BS IEC 62003:2009

BSI British Standards

# Nuclear power plants — Instrumentation and control important to safety — Requirements for electromagnetic compatibility testing



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The UK participation in its preparation was entrusted to Technical Committee NCE/8, Reactor instrumentation.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.



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# 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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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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International Standard IEC 62003 has been prepared by subcommittee 45A: Instrumentation and control of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

# 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.

# 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;

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

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

$\vec{M}$ 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]

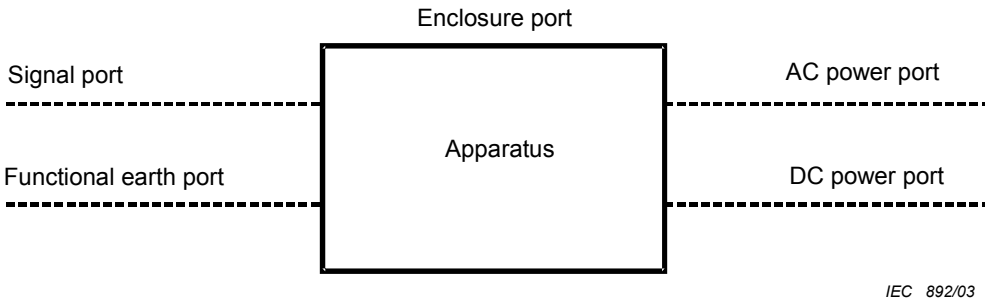


**Figure 1 – Examples of ports**

**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]

**3.36**
**radiofrequency**
**RF**
frequency of the electromagnetic spectrum that is between the audiofrequency portion and the infrared portion

[IEC 61000-4-23:2000]

**3.37**
**short interruption**
disappearance of the supply voltage at a point of the low voltage d.c. distributed system for a period of time typically not exceeding 1 min. In practice, a dip with amplitude at least 80 % of the rated voltage may be considered as an interruption

[IEC 61000-4-29:2000]

**3.38**
**(signal) port**
cable port at which there is a cable carrying information for transferring data to or from the apparatus. Examples are input/output (I/O) data ports, telecom ports, etc.

[IEC 61000-6-6:2003]

**3.39**
**voltage surge**
transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage

[IEV 161-8-11]

**3.40**
**transient**
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval that is short when compared with the time-scale of interest

[IEV 161-02-01]

**3.41**
**voltage dip**
sudden reduction of the voltage at a point in the low voltage d.c. distribution system, followed by voltage recovery after a short period of time, from a few milliseconds up to a few seconds

[IEV 161-08-10 modified]

**3.42**
**voltage fluctuation**
series of changes of r.m.s. voltage evaluated as a single value for each successive half-period between zero-crossings of the source voltage

[IEC 61000-3-3:2008]

**3.43**
**voltage variation**
gradual change of the supply voltage to a higher or lower value than the rated voltage. The duration of the change can be short or long

[IEC 61000-4-29:2000]

# 4 Requirements

## 4.1 General

Nuclear I&C equipment important to the safety of a nuclear plant shall satisfy the requirements for immunity to electromagnetic interference documented in this standard.

The establishment of immunity requirements shall address items a) to n), below. If an item is deemed to be inappropriate for the equipment under test, exemption shall be justified by consideration of operating conditions or other relevant factors. The immunity requirements shall address:

a) surge disturbances of large energy;
b) voltage dips, short interruptions, voltage variations;
c) electrical fast transients/bursts;
d) electrostatic discharges;
e) radio-frequency electromagnetic field, radiated;
f) power frequency magnetic field;
g) pulse magnetic field;
h) conducted disturbances, induced by radio-frequency field;
i) oscillatory damped disturbances;
j) fluctuations of power supply voltage;
k) conducted common mode disturbances in the range of 0 Hz to 150 Hz;
l) variations of power frequency in supply systems;
m) harmonics and interharmonics distortion of power supply waveform;
n) damped oscillatory magnetic field.

Nuclear I&C equipment supplied for use in systems important to safety may also be required to satisfy emission requirements. To provide guidance in this area, informative Annex E has been included to address recommended emissions requirements and acceptance criteria.

The degrees of test severity and functional quality criteria are established for nuclear I&C equipment immunity testing for electromagnetic disturbances, indicated in this subclause, items a) to n).

Immunity levels for nuclear I&C equipment shall be established in accordance with Table 1, based on the severity of the electromagnetic environment. Electromagnetic environments are classified in accordance with the qualitative parameters in informative Annex B. Country-specific clauses may require the application of higher immunity levels.

Depending on the installed location of nuclear I&C equipment, and the severity of electromagnetic conditions during the operation, the following severity category on disturbance immunity of nuclear I&C equipment should be established: I, II, III, and IV It is expected that all testing on a specific component meets the requirements of the appropriate severity category. Deviations are allowed if appropriately justified.

**Table 1 – Classification of disturbance immunity for nuclear I&C equipment important to safety**

| | Severity of electromagnetic environment of equipment location | | | |
|---|---|---|---|---|
| | **Light EME** | **Middle EME** | **Harsh EME** | **Severe EME** |
| Immunity level | I | II | III | IV |
| NOTE Representative qualitative parameters for the classification of the severity of electromagnetic conditions in location for the allocation of nuclear I&C equipment are given for guidance in Annex B. | | | | |

For each item of nuclear I&C equipment, the immunity level shall be individually determined for each of the disturbance types (items a) to n)).

