e.g. manufacturer, contractor, installer, integrator) who provides equipment or services associated with the machine.

NOTE – The user may act in the capacity of a supplier to himself.

4 Functional, design and environmental requirements

4.1 Functional requirements

4.1.1 Normal operation

In normal operation the ESPE shall respond by giving (an) appropriate output signal(s) when part of a person or an object enters, or is in the detection zone, or when the signal from a sensing device is within a defined signal range.

The ESPE response time shall not exceed that stated by the supplier. No means of adjustment of the response time shall be made available to the user.

4.1.2 Sensing function

The sensing function shall be effective over the detection zone or the defined signal range specified by the supplier. No adjustment of the detection zone or the defined signal range shall be possible without the use of a key, key-word or tool.

4.1.3 Types of ESPE

In this standard, four types of ESPE are considered and it is the responsibility of the machine manufacturer and/or the user to prescribe which type is required for a particular application.

A type 1 ESPE shall fulfil the fault detection requirements of 4.2.2.2.

A type 2 ESPE shall fulfil the fault detection requirements of 4.2.2.3.

For a type 1 ESPE and for a type 2 ESPE, in normal operation the output circuit of at least one OSSD shall go to the OFF-state when the sensing device is actuated, or when power is removed from the device.

A type 3 ESPE shall fulfil the fault detection requirements of 4.2.2.4.

A type 4 ESPE shall fulfil the fault detection requirements of 4.2.2.5.

For a type 3 ESPE and for a type 4 ESPE, in normal operation the output circuit of at least two OSSDs shall go to the OFF-state when the sensing function is actuated, or when power is removed from the device.

4.2 Design requirements

4.2.1 Electrical supply

The ESPE shall be designed to operate correctly with the conditions of the nominal supply as specified below, unless otherwise specified by the user:

AC supplies

Voltage	0,85 ... 1,1 of nominal voltage.
Frequency	0,99 ... 1,01 of nominal frequency (continuously); 0,98 ... 1,02 of nominal frequency (short-time).
Harmonics	Harmonic distortion not to exceed 10 % of the total r.m.s. voltage between live conductors for the sum of the second through to the fifth harmonic. An additional 2 % of the total r.m.s. voltage between live conductors for the sum of the sixth through to the 30th harmonic is permissible.

DC supplies

From batteries

Voltage	0,85 ... 1,15 of nominal voltage; 0,7 ... 1,2 of nominal voltage in the case of battery-operated vehicles.
---------	---

From converting equipment

Voltage	0,9 ... 1,1 of nominal voltage.
Ripple (peak to peak)	Not to exceed 0,05 of nominal voltage.

Any a.c. supplied ESPE or any type 4 d.c. supplied ESPE shall be provided with its own dedicated means of isolation from the supply source either by the use of an isolating transformer conforming to IEC 60742 or by an equivalent means of isolation.

When the ESPE incorporates a battery and is capable of being operated whilst the batteries are being charged, the charger shall incorporate an isolating transformer conforming to IEC 60742.

4.2.2 Fault detection requirements

4.2.2.1 General

The ESPE shall respond to the faults listed in annex B, in accordance with 4.2.2.2 to 4.2.2.5 as appropriate.

4.2.2.2 Particular requirements for a type 1 ESPE

Under consideration.

4.2.2.3 *Particular requirements for a type 2 ESPE*

A type 2 ESPE shall have a means of periodic test to reveal a failure to danger (e.g. loss of detection capability, response time exceeding that specified). The test signal shall simulate the actuation of the sensing device and the duration of the periodic test shall be as specified in the relevant part of IEC 61496. Where the periodic test is intended to be initiated by an external (e.g. machine) safety-related control system, the ESPE shall be provided with suitable input facilities (e.g. terminals).

At start-up (e.g. at switch-on), the OSSD(s) shall not attain the ON-state until a periodic test has been carried out and no fault has been detected.

A single fault affecting normal operation (e.g. loss of detection capability, increase in response time) shall be detected:

- immediately; or
- as a result of the next periodic test; or
- on actuation of the sensing device,

and shall result in one of the following actions:

- initiation of a lock-out condition within the ESPE; or
- for an ESPE with only one OSSD, the generation of an initiating signal to enable an external (e.g. machine) safety-related control system to perform the lock-out function.

NOTE – A SSD may fulfil this function.

It shall not be possible for the ESPE to achieve an automatic reset from a lock-out condition by interruption and restoration of the mains power supply when the fault which initiated the lock-out condition is still present.

4.2.2.4 *Particular requirements for a type 3 ESPE*

Under consideration.

