

Examination Procedure Title Electromagnetic Compatibility Verification	Document KBE EP-153
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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 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 shall 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 nuclear facilities. 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). If product standards are used, the Manufacturer/Supplier shall identify and inform the Purchaser if requirements in the product standards are less strict than the demands in IEC 61000-6-2 (immunity) and IEC 61000-6-4 (emission).

When applicable, methods according to IEC 61000-4-5 and IEC 60255-26 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 1.4.

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 in this document.

Voltage Interruption

Ref. IEC 61000-6-2 Requirement 4.3.

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 in this document. 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 100:1, “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 60255-26 class A.

4 Requirements

4.1 Immunity

After testing, it should be verified that there is no degradation in performance according to the Manufacturer’s product specification and the Purchaser’s 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 shall 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	Performance Criteria	Basic standards	Remarks
Immunity - Enclosure ports					
1.1	Power-frequency magnetic field	50 Hz, 60 Hz 30 A/m	A	IEC 61000-4-8 Table 1, level 4	See note ¹
1.2	Radio-frequency electromagnetic field. Amplitude modulated	80 – 1 000 MHz 10 V/m 80% AM (1 kHz)	A	IEC 61000-4-3 Table 1, level 3	
1.3	Radio-frequency electromagnetic field. Amplitude modulated	1,4 – 6,0 GHz 3 V/m 80% AM (1 kHz)	A	IEC 61000-4-3 Table 1, level 2	
1.4	Electrostatic discharge	±4 kV contact discharge (charge voltage)	B	IEC 61000-4-2 Table 1, level 2	See note ²
		±8 kV air discharge (charge voltage)		IEC 61000-4-2 Table 1, level 3	
Immunity – Signal ports					
2.1	Radio-frequency common mode	0,15 - 80 MHz 10 V 80 % AM (1 kHz)	A	IEC 61000-4-6 Table 1, level 3	See note ³
2.2	Surges line-to-earth	1,2/50 (8/20) T _r /T _d μs ±1 kV (open circuit test voltage)	B	IEC 61000-4-5 Table 1, level 2	
2.3	Fast transients	±1 kV (open circuit test voltage) 5/50 t _r /t _w ns 5 or 100kHz repetition frequency	B	IEC 61000-4-4 Table 1, level 3	See note ³

¹ 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.

² 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 a).

³ Requirement also applies for functional earth ports

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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
Immunity - Input and output d.c. power ports					
3.1	Radio-frequency common mode.	0,15 - 80 MHz 10 V 80 % AM (1 kHz)	A	IEC 61000-4-6 Table 1, level 3	
3.2	Surges line-to-earth line-to-line	1,2/50 (8/20) T _r /T _d μs ±1 kV (open circuit test voltage) ±0,5 kV (open circuit test voltage)	B	IEC 61000-4-5 Table 1, level 2	
3.3	Fast transients	±2 kV (open circuit test voltage) 5/50 t _r /t _w ns 5 or 100 kHz repetition frequency	B	IEC 61000-4-4 Table 1, level 3	Nuclear requirement (±2 kV)
Immunity - Input and output a.c. power ports					
4.1	Radio-frequency common mode.	0,15 - 80 MHz 10 V 80 % AM 1 kHz	A	IEC 61000-4-6 Table 1, level 3	
4.2	Voltage dips	70% residual voltage 25/30 cycle at 50/60 Hz	C	IEC 61000-4-11 Table 1	
		40 % residual voltage 10/12 cycle at 50/60 Hz	C		
4.3	Voltage interruptions	0% residual voltage 250/300 cycle at 50/60Hz	C	IEC 61000-4-11	
4.4	Surges line-to-earth line-to-line	1,2/50 (8/20) T _r /T _d μs ±2 kV (open circuit test voltage) ±1 kV (open circuit test voltage)	B	IEC 61000-4-5 Table 1, level 2	
4.5	Fast transients	±2 kV (open circuit test voltage) 5/50 t _r /t _w ns 5 or 100 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
3.1	Enclosure	30 – 230 MHz	40 dB ($\mu\text{V}/\text{m}$) quasi peak measured at 10 m distance		
		230 – 1 000 MHz	47 dB ($\mu\text{V}/\text{m}$) quasi peak measured at 10 m distance		
4.1	AC Mains	0,15 - 0,50 MHz	79 dB (μV) quasi peak 66 dB (μV) average		
		0,50 –30 MHz	73 dB (μV) quasi peak 60 dB (μV) average		
5.1	Wired network	0,15 - 0,50 MHz	97 to 87 dB (μV) quasi peak	53 to 43 dB (μA) quasi peak	
			84 to 74 dB(μV) average	40 to 30 dB (μA) Average	
		0,50 –30 MHz	87 dB (μV) quasi peak	43 dB (μA) quasi peak	
			74 dB(μV) average	30 dB (μA) Average	

5 Documentation

Type inspection (design verification) carried out shall 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 Manufacturer’s specification and/or in comparison with the Technical Specification shall be clearly specified as per KBE EP-180.

- Test procedure
It shall 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 shall be documented as per the procedure as well as any deviations from requirements in applicable specifications or test procedures shall be reported. Date of inspections and name of responsible inspectors shall be included. Measured values shall be documented in an auditable form. The documentation shall 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 Manufacturer's or the laboratory's internal QA/QC routines.