Functional quality criteria for testing on disturbance immunity, as well as norms of industrial disturbances, harmonic components of current consumed from electric mains and voltage variations, induced in the electric mains, shall be indicated in standards on nuclear I&C equipment of a specific type, in technical specifications and maintenance documentation on nuclear I&C equipment. To support this, operational quality parameters of nuclear I&C equipment at testing on disturbance immunity, corresponding to quality criteria A or B (C) according to Annex A shall be specified. This shall take into account destination, distinguished features of application and operation modes of nuclear I&C equipment of a specific type.

### 4.2 Requirements for EMC immunity

#### 4.2.1 Degrees of severity of tests for EMC immunity

##### 4.2.1.1 General

Degrees of severity of tests for disturbance immunity and characteristics of types of these disturbances, indicated in 4.1, items a) to n) and impacting different parts of nuclear I&C equipment of I, II, III and IV arrangement groups, are given in 4.2.1.1 to 4.2.1.14.

The EMC practices and methodologies for testing included in this standard are only elements of the total program that is needed to ensure EMC within nuclear power plants. In addition to assessing the electromagnetic environment, plants should apply appropriate practices for grounding, noise-minimization and emission control techniques for I&C systems as part of the overall EMC program.

##### 4.2.1.2 Immunity to surge disturbances of large energy according to IEC 61000-4-5

These phenomena correspond to switching transients and lightning transients. High currents and voltages are induced in cables connected to the ground and in cables not connected to ground.

Parameters for testing nuclear I&C equipment for disturbance immunity due to the impact of surge disturbances of large energy according to IEC 61000-4-5 on input/output connectors, including AC power supply, DC power supply, signal and control connectors are set up in accordance with Table 2.

**Table 2 – Surge disturbances of large energy**

| Type of connector | Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| | Value of voltage pulse at non-loaded output of test oscillator kV[a] | Value of voltage pulse at non-loaded output of test oscillator kV[a] | Value of voltage pulse at non-loaded output of test oscillator kV[a] | Value of voltage pulse at non-loaded output of test oscillator kV[a] |
| Input/output connectors for AC power supply: | | | | |
| disturbance is applied in line-to-line mode; | – | 0,5 | 1 | 2 |
| disturbance is applied in line-to-ground mode | 0,5 | 1 | 2 | 4 |
| Input/output connectors for DC power supply: | | | | |
| disturbance is applied in line-to-line mode; | – | – | 0,5[b] | 1[b] |
| disturbance is applied in line-to-ground mode | – | – | 1[b] | 2[b] |
| Signal, control information input/output connectors: disturbance is applied in common mode | – | 0,5[c] | 1[c] | 2[c] |

[a] When disturbances are applied to connectors of AC and DC power supply, signal, control or input/output connectors, which are not connected to wirelines or which are connected to wirelines laid inside the building, a combined test oscillator of surge disturbances according to IEC 61000-4-5 shall be used.

When disturbances are applied to signal, control or input/output connectors connected to wirelines laid outside the building, a test oscillator of surge disturbances according to IEC 61000-4-5 shall be used.

[b] This requirement shall be established for connectors permanently connected with cables of which the length may exceed 10 m.

[c] This requirement shall be established for connectors permanently connected with cables of which the length may exceed 3 m.

#### 4.2.1.3 Immunity to voltage dips, short interruptions, voltage variations according to IEC 61000-4-11

This standard addresses the disturbance due to the quality of the power supply.

Parameters for testing nuclear I&C equipment for disturbance immunity due to the impact of voltage dips, short interruptions, voltage variations according to IEC 61000-4-11 on the input connectors of AC power supply shall be established in accordance with the test requirements and acceptance criteria of IEC 61000-4-11.

**Table 3 – Voltage dips, short interruptions, variations**

| Type of changes in power supply voltage | Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| **Voltage dips** | | | | |
| Testing voltage (%$U_n$[a]) | 70 % | 70 % | 70 % | 70 % |
| Duration (DC) | 200 ms | 500 ms | 1 000 ms | 2 000 ms |
| Cycles-50 Hz (AC) | 10 | 25 | 50 | 100 |
| Cycles-60 Hz (AC) | 12 | 30 | 60 | 120 |
| **Voltage interruptions** | | | | |
| Testing voltage (%$U_n$[a]) | 0 % | 0 % | 0 % | 0 % |
| Duration (DC) | 5 000 ms | 5 000 ms | 5 000 ms | 5 000 ms |
| Cycles-50 Hz (AC) | 250 | 250 | 250 | 250 |
| Cycles-60 Hz (AC) | 300 | 300 | 300 | 300 |
| **Voltage surges**[b] | | | | |
| Testing Voltage (%$U_n$[a]) | 120 % | 120 % | 120 % | 120 % |
| Duration (DC) | 200 ms | 500 ms | 1 000 ms | 2 000 ms |
| Cycles-50 Hz (AC) | 10 | 25 | 50 | 100 |
| Cycles-60 Hz (AC) | 12 | 30 | 60 | 120 |

[a] $U_n$ – nominal power supply voltage of nuclear I&C equipment.

[b] Optional testing based on country specific standards.

#### 4.2.1.4 Immunity to electrical fast transient/burst according to IEC 61000-4-4

The phenomena correspond to transient disturbances of an I&C equipment such as switching transients (interruption of inductive loads, relay contact bounce, etc.)

Parameters for testing nuclear I&C equipment for disturbance immunity due to the impact of electrical fast transient/burst disturbances according to IEC 61000-4-4 on the input/output connectors, including AC and DC power supply, signal and control connectors, shall be established in accordance with Table 4.

**Table 4 – Electrical fast transient/burst disturbances**

| Type of connector | Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| | Output voltage of testing oscillator under no-load conditions<br>kV | Output voltage of testing oscillator under no-load conditions<br>kV | Output voltage of testing oscillator under no-load conditions<br>kV | Output voltage of testing oscillator under no-load conditions<br>kV |
| Input/output connectors for AC power supply | 0,5 | 1 | 2 | 4 |
| Input/output connectors for DC power supply | – | 0,5 | 1 | 2 |
| Signal, control information input/output connectors [a] | 0,25 | 0,5 | 1 | 2 |

[a] This requirement shall be established for connectors permanently connected with cables the length of which may exceed 3 m.

