

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Nuclear power plants – Instrumentation and control important to safety –  
Requirements for electromagnetic compatibility testing**

**Centrales nucléaires de puissance – Instrumentation et contrôle-commande  
importants pour la sûreté – Exigences relatives aux essais de compatibilité  
électromagnétique**



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**NUCLEAR POWER PLANTS –  
INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY –  
REQUIREMENTS FOR ELECTROMAGNETIC COMPATIBILITY TESTING**

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

FDIS	Report on voting
45A/725/FDIS	45A/732/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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## INTRODUCTION

### a) Technical background, main issues and organisation of the standard

This International Standard was prepared and based, to a very strong extent, on the current application of the IEC 61000 series for commercial equipment qualification for electromagnetic interference (EMI) and radio-frequency interference (RFI).

It is intended that this standard be used by operators of NPPs (utilities), systems evaluators and by licensors.

### b) Situation of the current standard in the structure of the SC 45A standard series

IEC 62003 is the third level SC 45A document dealing with the issue of qualification for electromagnetic interference (EMI) and radio-frequency interference (RFI) applicable to I&C systems important to safety in nuclear facilities.

For more details on the structure of the SC 45A standard series see item d) of this introduction.

### c) Recommendation and limitation regarding the application of this standard

It is important to note that this standard establishes no additional functional requirements for safety systems but clarifies the criteria to be applied for qualification to EMI/RFI from the commercial standards.

Aspects for which special requirements and recommendations have been produced, are:

- 1) IEC 61000 series with specific qualifications for nuclear applications around the world;
- 2) regulatory interpretations for requirements on level of qualification necessary and types of recommended testing to address all potential environmental stressors, related to this type of qualification;
- 3) IEC 61000-6-2, Electromagnetic compatibility (EMC) – Part 6-2: Generic Standards – Immunity for industrial environments addresses requirements for all industrial environments while this standard addresses environments in nuclear facilities specifically.

### d) Description of the structure of the SC 45A standard series and relationships with other IEC documents and other bodies documents (IAEA, ISO)

The top-level document of the IEC SC 45A standard series is IEC 61513. It provides general requirements for I&C systems and equipment that are used to perform functions important to safety in NPPs. IEC 61513 structures the IEC SC 45A standard series.

IEC 61513 refers directly to other IEC SC 45A standards for general topics related to categorization of functions and classification of systems, qualification, separation of systems, defence against common cause failure, software aspects of computer-based systems, hardware aspects of computer-based systems, and control room design. The standards referenced directly at this second level should be considered together with IEC 61513 as a consistent document set.

At a third level, IEC SC 45A standards not directly referenced by IEC 61513 are standards related to specific equipment, technical methods, or specific activities. Usually, these documents, which make reference to second-level documents for general topics, can be used on their own.

A fourth level extending the IEC SC 45A standard series, corresponds to the Technical Reports which are not normative.



IEC 61513 has adopted a presentation format similar to the basic safety publication IEC 61508 with an overall safety life-cycle framework and a system life-cycle framework and provides an interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector. Compliance with IEC 61513 will facilitate consistency with the requirements of IEC 61508 as they have been interpreted for the nuclear industry. In this framework, IEC 60880 and IEC 62138 correspond to IEC 61508-3 for the nuclear application sector.

IEC 61513 refers to ISO as well as to IAEA 50-C-QA (now replaced by IAEA GS-R-3) for topics related to quality assurance (QA).

The IEC SC 45A standards series consistently implements and details the principles and basic safety aspects provided in the IAEA code on the safety of NPPs and in the IAEA safety series, in particular the Requirements NS-R-1, establishing safety requirements related to the design of Nuclear Power Plants, and the Safety Guide NS-G-1.3 dealing with instrumentation and control systems important to safety in Nuclear Power Plants. The terminology and definitions used by SC 45A standards are consistent with those used by the IAEA.

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# NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – REQUIREMENTS FOR ELECTROMAGNETIC COMPATIBILITY TESTING

## 1 Scope

This International Standard establishes requirements for electromagnetic compatibility testing of instrumentation and control equipment supplied for use in systems important to safety at nuclear power plants. The standard lists the applicable IEC standards (principally the IEC 61000 series) which define the general test methods, and provides the necessary application-specific parameters and criteria to ensure that nuclear safety requirements are met.