4.2.2.5 *Particular requirements for a type 4 ESPE*

A single fault resulting in a loss of detection capability shall cause the ESPE to go to a lock-out condition within the response time.

A single fault resulting in an increase in response time beyond the specified value or preventing one or more than one OSSD going to the OFF-state, shall cause the ESPE to go to a lock-out condition immediately, i.e. within the response time, or immediately upon any of the following demand events where fault detection requires a change of state:

- on actuation of the sensing device;
- on switch off/on;
- on reset.

It shall not be possible for the ESPE to achieve an automatic reset from a lock-out condition by interruption and restoration of the mains power supply when the fault which initiated the lock-out condition is still present.

In cases where a single fault which in itself does not cause a failure to danger is not detected, the occurrence of further faults shall not cause a failure to danger. For verification of this requirement see 5.3.5.

NOTES

- 1 Design measures for a type 4 ESPE may include:
 - single-channel technique with dynamic fault detection measures; or
 - single-channel technique with an internally generated automatic check, performed frequently so that the automatic check interval for fault detection is included in the response time; and
 - multiple channel techniques such that any disparity between channels results in a lock-out condition.
- 2 For additional requirements for integrated circuits, complex or programmable, see 4.2.10.

4.2.3 *Electrical equipment of the ESPE*

4.2.3.1 *General*

The electrical equipment (components) of the ESPE shall:

- conform to IEC standards where they exist;
- be suitable for the intended use; and
- be operated within their specified ratings.

4.2.3.2 *Protection against electric shock*

Protection against electric shock shall be provided in accordance with 6.1 of IEC 60204-1.

4.2.3.3 *Protection of electrical equipment*

Overcurrent protection shall be provided in accordance with 7.2.1, 7.2.3, 7.2.7, 7.2.8, and 7.2.9 of IEC 60204-1.

NOTE – Information may need to be given to the user of the ESPE as to the maximum rating of fuses, or setting of an overcurrent protective device for the circuit(s) connected to the OSSD(s) output connection points.

4.2.3.4 *Pollution degree*

The electrical equipment shall be suitable for pollution degree 2 (see 6.1.2.3 of IEC 60439-1).

4.2.3.5 *Clearance, creepage distances and isolating distances*

The electrical equipment shall be designed and constructed in accordance with 7.1.2 of IEC 60439-1.

4.2.3.6 *Wiring*

The electrical equipment shall be wired in accordance with 7.8.3 of IEC 60439-1.

4.2.4 *Output signal switching devices (OSSDs)*

Separate output connections points (terminals) shall be provided for each OSSD.

The OSSDs should be so rated that their loads can be switched without the use of arc suppression devices. In the interest of improved reliability, it is strongly recommended that switching voltage-suppression devices are fitted, which should be connected across the loads and not across the contacts.

The output circuit(s) of the OSSDs should be adequately protected to prevent failure to danger, for example welded contacts under overcurrent conditions (see 7.2.9 of IEC 60204-1).

Some functions of the safety-related control system of the machine may be performed by the ESPE, for example the OSSD may perform the function of a FSD.

Both a type 3 ESPE and a type 4 ESPE shall incorporate a minimum of two OSSDs.

4.2.5 *Indicator lights and displays*

Devices shall be provided to:

- a) indicate the actuation of the sensing device. Neither the time from the actuation of the sensing device to the indicator achieving 50 % of its final brightness (luminescence), nor the time from the de-actuation of the sensing device to the indicator brightness decaying to 50 % of its initial brightness, shall exceed 100 ms;
- b) indicate the output status of an OSSD. The ON-state shall be represented by a green indicator, the OFF-state by a red indicator.

4.2.6 *Adjustment means*

All adjustment means shall be so designed that a failure to danger is not possible at any point in the range of adjustment.

4.2.7 *Disconnection of subsystems*

When means are provided to permit disconnection of any subsystem, part of a subsystem or any plug-in component, such disconnection shall result in at least one OSSD going to the OFF-state, in accordance with 4.2.2.

4.2.8 *Non-electrical components*

Non-electrical components shall be suitable for the intended use.

4.2.9 *Common cause failures*

The design should be such as to minimize the possibility of a failure to danger from common cause failures arising from:

- environmental influences;
- multichannel systems using a common substrate;
- short circuits between channels of multichannel systems.

NOTE – Common cause failure can also result from the use of components degraded by mishandling, faulty manufacture, etc.

None of the components in a common semi-conductor substrate shall be used for more than one channel of a multichannel system.

4.2.10 *Programmable or complex integrated circuits*

Where programmable or complex integrated circuits are used in a type 4 ESPE, the safety-related performance shall be maintained by two independent controlling/monitoring channels. This requirement shall be verified in accordance with 5.5.