#### 4.2.1.5 Immunity to electrostatic discharges according to IEC 61000-4-2

This phenomenon corresponds to the electric discharge similar to that which occurs through the body of an operator when he touches the metal parts of an equipment.

Parameters for testing nuclear I&C equipment for disturbance immunity due to the impact of contact and air electrostatic discharges according to IEC 61000-4-2 on casing shall be established in accordance with Table 5.

**Table 5 – Electrostatic discharges**

| Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|
| I | II | III | IV |
| Voltage on a reservoir capacitor of testing oscillator<br>kV | Voltage on a reservoir capacitor of testing oscillator<br>kV | Voltage on a reservoir capacitor of testing oscillator<br>kV | Voltage on a reservoir capacitor of testing oscillator<br>kV |
| 2 (contact discharge)<br>2 (air discharge) | 4 (contact discharge)<br>4 (air discharge) | 6 (contact discharge)<br>8 (air discharge) | 8 (contact discharge)<br>15 (air discharge) |

#### 4.2.1.6 Immunity to radio-frequency electromagnetic field according to IEC 61000-4-3

The phenomena include the disturbances generated by small hand-held radio transceivers including cell phones that are used by operating, maintenance and security personnel (inside or outside the room), fixed-station radio and television transmitters, vehicle radio transmitters, and various industrial electromagnetic sources.

The environment conditions are given by the frequency range of the transmitter, the efficiency of the shielding given by the walls of the building for the transmitters located outside the building.

Parameters for testing nuclear I&C equipment for disturbance immunity due to the impact of radio-frequency electromagnetic field on casing according to IEC 61000-4-3 within a frequency range of 80 MHz to 1 000 MHz, 800 MHz to 960 MHz and 1 400 MHz to 2 700 MHz shall be established in accordance with Table 6.

**Table 6 – Radio-frequency electromagnetic field**

| **Frequency range** MHz | **Arrangement group on disturbance immunity of nuclear I&C equipment** | | | |
|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** |
| | **Strength of electromagnetic testing field** V/m (dB in relation to 1 μV/m) | **Strength of electromagnetic testing field** V/m (dB in relation to 1 μV/m) | **Strength of electromagnetic testing field** V/m (dB in relation to 1 μV/m) | **Strength of electromagnetic testing field** V/m (dB in relation to 1 μV/m) |
| 80 – 1 000 | 1 (120) | 3 (130) | 10 (140) | 10 (140) |
| 800 – 960 | 3 (130) | 10 (140) | 10 (140) | 10 (140) |
| 1 400 – 2 700 | 1 (120) | 3 (130) | 10 (140) | 10 (140) |
| NOTE 1 For ranges above 1 000 MHz, see IEC 61000-4-3. Administrative limits should be applied to address limitation of use of portable emitters, where indicated by results of testing or analysis. NOTE 2 The second range above (800 MHz – 960 MHz) is not included in the first range per IEC 61000-4-3. | | | | |

#### 4.2.1.7 Degrees of severity of tests on the immunity to power frequency magnetic field according to IEC 61000-4-8

The power frequency magnetic field is generated by power frequency current in conductors or from other devices (e.g. leakage of transformers) in the proximity of equipment. Equipment that is not intended to be installed in areas with strong sources of magnetic fields (e.g. CRTs, motors, cable bundles carrying high currents) may be exempted from this test.

Degrees of severity of tests on the immunity to power frequency magnetic field according to IEC 61000-4-8 shall be established in accordance with Table 7.

**Table 7 – Power frequency magnetic field**

| **Type of testing magnetic field** | **Arrangement group on disturbance immunity of nuclear I&C equipment** | | | |
|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** |
| | **Strength of testing magnetic field** A/m | **Strength of testing magnetic field** A/m | **Strength of testing magnetic field** A/m | **Strength of testing magnetic field** A/m |
| Long-time magnetic field | 3 | 10 | 30 | 40 |
| Short-time magnetic field with a duration of 3 s | – | 300 | 300 | 600 |
| NOTE The requirements are not applicable to the equipment containing instrumentation based on the measurement of magnetic field parameters. | | | | |

#### 4.2.1.8 Immunity to pulse magnetic field according to IEC 61000-4-9

Pulse magnetic fields are generated by lightning strikes on buildings and other metal structures including aerial masts, earth conductors and earth networks and by initial fault transients in LV, MV and HV electrical systems.

If the equipment is located in an electrical room well-protected from the risk of high lightning current, away from the MV and HV substations, this requirement may be met by analysis rather than testing.

Degrees of severity of tests of nuclear I&C equipment on disturbance immunity due to the impact of pulse magnetic field according to IEC 61000-4-9 on casing shall be established in accordance with Table 8.

**Table 8 – Pulse magnetic field**

| Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|
| **I** | **II** | **III** | **IV** |
| **Strength of testing magnetic field** A/m | **Strength of testing magnetic field** A/m | **Strength of testing magnetic field** A/m | **Strength of testing magnetic field** A/m |
| – | 100 | 300 | 600 |
| NOTE The requirements are not applicable to the equipment containing instrumentation based on the measurement of magnetic field parameters. | | | |

#### 4.2.1.9 Immunity to conducted disturbances induced by radiofrequency fields according to IEC 61000-4-6

Degrees of severity of tests of nuclear I&C equipment on disturbance immunity due to the impact of conducted disturbances induced by radiofrequency fields according to IEC 61000-4-6 within a frequency range of 0,15 MHz to 80 MHz on input/output connectors, including AC and DC power supply, signal and control connectors, shall be established in accordance with Table 9.