The normative part of this standard is limited to the testing of equipment prior to installation in a nuclear power plant to demonstrate immunity to electromagnetic disturbances. This document includes informative annexes which provide additional guidance and describes approaches to maintaining electromagnetic compatibility for installed equipment.

## 2 Normative references

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

IEC 61000-4-2:2001, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2008, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

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

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

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2001, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-9, *Electromagnetic compatibility (EMC) – Part 4-9: Testing and measurement techniques – Pulse magnetic field immunity test*

IEC 61000-4-10, *Electromagnetic compatibility (EMC) – Part 4-10: Testing and measurement techniques – Damped oscillatory magnetic field immunity test*

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

IEC 61000-4-12:2006, *Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Ring wave immunity test*

IEC 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurements techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*

IEC 61000-4-14, *Electromagnetic compatibility (EMC) – Part 4-14: Testing and measurement techniques – Voltage fluctuation immunity test*

IEC 61000-4-16, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz*

IEC 61000-4-28, *Electromagnetic compatibility (EMC) – Part 4-28: Testing and measurement techniques – Variation of power frequency, immunity test*

CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

### 3 Terms and definitions

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

Definitions and terms that can be found in the IEC International Electrotechnical Vocabulary (IEV) and IEC standards have their sources indicated in brackets []. Any unreferenced definitions and terms are related to the nuclear I&C equipment area and specific to this standard.

#### 3.1

##### **acceptance criteria**

specified bounds on the value of a functional indicator or condition indicator used to assess the ability of a structure, system or component to perform its design function

[IAEA Safety Glossary:2007]

#### 3.2

##### **(cable) port**

port at which a conductor or a cable is connected to the apparatus

[IEC 61000-6-2:2005]

#### 3.3

##### **common mode voltage**

mean of the phasor voltages appearing between each conductor and a specified reference, usually earth or frame

[IEV 161-04-09]

#### 3.4

##### **(communication) port**

interface with a communication and/or control system, using low energy signals, permanently connected to the EUT

[IEC 60255-22-5:2002]

**3.5**

**conducted emissions**

transients and/or other disturbances observed on the external terminals of a device during its normal operation

[IEC 61967-1:2002]

**3.6**

**conducted susceptibility**

susceptibility of a system to conducted signals on cables connected to the system

[IEC 61000-1-5:2004]

**3.7**

**continuous wave**

time waveform that has a fixed frequency and is continuous

[IEC 61000-2-13:2005]

**3.8**

**(control) port**

point at which a cable for the control signal is connected to the equipment

[IEC 60728-2:2002]

**3.9**

**damped alternating (oscillatory) voltage**

starting from a (negative or positive) charging voltage level and having damped sinusoidal oscillation around the zero level

[IEC 60060-3:2006]

**3.10**

**differential mode voltage**

voltage between any two of a specified set of active conductors

[IEV 161-04-08]

**3.11**

**electric field**

vector field quantity  $\vec{E}$  which exerts on any charged particle at rest a force  $\vec{F}$  equal to the product of  $\vec{E}$  and the electric charge  $q$  of the particle:

$$\vec{F} = q\vec{E}$$

where

$\vec{F}$  is the vector force acting on the particle in newtons;

$q$  is the charge of the particle in coulombs;

$\vec{E}$  is the electric field in volts per metre.

[IEC 62209-1:2005]

**3.12**

**electric field strength**

magnitude of the electric field vector of an electromagnetic wave, or of a field created by an electric charge distribution measured in volts per metre

[IEC 61000-4-23:2000]

**3.13****electromagnetic compatibility (EMC)**

ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[IEV 161-01-07]

**3.14****electromagnetic disturbance**

any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

[IEV 161-01-05]

**3.15****electromagnetic environment**

totality of electromagnetic phenomena existing at a given location

[IEV 161-01-01]

**3.16****(electromagnetic) immunity (to a disturbance)**

ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

**3.17****electromagnetic radiation**

phenomenon by which energy in the form of electromagnetic waves emanates from a source into space

[IEV 161-01-10]

**3.18****electromagnetic wave**

radiant energy produced by the oscillation of an electric charge characterized by oscillation of the electric and magnetic fields

[IEC 61000-4-3:2006]

**3.19****electrostatic discharge**

transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

[IEV 161-01-22]

**3.20****(EM surge) burst**

sequence of a limited number of distinct pulses or an oscillation of limited duration

[IEV 161-02-07]

**3.21****(enclosure) port**

physical boundary of the apparatus which electromagnetic fields may radiate through or impinge upon. The equipment case is normally considered the enclosure port

[IEC 61000-6-6:2003]

**3.22**

**EUT (equipment under test)**

equipment under test can be a single unit or multiple units interconnected by cables, data links, etc.

