

<b>Examination Procedure</b>  Rubrik / Title <b>Electromagnetic Compatibility Verification</b>	Beteckning / Document <b>KBE EP-153</b>
	Utgåva / Issue <b>3 (E)</b>
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## 1 Scope

This Examination Procedure is applicable to type inspection (type tests / design verification tests) only and defines the electromagnetic compatibility (EMC) test requirements for electrical equipment intended for to installation in locations and related environments as defined in TBE 101.

Any deviations/additional requirements are specified in the Technical Specification.

The tests include continuous and transient conducted and radiated disturbances including electrostatic discharges. Both immunity and emission have to be considered.

## 2 Objective

The objective of this examination procedure is to assure that electrical equipment will have a sufficient level of immunity against malfunctions caused by electromagnetic interference generated by other equipment and machinery present in a nuclear power plant. Also to assure that equipment to be installed fulfils basic requirements on limited radiation of interference that could influence the reliable and safe operation of other equipment.

## 3 Method

All test setups should be made in accordance with applicable specified product standards for EMC-verification or if product standards do not exist the test setups should be made in accordance with basic standards listed in IEC 61000-6-2 (immunity) and IEC 61000-6-4 (emission).

When applicable, methods according to IEC 61000-4-5 and IEC 60255-22-4 shall be used.

The test specimen should be assembled and provided with all protective and mounting devices, electrical and mechanical interfaces required for the operation when installed in a system.

### 3.1 Additional test requirements

In addition to the test requirements of IEC 61000-6-2 the following shall apply.

#### **Power Frequency Magnetic Field 50 Hz**

Ref. IEC 61000-6-2 Requirement 1. 1.

#### Additional test and performance requirements:

- For equipment in switchgear and other areas with high levels of magnetic fields:  
300 A/m continuously and 1 000 A/m during 3 s.

## **Electrostatic Discharge**

Ref. IEC 61000-6-2 Requirement 1. 3.

Additional test and performance requirements for operator panels and all parts accessible during normal operation:

- Test levels should be:
  - Contact discharge 6 kV
  - Air discharge 15 kV
- Performance criterion A according to chapter 4.1.

## **Voltage Interruption**

Ref. IEC 61000-6-2 Requirement 4.5.

Additional test and performance requirements:

- Interruption in supply voltage, applicable to both AC and DC supply.  
Reduction >95 % of nominal voltage of any duration 10 – 5 000 ms. The time that is most unfavourable for the equipment shall be chosen.
- Performance criterion B according to chapter 4.1. The electrical equipment has to recover to the required operating state without any external intervention after that the supply voltage has been restored.

## **Voltage and frequency fluctuations**

According to TBE 100, “Main and auxiliary power supply”.

## **3.2 Additional test requirements for relay protection systems**

This additional test requirement is only applicable to relay protection systems that are interfacing switchgears that are part of the outside plant external system.

Tests shall be performed according to IEC 61000-4-5 class 4 and IEC 60255-22-4 class A.

# **4 Requirements**

## **4.1 Immunity**

After testing, it should be verified that there is no degradation in performance according to the Manufacturers product specification and the Purchasers Technical Specification.

A functional description and a definition of performance criteria, during or as a consequence the EMC testing, shall be provided by the Manufacturer and noted in the test report, based on the following criteria:

### **Performance Criterion A:**

The apparatus shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the Technical Specification, when the apparatus is used as intended.

### **Performance Criterion 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 Technical Specification, when the apparatus is used as intended.

### **Performance Criterion C:**

Temporary loss of function is allowed, provided the function according to the Technical Specification is self-recoverable or can be restored by the operation of the controls.

## **4.2 Emission**

It has to be demonstrated that the requirements according to IEC 61000-6-4 are fulfilled.

## Table 1 - Electrical Environment - Immunity

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Immunity–Requirements according to IEC 61000-6-2, generic standards for industrial environment					
Table reference	EMC Environmental Phenomena	Parameter Specification	Perfor- mance Criteria	Basic standards	Remarks
Immunity - Enclosure ports					
1.1	Power-frequency magnetic field	50 Hz 30 A/m	A	IEC 61000-4-8 Table 1, level 4	See note 1
1.2	Radio-frequency amplitude modulated electromagnetic field	80 – 1 000 MHz 10 V/m rms, unmodulated 80% AM (1 kHz)	A	IEC 61000-4-3 Table 1, level 3	
1.3	Electrostatic discharge	±4 kV contact discharge	B	IEC 61000-4-2 Table 1, level 2	See note 2
		±8 kV air discharge		IEC 61000-4-2 Table 1, level 3	
Immunity – Signal ports					
2.1	Radio-frequency common mode	0,15 - 80 MHz 10 V rms, unmodulated 80 % AM (1 kHz)	A	IEC 61000-4-6 Table 1, level 3	
2.2	Fast transients	±1 kV (charge voltage) 5/50 Tr/Th ns 5 kHz repetition frequency	B	IEC 61000-4-4 Table 1, level 3	
2.3	Surges line-to-earth	1,2/50 (8/20) Tr/Th µs ±1 kV (open circuit)	B	IEC 61000-4-5 Table 1, level 2	

<sup>1</sup> Additional test and performance requirements for equipment in switchgear and other areas with high levels of magnetic fields according to IEC 61000-4-8:

- Table 1 level X (special) 300 A/m.
- Table 2 level 4, 1000 A/m under 3 s.