**Table 9 – Conducted disturbances induced by radiofrequency fields**

| Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|
| **I** | **II** | **III** | **IV** |
| **Testing voltage** V (dB relative to 1 μV) | **Testing voltage** V (dB relative to 1 μV) | **Testing voltage** V (dB relative to 1 μV) | **Testing voltage** V (dB relative to 1 μV) |
| 1 (120) | 3 (130) | 10 (140) | 10 (140) |

#### 4.2.1.10 Immunity to oscillatory damped disturbances according to IEC 61000-4-12

According to the frequencies considered in this standard, this test is only relevant for disturbances arising from air insulated switchgear.

Degrees of severity of tests of nuclear I&C equipment on disturbance immunity due to the impact of oscillatory damped disturbances according to IEC 61000-4-12 on input/output connectors of AC and DC power supply shall be established in accordance with Table 10.

**Table 10 – Oscillatory damped disturbances**

| Disturbance and connector types | Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| | Testing voltage kV | Testing voltage kV | Testing voltage kV | Testing voltage kV |
| Single oscillatory damped disturbances | | | | |
| Input connectors of AC and DC power supply: | | | | |
| disturbance is applied in common mode; | 0,5 | 1 | 2 | 4 |
| disturbance is applied in different mode | 0,25 | 0,5 | 1 | 2 |
| Output connectors of AC and DC power supply: | | | | |
| disturbance is applied in common mode; | – | 0,5 | 1 | 2 |
| disturbance is applied in different mode | – | 0,25 | 0,5 | 1 |
| Periodic oscillatory damped disturbances[a] | | | | |
| Input connectors of AC and DC power supply: | | | | |
| disturbance is applied in common mode; | 0,5 | 1 | 2 | 2,5 |
| disturbance is applied in different mode | 0,25 | 0,5 | 1 | 1 |

**Table 10** *(continued)*

| Disturbance and connector types | Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| | Testing voltage kV | Testing voltage kV | Testing voltage kV | Testing voltage kV |
| Output connectors of AC and DC power supply: | | | | |
| disturbance is applied in common mode; | – | 0,5 | 1 | 2 |
| disturbance is applied in different mode | – | 0,25 | 0,5 | 1 |

[a] The requirements are established for nuclear I&C equipment used at electrical substations of middle (6 kV to 35 kV) and high (above 35 kV) voltage.

#### 4.2.1.11 Immunity to fluctuations of power supply voltage according to IEC 61000-4-14

Degrees of severity of tests of nuclear I&C equipment on disturbance immunity due to the impact of a step change of power supply voltage according to IEC 61000-4-14 on input connectors of AC power supply shall be established in accordance with Table 11.

**Table 11 – Fluctuations of power supply voltage**

| Arrangement group on disturbance immunity of nuclear I&C equipment | | | |
|---|---|---|---|
| I | II | III | IV |
| Value of voltage step change % $U_n$ | Value of voltage step change % $U_n$ | Value of voltage step change % $U_n$ | Value of voltage step change % $U_n$ |
| N.a. | ±8 | ±12 | ±20 |

#### 4.2.1.12 Immunity to conducted common mode disturbances in the frequency range of 0 Hz to 150 kHz according to IEC 61000-4-16

These requirements and associated test methods cover susceptibility to conducted interference resulting from noise coupling through power leads of I&C equipment in nuclear power plants.

Degrees of test severity of nuclear I&C equipment on disturbance immunity due to the impact of electromagnetic interference, being non-symmetrical voltages within a frequency range of 0 Hz to 150 kHz, according to IEC 61000-4-16 on input/output both AC and DC power supply connectors, signal and control connectors shall be established in accordance with Table 12.

**Table 12 – Conducted common mode disturbances in the frequency range of 0 Hz to 150 kHz**

| Disturbance type | Arrangement group on disturbance immunity of nuclear I&C equipment [a] | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| | Output voltage of testing oscillator under no-load conditions | Output voltage of testing oscillator under no-load conditions | Output voltage of testing oscillator under no-load conditions | Output voltage of testing oscillator under no-load conditions |
| | V | V | V | V |
| Long-time disturbances at a frequency of 50 Hz | 1 | 3 | 10 | 30 |
| Short-time disturbances at a frequency of 50 Hz | 3 | 10 | 30 | 100 |
| Long-time disturbances within a frequency band of 15 Hz to 150 kHz, in particular: | | | | |
| within a frequency band of 15 Hz to 150 Hz; | 1 – 0,1[b] | 3 – 0,3[b] | 10 – 1[b] | 30 – 3[b] |
| within a frequency band of 150 Hz to 1,5 kHz; | 0,1 | 0,3 | 1 | 3 |
| within a frequency band of 1,5 kHz to 15 kHz; | 0,1 – 1[c] | 0,3 – 3[c] | 1– 10[c] | 3 – 30[c] |
| within a frequency band of 15 kHz to 150 kHz | 1 | 3 | 10 | 30 |

[a] The requirements are established for nuclear I&C equipment whose connectors could be connected to cables with a length exceeding 20 m.
[b] Testing voltage is decreased by 20 dB per decade.
[c] Testing voltage is increased by 20 dB per decade.

NOTE The requirements should be established only for nuclear I&C equipment being composite elements of electrical installation of significant power.

#### 4.2.1.13 Immunity to variation of power frequency according to IEC 61000-4-28

This test is applicable only to AC supplied I&C equipment.