[IEC 61000-4-25:2001]

**3.23**

**(functional earth) port**

cable port other than signal, control or power port, intended for connection to earth for purposes other than safety

[IEC 61000-6-6:2003]

**3.24**

**harmonic components**

components of the harmonic content as expressed in terms of the order and r.m.s. values of the Fourier series terms describing the periodic function

[IEC 62310-2:2006]

**3.25**

**harmonic distortion**

non-linear distortion characterized by the generation of undesired spectral components harmonically related to the desired signal frequency. Each harmonic component is usually expressed as a power (in decibels) relative to the output power of the desired signal

[IEC 60679-1, definition 3.2.30]

**3.26**

**immunity test level**

value of an influencing electromagnetic quantity specified for an immunity test

[IEC 61000-4-25:2001]

**3.27**

**interharmonic frequency**

any frequency which is not an integer multiple of the fundamental frequency

[IEC 61000-2-2, definition 3.2.5]

**3.28**

**interruption threshold; <measurement of voltage dips and short interruptions>**

r.m.s. value of the voltage on an electricity supply system specified as a boundary such that a voltage dip in which the voltage on all phases falls below it is classified as a short interruption

[IEC 61000-2-8:2002]

**3.29**

**magnetic field**

vector quantity obtained at a given point by subtracting the magnetization  $\vec{M}$  from the magnetic flux density  $\vec{B}$  divided by the magnetic constant (permeability)  $\mu$ :

$$\vec{H} = \frac{\vec{B}}{\mu} - \vec{M}$$

where

$\vec{H}$  is the magnetic field in amperes per metre;

$\bar{B}$  is the magnetic flux density in teslas;

$\mu$  is the magnetic constant (permeability) of the vacuum in henries per metre;

$\bar{M}$  is the magnetization in amperes per metre.

[IEC 62209-1:2005]

### 3.30 magnetic field strength

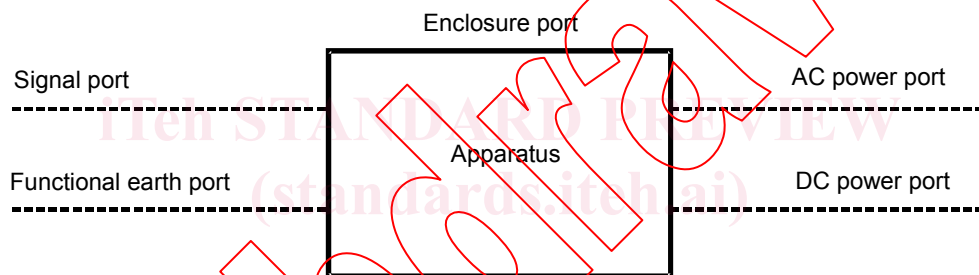
magnitude of the magnetic field vector of an electromagnetic wave, or the field produced by a current flowing in a wire, loop antenna, etc

[IEC 61000-4-23:2000]

### 3.31 port

particular interface of the Equipment Under Test (EUT) with the external electromagnetic environment

[IEC 61000-4-12:2006]



IEC 892/03

Figure 1 – Examples of ports

### 3.32 (power) port

point at which a conductor or cable carrying the electrical power needed for the operation of the equipment is connected to the apparatus

[IEC 61000-6-6:2003]

### 3.33 pulse

transient waveform that usually rises to a peak value and then decays, or a similar waveform that is an envelope of an oscillating waveform

[IEC 61000-2-13:2005]

### 3.34 radiated emissions

any wanted or unwanted emission from an electrical device

[IEC 61000-4-21:2003]

### 3.35 radiated susceptibility

susceptibility of a system to radiated electromagnetic fields

[IEC 61000-1-5:2004]