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Electro-Sensitive Protective Equipment, Part 1: General Requirements and Tests

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UL Standard for Safety for Electro-Sensitive Protective Equipment, Part 1: General Requirements and Tests, UL 61496-1

First Edition, Dated January 29, 2002

Revisions: This Standard contains revisions through and including February 27, 2007.

Summary of Topics

This revision to ANSI/UL 61496-1 is issued to reaffirm the ANSI approval. No technical changes have been made to the document.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net/ulforeword.html>

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the preface. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listed and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

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UL 61496-1

**Standard for Electro-Sensitive Protective Equipment, Part 1: General
Requirements and Tests**

First Edition

January 29, 2002

The most recent designation of ANSI/UL 61496-1 as a Reaffirmed American National Standard (ANS) occurred on February 19, 2007.

This ANSI/UL Standard for Safety, which consists of the First edition with revisions through February 27, 2007, is under continuous maintenance, whereby each revision is ANSI approved upon publication.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

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Preface (UL)

This UL standard is based on IEC Publication 61496-1: First Edition Safety of Machinery – Electro-Sensitive Protective Equipment – Part 1: General Requirements and Tests. IEC Publication 61496-1 is copyrighted by the IEC.

This is the UL Standard for Safety for Electro-Sensitive Protective Equipment, Part 1: General Requirements and Tests. This UL Part 1 is to be used in conjunction with the appropriate UL Part 2, which contains clauses to supplement or modify the corresponding clauses in Part 1, to provide relevant requirements for each type of product.

The text, figures and tables of IEC Publication Safety of Machinery – Electro-Sensitive Protective Equipment – Part 1: General Requirements and Tests, IEC 61496-1 copyright 1997 are used in this Standard with the consent of the IEC and the American National Standards Institute (ANSI). The IEC copyrighted material has been reproduced with permission from ANSI. ANSI should be contacted regarding the reproduction of any portion of the IEC material. The IEC Foreword and Introduction are not a part of the requirements of this Standard but are included for information purposes only. Copies of IEC Publication 61496-1 may be purchased from ANSI, 11 West 42 nd Street, New York, New York, 10036, (212) 642-4900.

Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

UL Effective Date

As of July 29, 2004 all products Listed or Recognized by UL must comply with the requirements in this standard.

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DEVIATIONS

GENERAL

Deviations from the text of International Electrotechnical Commission (IEC) Publication 61496-1, Safety of Machinery – Electro-Sensitive Protective Equipment – Part 1: General Requirements and Tests copyright 1997 are indicated by notations (deviations) and are presented in bold text.

There are five types of deviations as noted below. The deviation type is noted on the first line of the deviation in the standard. The standard may not include all types of these deviations.

DR – These are deviations based on the **National Electrical Code (NEC)** and **other U.S. Regulatory Requirements**.

D1 – These are deviations which are based on **basic safety principles and requirements**, elimination of which would compromise safety for U.S. consumers and users of products.

D2 – These are deviations based on **safety practices**. These are deviations for IEC requirements that may be acceptable, but adopting the IEC requirements would require considerable retesting or redesign on the manufacturer's part.

DC – These are deviations based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are deviations based on **editorial comments or corrections**.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF MACHINERY – ELECTRO-SENSITIVE PROTECTIVE EQUIPMENT – Part 1: General Requirements and Tests

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61496-1 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects, in collaboration with CENELEC technical committee 44X: Safety of machinery – Electrotechnical aspects.

This standard has the status of a product family standard and may be used as a normative reference in a dedicated product standard for the safety of machinery.

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 manufacturers, industrial users and safety enforcement authorities.

The text of this standard is based on the following documents:

FDIS	Report on voting
44/206/FDIS	44/209/RVD

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

Annexes A and B form an integral part of this standard.

Annex C is for information only.

INTRODUCTION (IEC)

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

2.1DV DC Deletion:

Delete the reference to IEC 60050(191).

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 Requirements (To be published.)

2.2DV DC Deletion:

Delete the reference to IEC 60204-1.

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

2.3DV DC Deletion:

Delete the reference to IEC 60249-2.

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

2.4DV DC Deletion:

Delete the reference to IEC 60439-1.

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

2.5DV DC Deletion:

Delete the reference to IEC 60445.

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

2.6DV DC Deletion:

Delete the reference to IEC 60447.

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

2.7DV DC Deletion:

Delete the reference to IEC 60664-1.

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

2.8DV DC Deletion:

Delete the reference to IEC 60742.

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

2.9DV DC Deletion:

Delete the reference to IEC 60947-5-1.

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

2.10DV DC Deletion:

Delete the reference to IEC 61310-1.

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

2.11DV DC Deletion:

Delete the reference to ISO/TR 12100-1.

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

2.12DV DC Deletion:

Delete the reference to ISO/TR 12100-2.

2.13DV DC Addition:

Add the following references:

2.13DV.1 UL 508,
Industrial Control Equipment

2.13DV.2 UL 796,
Printed-Wiring Boards

2.13DV.3 UL 840,
Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment

2.13DV.4 NFPA 79:1997,
Electrical Standard for Industrial Machinery (National Fire Codes, Volume 3)

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.

3.7DV D2 Deletion:

Delete the reference to IEV 191-04-01.

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 preventative 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 circuits – 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.