Degrees of severity of tests of nuclear I&C equipment on disturbance immunity due to the impact of variation of power frequency according to IEC 61000-4-28 on input connectors of AC power supply shall be established in accordance with Table 13.

**Table 13 – Variations of power frequency in supply systems**

| Test level | | | |
|---|---|---|---|
| **I** | **II** | **III** | **IV** |
| **Relative variation of frequency** $\Delta f/f_1$, % | **Relative variation of frequency** $\Delta f/f_1$, % | **Relative variation of frequency** $\Delta f/f_1$, % | **Relative variation of frequency** $\Delta f/f_1$, % |
| ±3 | +4, –6 | ±15 | ±15 |
| NOTE $\Delta f$ – variation of frequency; $f_1$ – basic frequency in power supply system. | | | |

#### 4.2.1.14 Immunity to a distortion of harmonics and interharmonics including mains signalling at a.c. power port according to IEC 61000-4-13

Degrees of severity of tests of nuclear I&C equipment on disturbance immunity in conditions of a harmonic distortion due to the impact of harmonics and inter-harmonics of power supply voltage shall be established in accordance with Tables 14 to 17.

**Table 14 – Odd harmonics of power supply voltage, non-divisible by 3 (percent of nominal value of voltage of basic component)**

| **Harmonics number** | **Test level** | | | |
|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** |
| 5 | N.a. | 9 | 12 | The level of the harmonics shall be established in the specification to nuclear I&C equipment |
| 7 | N.a. | 7,5 | 10 | "-" |
| 11 | N.a. | 5 | 7 | "-" |
| 13 | N.a. | 4,5 | 7 | "-" |
| 17 | N.a. | 3 | 6 | "-" |
| 19 | N.a. | 2 | 6 | "-" |
| 23 | N.a. | 2 | 6 | "-" |
| 25 | N.a. | 2 | 6 | "-" |
| 29 | N.a. | 1,5 | 6 | "-" |
| 31 | N.a. | 1,5 | 3 | "-" |
| 35 | N.a. | 1,5 | 3 | "-" |
| 37 | N.a. | 1,5 | 3 | "-" |

**Table 15 – Odd harmonics of power supply voltage, divisible by 3 (percent of nominal value of voltage of basic component)**

| Harmonics number | Test level | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| 3 | N.a. | 8 | 9 | The level of the harmonics shall be established in the specification to nuclear I&C equipment |
| 9 | N.a. | 2,5 | 4 | "-" |
| 15 | N.a. | N.a. | 3 | "-" |
| 21 | N.a. | N.a. | 2 | "-" |
| 27 | N.a. | N.a. | 2 | "-" |
| 33 | N.a. | N.a. | 2 | "-" |
| 39 | N.a. | N.a. | 2 | "-" |

**Table 16 – Even harmonics of power supply voltage (percent of nominal value of voltage of basic component)**

| Harmonics number | Test level | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| 2 | N.a. | 3 | 5 | The level of the harmonics shall be established in the specification to nuclear I&C equipment |
| 4 | N.a. | 1,5 | 2 | "-" |
| 6 | N.a. | N.a. | 1,5 | "-" |
| 8 | N.a. | N.a. | 1,5 | "-" |
| 10 | N.a. | N.a. | 1,5 | "-" |
| 12 – 40 | N.a. | N.a. | 1,5 | "-" |

**Table 17 – Harmonic components with frequencies allocated between frequencies of harmonics (percent of nominal value of voltage of basic component)**

| Range of frequency Hz | Test level | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| 16 – 100 | N.a. | 2,5 | 4 | The level of the harmonics shall be established in the specification to nuclear I&C equipment |
| 100 – 500 | N.a. | 5 | 9 | "-" |
| 500 – 750 | N.a. | 3,5 | 5 | "-" |
| 750 – 1 000 | N.a. | 2 | 3 | "-" |
| 1 000 – 2 000 | N.a. | 1,5 | 2 | "-" |

#### 4.2.1.15 Immunity to a damped oscillatory magnetic field according to IEC 61000-4-10

The phenomenon addressed by this test is the disturbance to I&C equipment from large radiated magnetic fields. Equipment that is not intended to be installed in areas with strong sources of magnetic fields (e.g. CRTs, motors, cable bundles carrying high currents) may be exempt from this test, based on analysis.

Degrees of severity of tests of nuclear I&C equipment on disturbance immunity due to the impact of a damped oscillatory magnetic field according to IEC 61000-4-10 shall be established in accordance with Table 18.

**Table 18 – Damped oscillatory magnetic field**

| Test level | | | |
|---|---|---|---|
| **I** | **II** | **III** | **IV** |
| **Strength of magnetic field** A/m | **Strength of magnetic field** A/m | **Strength of magnetic field** A/m | **Strength of magnetic field** A/m |
| – | 10 | 30 | 100 |
| NOTE The requirements should be established only for nuclear I&C equipment used in substations of middle (6 kV – 35 kV) and high (above 35 kV) voltage, except the equipment based on the measurement of magnetic field parameters. | | | |

### 4.2.2 Safety system equipment

Nuclear I&C equipment belonging to safety systems (items) or systems (items) of normal operation important to safety shall meet quality criterion A, as defined in Annex A, for operation due to the impact of all types of disturbances indicated in 4.1 items a) to n) unless otherwise specified by country specific practices.

Criterion B and Criterion C, as defined in Annex A, may be acceptable based on country specific practices.

## 5 Test methods

### 5.1 General

Nuclear I&C equipment shall be tested for disturbance immunity in order to evaluate the compliance with requirements established in this standard.

Test equipment and test methods shall be defined in accordance with the specific standards identified in 4.2.1.

The following equipment is tested for disturbance immunity:

- batch-produced nuclear I&C equipment – during the certification and type tests;
- newly developed and modernized nuclear I&C equipment – during the acceptance tests.