<sup>2</sup> Additional test and performance requirements for operator panels and all parts accessible during normal operation according to IEC 61000-4-2 table 1:

- Contact discharge 6 kV (level 3).
- Air discharge 15 kV (level 4).
- Performance Criterion A according to IEC 61000-6-2 Requirement 4.1

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## Immunity-Requirements according to IEC 61000-6-2, generic standard for industrial environment

Table reference	EMC Environmental Phenomena	Parameter Specification	Performance Criteria	Basic standards	Remarks
<b>Immunity - Input and output d.c. power ports</b>					
3.1	Radio-frequency common mode.	0,15 - 80 MHz 10 V rms, unmodulated 80 % AM (1 kHz)	A	IEC 61000-4-6 Table 1, level 3	
3.2	Fast transients	±2 kV (charge voltage) 5/50 Tr/Th ns 5 kHz repetition frequency	B	IEC 61000-4-4 Table 1, level 3	
3.3	Surges line-to-earth line-to-line	1,2/50 (8/20) Tr/Th µs ±0,5 kV (open circuit) ±0,5 kV (open circuit)	B	IEC 61000-4-5 Table 1, level 2	
<b>Immunity - Input and output a.c. power ports</b>					
4.1	Radio-frequency common mode.	0,15 - 80 MHz 10 V rms, unmodulated 80 % AM 1 kHz	A	IEC 61000-4-6 Table 1, level 3	
4.2	Fast transients	±2 kV (charge voltage) 5/50 Tr/Th ns 5 kHz repetition frequency	B	IEC 61000-4-4 Table 1, level 3	
4.3	Surges line-to-earth line-to-line	1,2/50 (8/20) Tr/Th µs ±2 kV (open circuit) ±1 kV (open circuit)	B	IEC 61000-4-5 Table 1, level 2	
4.4	Voltage dips	30 % reduction 0,5 periods	B	IEC 61000-4-11 Table 1	
		60 % reduction 5 periods	C		
		60 % reduction 50 periods	C		
4.5	Voltage interruptions	>95 % reduction 250 periods	C	IEC 61000-4-11	
<b>Immunity – Functional earth ports</b>					
5.1	Radio-frequency common mode.	0,15 - 80 MHz 10 V rms, unmodulated 80 % AM 1 kHz	A	IEC 61000-4-6 Table 1, level 3	
5.2	Fast transients	±1 kV (charge voltage) 5/50 Tr/Th ns 5 kHz repetition frequency	B	IEC 61000-4-4 Table 1, level 3	

## Tabell 2 – Electrical environment- Emission

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Emission - Requirements according to IEC 61000-6-4, generic standard for industrial environment				
Table reference	Port	Frequency range	Limits	Basic standards
1.1	Enclosure	30 – 230 MHz	30 dB (μV/m) quasi peak measured at 30 m distance	CISPR 11
		230 – 1 000 MHz	37 dB (μV/m) quasi peak measured at 30 m distance	
1.2	AC Mains	0,15 - 0,50 MHz	79 dB (μV) quasi peak 66 dB (μV) average	CISPR 11
		0,50 – 5 MHz	73 dB (μV) quasi peak 60 dB (μV) average	
		5 – 30 MHz	73 dB (μV) quasi peak 60 dB (μV) average	

## 5 Documentation

Type inspection (design verification) carried out is to be documented in a technical report as required in the Inspection Plan. The complete type inspection of the product may be documented in the same report.

The report shall as a minimum include the following:

- Product identification  
Product type, designations, versions, variations, etc.
- Test specimens  
Type, designation, quantity, serial numbers, preparations, etc.
- Identity / Traceability  
The identity of the product/test specimens in comparison with the Manufacturers specification and/or in comparison with the Technical Specification shall be clearly specified as per KBE EP-180.
- Test procedure  
It must be clearly stated if the inspection has been performed according to this Examination Procedure or to any other procedure agreed upon.
- Acceptance criteria  
Performance requirements before, during and after specified tests.
- Test set-up  
Detailed description of test set-ups, electrical and mechanical interfaces.

- Measurement equipment  
Type of equipment, accuracy, identification, etc, and current calibration data for monitoring and recording equipment.
- Results  
Measured and recorded values that are to be documented as per the procedure as well as any deviations from requirements in applicable specifications or test procedures must be reported. Date of inspections and name of responsible inspectors are to be included. Measured values have to be documented in an auditable form. The documentation has to include a statement whether the product was successfully tested, and that all product specifications and requirements are fulfilled.
- Summary and conclusion  
It shall be evident that the product has fulfilled stated requirements and acceptance criteria.
- Approval  
The report shall be reviewed and approved in accordance with the Manufacturers or the laboratory's internal QA/QC routines.