The need for tests on disturbance immunity when conducting acceptance and sampling tests is given in the standards and specifications for nuclear I&C equipment of specific types.

It is the responsibility of the owner/operator to ensure that operating nuclear equipment environments are within the boundaries tested by following this standard.

An example procedure for tests and evaluation of the compliance of operating nuclear I&C equipment with the requirements for disturbance immunity is given in Annex C.

Certification tests of nuclear I&C equipment on the compliance with the requirements of this standard shall be carried out in accredited test laboratories (centers).

Nuclear I&C equipment shall be tested for disturbance immunity with the minimum necessary set of technical equipment functionally interacting with nuclear I&C equipment under test. Tests of nuclear I&C equipment are carried out in the operational modes envisaged in the technical documentation on nuclear I&C equipment.

Nuclear I&C equipment under test shall be installed and connected to power supply, input/output lines, signal and grounding circuits in accordance with vendor technical documentation. Additional grounding, not provided in the project, is inadmissible.

The position of tested nuclear I&C equipment and equipment functionally interacting with it shall correspond to the conditions indicated in technical documentation on the nuclear I&C equipment. If the position of equipment and cables is not indicated, it shall correspond to a typical application.

The composition of technical equipment, functionally interacting with nuclear I&C equipment under test, the operational modes of the nuclear I&C equipment during the tests on disturbance immunity, nuclear I&C equipment circuits impacted by disturbances and also the procedure for evaluation of operational quality of nuclear I&C equipment during the tests and its compliance with the established criterion should be indicated:

– for preproduction models under operating conditions – in the test program and methods;
– for batch-produced items – in the specification;
– for certified nuclear I&C equipment – in test methods developed by an accredited testing laboratory (center).

Technical equipment functionally interacting with the tested nuclear I&C equipment, or signal sources necessary for operating nuclear I&C equipment during the tests on disturbance immunity, can be substituted by validated simulators;

The intensity of a disturbance during the tests on disturbance immunity shall be smoothly or stepwise increased without exceeding the value stated for a chosen nuclear I&C equipment arrangement group. The operational quality of nuclear I&C equipment during the test shall comply with the established criterion for the assigned and lower degrees of test severity.

In the case of the use of additional equipment, the latter shall be protected from any adverse effects of the tests.

Tests of nuclear I&C equipment on disturbance immunity norms shall be carried out at normal environment conditions, as follows (unless specific environmental conditions are required)

– temperature of surrounding air (15 °C to 35 °C);
– relative humidity 25 % to 75 %;
– atmospheric pressure 86 kPa to106 kPa.

The preparation of nuclear I&C equipment for the tests on disturbance immunity shall be carried out in correspondence with the basic standards listed in Clause 2 and in 4.2.1.1 to 4.2.1.14.

Test reports may be prepared in correspondence with Annex D.

### 5.2 Test results assessment

Assessment of industrial emissions test results shall be performed in accordance with CISPR 11, CISPR 22 and guidance in this standard.

## 6 Safety requirements

Safety requirements shall be followed during the tests on disturbance immunity and emission norms according to the standards established for test methods.

# Annex A
(normative)

# Functional quality criteria of nuclear I&C equipment under test for disturbance immunity

Functional quality criteria of nuclear I&C equipment under test for disturbance immunity are given in Table A.1.

**Table A.1 – Functional quality criteria of nuclear I&C equipment under test for disturbance immunity**

| Functional quality criteria of nuclear I&C equipment under test for disturbance immunity | Operational quality of nuclear I&C equipment during tests for disturbance immunity |
|---|---|
| A | The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended. |
| B | The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. During the test degradation of performance is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended. |
| C | Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of controls. |

# Annex B
(informative)

# Quality characteristics defining the classification of electromagnetic environment severity in the locations where nuclear I&C equipment is to be installed

**Table B.1 – Quality characteristics defining the classification of electromagnetic environment severity in the locations where nuclear I&C equipment is to be installed**
(see Note 1)

| Conditions for placing, mounting and assembling nuclear I&C equipment | Severity of electromagnetic environment | | | |
|---|---|---|---|---|
| | Light electromagnetic environment | Middle electromagnetic environment | Harsh electromagnetic environment | Severe electromagnetic environment |
| Grounding system | Nuclear I&C equipment is equipped with specially designed systems of signalling and protecting grounding systems | Nuclear I&C equipment is equipped with specially designed signalling grounding system and is connected to the general protecting grounding system | Nuclear I&C equipment and power equipment have common protecting grounding system | There is no grounding system specially designed for nuclear I&C equipment, and the equipment is grounded inappropriately |
| Screening properties of a location | Walls, floor and ceiling of a location have satisfactory screening properties. Damping factor for the noise in a range of 0,15 MHz – 30 MHz is not less than 20 dB – 30 dB | A location does not possess screening properties. Damping factor for the noise in a range of 0,15 MHz – 30 MHz does not exceed 10 dB | There are no requirements for screening a location | There are no requirements for screening a location |
| Power supply system | Nuclear I&C equipment is powered from a source of uninterrupted power supply or from an independent feeder | Nuclear I&C equipment has a line supply through decoupling transformers, or it is powered from a source of uninterrupted power supply or from an independent feeder | Nuclear I&C equipment has a power supply that is common with other equipment | Nuclear I&C equipment has a power supply that is common with other equipment |
| Mounting and assembling conditions in a location | Commutable inductive loads are equipped with noise suppression appliances. Feeding and information lines are screened, and screens are connected at both ends to grounding system. Feeding lines have line filters and protection against excessive voltage | Inductive loads commuted by relay contacts are not equipped with noise suppression appliances. Loads commuted by contacts are protected. Lines with different levels of signals and voltages are unsatisfactorily spaced each from the other. There are cables, which contain feeding lines, information lines, lines of control and communication. Feeding lines have protection against excessive voltage | Commutable inductive loads are not equipped with noise suppression appliances. There is no space between lines with different levels of signals and voltage. Cables for feeding, control, information and communication are not spaced. Cables are used with lines of different destination. Cables are not screened and not protected against excessive voltage | Commutable inductive loads are not equipped with noise suppression appliances. There is no space between lines with different levels of signals and voltage. Cables for feeding, control, information and communication are not spaced. Cables are used with lines of different destination. Cables are not screened and not protected against excessive voltage |

**Table B.1** *(continued)*

| Conditions for placing, mounting and assembling nuclear I&C equipment | Severity of electromagnetic environment | | | |
|---|---|---|---|---|
| | **Light electromagnetic environment** | **Middle electromagnetic environment** | **Harsh electromagnetic environment** | **Severe electromagnetic environment** |
| Nuclear I&C equipment placement conditions | Nuclear I&C equipment is placed in a common location. External information cables connected to nuclear I&C equipment are protected against excess voltage and have galvanic separation | Part of nuclear I&C equipment is placed in another location of the same building. Information communications to these parts have galvanic separation. Communications of the equipment going beyond the building are protected against excess voltage and have galvanic separation | Nuclear I&C equipment is placed outside the main building. Parts of nuclear I&C equipment are concentrated in different places and have galvanic separation each from other. Communication cables going beyond the main building are protected against excess voltage | Nuclear I&C equipment is placed within the main building and outside it. Not all the parts of the equipment being remote each from other have galvanic separation. Not all the information cables are protected against excess voltage. There are information cables going beyond the main building |
| The existence of other equipment in a location | There is no other equipment connected to the same supply main as the supply main of nuclear I&C equipment. The light is provided by incandescent or luminescent lamps operating from a separate supply main | There is other equipment in a location connected to the same supply main as the supply main of nuclear I&C equipment. No requirements are given for the type and power supply of lamps. There could be high-voltage equipment and sources of electrostatic discharges in the location | There is other equipment in a location connected to the same supply main as the supply main of nuclear I&C equipment. No requirements are given for the type and power supply of lamps. There could be high-voltage equipment and sources of electrostatic discharges in the location | There is other equipment in a location connected to the same supply main as the supply main of nuclear I&C equipment. No requirements are given for the type and power supply of lamps. There could be high-voltage equipment and sources of electrostatic discharges in the location |
| The use of cellular telephone systems and radio stations in locations where nuclear I&C equipment is placed | The use of cellular telephone systems and radio stations is prohibited | Limited use of cellular telephones and radio stations with a power of not more than 2 W at an appropriate distance – based on the maximum disturbance you can allow and the power of the device | Possible use of cellular telephones and radio stations with a power of not more than 12 W | Possible unlimited use of cellular telephones and radio stations. Powerful radio transmitters can be nearby nuclear I&C equipment |
| NOTE 1 This Table is representative of an approach to defining the Electromagnetic Environment (EME). It is not intended to be definite – each user should consider what characteristics are appropriate for their application.<br>NOTE 2 Electromagnetic environment as a whole is determined by the most severe condition, characterizing environment for placing, mounting and assembling nuclear I&C equipment. | | | | |

# Annex C
(informative)

## Guidance for tests and evaluation of conformance with the requirements for disturbance immunity of operating nuclear I&C equipment

Evaluation of conformance of operating nuclear I&C equipment with disturbance immunity requirements, established in this standard, may be carried out taking into account test results of nuclear I&C equipment on disturbance immunity. On-site testing on the immunity to electromagnetic disturbances should be carried out on a shutdown reactor. Test methods should correspond to Clause 5 of this standard.

Tests may be carried out during remedial maintenance at NPP. The period between tests may be determined by national regulatory bodies.

Tests are carried out in accordance with programs and methods approved according to the established procedure.

Testing programs and methods should establish a composition of nuclear I&C equipment under test, testing scope as well as the procedure of tests and disturbance immunity evaluation of NPP regular systems according to test results of nuclear I&C equipment belonging to these systems.

A proper arrangement group on disturbance immunity may be determined for each nuclear I&C equipment under tests according to Table 1 and in conformity with nuclear I&C equipment destination and influence on safety as well as in conformity with class of severity of electromagnetic environment.

Tests of nuclear I&C equipment on disturbance immunity may be carried out due to the impact of disturbances of which the type is established in the test method taking into account specific electromagnetic conditions in places where nuclear I&C equipment is installed. The degree of disturbance immunity test severity is determined with use of this standard for the chosen arrangement group. An actual compliance of operational quality of nuclear I&C equipment with the criteria of Annex A is revealed during the tests.

Nuclear I&C equipment under test belonging to safety systems (items), safety-related systems (items) and non - safety related systems (items) is considered as meeting the requirements for disturbance immunity in operating conditions if actual quality parameters determined during the tests correspond to the criteria indicated in 4.2.2 or to the criteria indicated in testing program and method (for equipment developed and produced before the introduction of this standard).

In the case of discrepancy of a specific sample of nuclear I&C equipment operating in NPP with the requirements for disturbance immunity, the decision regarding its further operation may be taken in accordance with the established order.

# Annex D
(informative)

## Example form of test report for nuclear I&C equipment tests for disturbance immunity

The form recording the testing may include any suitable format with the following categories of recommended information:

– organization which carried out tests;

– report number;

– test number of electromagnetic compatibility test;

– characteristics of nuclear I&C equipment under the tests (name, type, pre-production or production samples), name of manufacturer, its postal address, number according to numeration system of the manufacturer, date of manufacture, safety class according to IEC 61513, IEC 61226, IAEA Safety guide NS-G-1.3, designation of normative documentation of nuclear I&C equipment, brief description of nuclear I&C equipment (including its type – desk-top, floor, combined, names of constituent items, arrangement group of nuclear I&C equipment on disturbance immunity);

– purpose of tests of nuclear I&C equipment (test category, designation of normative testing documentation with the indication of clauses establishing requirements for disturbance immunity and test methods);

– date of test of nuclear I&C equipment (year, month, day of tests) and place of tests (open area, shielded room);

– testing equipment and measurement instrumentation (name, type, number, manufacturer, information on the certification and verification);

– testing impacts on nuclear I&C equipment (nuclear I&C equipment ports under the testing and degree of severity for each type of disturbance);

– operating modes of nuclear I&C equipment during the tests for each type of disturbance (conditions for power supply, grounding, signal injection to input/output circuits, characteristics of operating cycle, simulators, testing software, safety functions and acceptance criteria used during the tests);

– test results for each nuclear I&C equipment sample tested (in view of a table containing regulated and actual parameters of testing impacts as applied to types of disturbances, results of testing impact, conclusions on actual operational quality criteria of nuclear I&C equipment under test, information on discrepancies of operational quality of nuclear I&C equipment under test with the criteria established in the technical documentation, statistical estimation of the results);

– conclusion, degree of compliance of nuclear I&C equipment disturbance immunity parameters with the requirements of normative documentation;

– annexes. Testing procedures and any materials related to nuclear I&C equipment under test are determined by the assigned test organization or user.

Tests were carried out by:

| Positions | Names | Signatures |
|---|---|---|

Tests were carried out in the presence of:

| Positions | Names | Signatures |
|---|---|---|

# Annex E
(informative)

# Emissions testing guidelines

## E.1 General

Nuclear I&C equipment may also be required to satisfy emission limitations. To provide guidance in this area, this annex has been included to address recommended emissions requirements and acceptance criteria.

In the following clause, guidance is provided on specific subjects, as indicated below, items a) to c). It is assumed that some of the recommended requirements indicated below, items a) to c), may be analyzed for acceptance versus direct testing, when it is well-founded by operating condition and safety.

a) Industrial field strength emissions in the ranges of 0,15 MHz to 30 MHz and 30 MHz to 1 000 MHz.

b) Harmonic components of consumption current.

c) Voltage variations caused by nuclear I&C equipment.

## E.2 Limits for disturbance emission

### E.2.1 Limits for man-made interference

Nuclear I&C equipment belonging to the equipment of information technologies may be required to meet the norms for man-made interference of class A established in Tables 1 and 5 of CISPR 22:2003.

Nuclear I&C equipment may be required to meet the norms for man-made interference given in Tables E.1 and E.2 (these norms correspond to the norms established in CISPR 11:2003, class A, group 1).

**Table E.1 – Limits for field strength of man-made interference from nuclear I&C equipment not belonging to information technologies equipment at a distance of measurement of 30 m**

| Ports | Frequency band<br>MHz | Field strength<br>dB (μV/m)<br>(quasi-peak value) |
|---|---|---|
| Casing | 30 – 230 | 30 |
| | 230 – 1 000 | 37 |
| NOTE 1 It is acceptable to carry out measurement at a distance of 10 m using norms of this table, increased by 10 dB.<br><br>NOTE 2 Stationary or large-sized equipment for which testing in a laboratory in accordance with norms of this table is not possible, may be tested in its operational place at a distance of 10 m from the wall of the building where the equipment is allocated.<br><br>NOTE 3 At a boundary frequency, the limit is equal to the lower value of the field strength of man-made interference in main supply. | | |

**Table E.2 – Limits for voltage level of man-made interference from nuclear I&C equipment not belonging to information technologies equipment**

| Connector | Frequency band<br>MHz | Voltage value<br>dB (μV) |
|---|---|---|
| Output connectors of AC power supply | 0,15 – 0,5 | 79 (quasi-peak value)<br>66 (average value) |
| | 0,5 – 30 | 73 (quasi-peak value)<br>60 (average value) |
| NOTE 1 Stationary or large-sized equipment for which testing in a laboratory in accordance with the norms of this table is not possible, may be tested on its operational place.<br><br>NOTE 2 At a boundary frequency, the norm is equal to the lesser value of the voltage value of the man-made interference.<br><br>NOTE 3 Short duration man-made interferences, emitted by nuclear I&C equipment with a repetition rate of less than 5 per minute, need not be taken into account. Short duration man-made interference with a repetition rate of more than 30 per minute should be taken into account with norms given in this table. It is acceptable to decrease norms by 20/N to 30/N (where N is the number of interference repetition per minute) for short-time man-made interferences with a repetition rate of between 5 and 30 per minute.<br><br>NOTE 4 Also, any connections other than AC power connectors may be taken into account(signal, control, DC power). | | |

### E.2.2 Limits for harmonic components of consumption current

Nuclear I&C equipment feeding from a common electricity supply network may be required to meet emission norms for harmonic components of consumption current established in IEC 61000-3-2, Clause 7.

### E.2.3 Limits for voltage variations caused by nuclear I&C equipment

Nuclear I&C equipment feeding from a common electricity supply network may be required to meet the following limits for voltage variations in the electricity supply network, caused by nuclear I&C equipment (these norms are taken from IEC 61000-3-3, Clause 5):

– steady relative variation of voltage – less than 3 %;

– maximum relative variation of voltage – less than 4 %;

– characteristics of relative variation of voltage – less than 3 % for time interval of voltage variation exceeding 0,2 s.

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