

<b>Technical Requirements for Electrical Equipment</b>  <small>Title</small> <b>Environmental Specification for Normal Operation</b>	Document TBE 101
	Issue 10
	Date 2020-04-20
	Supersedes 9

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# 1 Introduction

This document defines the environmental conditions applicable for electrical equipment during normal plant operation considering the following environmental parameters. (Environmental specifications applicable for accident conditions are described in TBE 102:1).

- Industrial environmental conditions as classified by IEC 60721-3-3 and IEC 60721-3-4
- Ionising radiation
- Temperature transients
- Electrical environmental conditions according to IEC 61000-6-2 <sup>1</sup>

# 2 Definitions

The typical environments in a nuclear power plant have been divided in four basic severity categories, depending on the location:

- Severity A**      Applicable to equipment installed in electrical rooms or similar mild environments.  
Ionising radiation level is insignificant.
- Severity B**      Applicable to equipment installed in process locations outside the reactor containment.  
Equipment may be subjected to ionising radiation.
- Severity C**      Applicable to equipment installed inside the reactor containment.  
Equipment is subject to ionising radiation.
- Severity D**      Applicable to equipment installed at non-weather protected locations.

# 3 Environmental Conditions

## 3.1 General

Each electrical equipment is assigned one of the above listed severities. If the equipment cannot be assigned to one of the above listed severities shall the necessary additional requirements be specified in the Technical Specification.

The different severities are specified in Tables 1-4. The applicable severity and additional requirements are stated in the Technical Specification.

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<sup>1</sup> IEC 61000-6-2 is a test specification, here used as a reference for description of the electrical environment. For relay protection IEC 60255-26 applies.

## 3.2 Specific Environments

The following environmental conditions are applicable in addition to the conditions specified according to IEC 60721-3-3 and IEC 60721-3-4.

### Severity C

Temperature Transient Exposure to +90°C and 100% RH during 8 hours per year

### Severity B and C

For locations according to severity B or C ionising radiation shall be taken in consideration. Radiation levels are specified in the Technical Specification.

### Severity D

For equipment in non-weather protected locations special attention shall be taken to moving parts that can be affected by ice and frost formations.

### Wetwell

The Environmental Conditions for BWR Wetwell are described in Technical Specification.

## 3.3 Electrical Environmental Conditions

In addition to IEC 61000-6-2, as specified in table 5, the following conditions are applicable.

### IEC 61000-6-2

#### Table Reference

- |     |  |
|-----|--|
| 1.1 | Power-frequency magnetic field, 50 Hz.<br>3 A/m (rms) for CRT Displays.<br>30 A/m (rms) for control room and similar environments without high levels of magnetic fields.<br>300 A/m (rms) for switchgear and other areas with high levels of magnetic fields.   |
| 1.3 | Electrostatic discharge<br>Performance criteria “A” for operator panels and all parts accessible during normal operation<br>No degradation of function or performance allowed.   |
| 4.5 | Interruptions in supply voltage, applicable to both AC and DC supply.<br>Interruption (reduction >95 % of nominal voltage) of any duration typically shorter than 5 000 ms. The electrical equipment has to recover to the required operating state without external intervention after the supply voltage interruption. |

## Voltage and frequency fluctuations

The product shall conform to specified requirements on function and accuracy within variations in voltage and frequency at the point of connection of the object/product as stated below:

DC supply	85 ... 110%	Continuously
AC supply, 220 V *	187 ... 242 V	Continuously
AC supply, 380 V *	323 ... 418 V	Continuously
AC supply, other	85 ... 110%	Continuously
Mains frequency	47,5 ... 53 Hz	Continuously
Mains frequency	45 ... 55 Hz	Duration in the range of 10 s

\* Nominal voltage from the auxiliary supply system of the plant to objects with rated voltage 220/230 VAC and 380/400 VAC respectively.

## Additional electrical environmental conditions for relay protection systems

Environmental class 4 according to IEC 61000-4-5 defines the electrical environment for relay protection systems that are interfacing switchgears that are part of the outside plant external system.

### 3.4 Standardisation

The environmental conditions are to the extent possible specified according to the following standards:

#### **IEC 60721-3-3** Classification of environmental conditions

- Part 3: Classification of groups of environmental parameters and their severities.
- Section 3: Stationary use in weather protected locations

Applicable environmental parameters are listed in Tables 1-3.

#### **IEC 60721-3-4** Classification of environmental conditions

- Part 3: Classification of groups of environmental parameters and their severities.
- Section 4: Stationary use in non-weather protected locations

Applicable environmental parameters are listed in Table 4.

#### **IEC 61000-6-2** Electromagnetic Compatibility (EMC)

- Part 6-2 Generic standards - Immunity for Industrial environments

Applicable parameters are listed in Table 5. Deviations from the standard are stated as remarks and also listed in section 3.3 above.

#### **IEC 61000-4-5** Electromagnetic Compatibility (EMC)

- Part 4-5: Testing and Measurement Techniques - Surges Immunity Test

Applicable parameters are listed in Table 5.

## 4 Tables

### 4.1 Table 1 - Severity A - Environmental conditions for normal operation

<b>SEVERITY A - Environmental conditions for normal operation</b>				
Environmental Classes according to IEC 60721-3-3				
Environment	Class	Description	Level	Remarks
Temperature	3K3	Low	+5°C	Normal ambient temperature is 25°C unless other is given in the Technical Specification
	3K3	High	+40°C	
Temperature change	3K3	Ramp	0.5°C / min	
Humidity	3K3	RH	5-85 %	Non-condensing
Water	3Z7	Dripping		
Chemically active substances	3C2	Salt and sulphur pollutions	Average: 0.1 mg/m <sup>3</sup> Max: 0.5 mg/m <sup>3</sup>	Applies only to Ringhals
Mechanically active substances	3S1	Sand	N/A	
		Dust: Air borne Sediment	0.01 mg/m <sup>3</sup> 0.4 mg/m <sup>2</sup> ·h	
Stationary & non-stationary vibration including shock	3M1	Displacement Acceleration Frequency Chock	0.3 mm 1 m/s <sup>2</sup> 2-9 / 9-200 Hz $\hat{a} = 40 \text{ m/s}^2$	Only applicable to floor standing equipment or equipment mounted to the building structure
Stationary & non-stationary vibration including shock	3M5	Displacement Acceleration Frequency Chock	3.0 mm 10 m/s <sup>2</sup> 2-9 / 9-200 Hz $\hat{a} = 250 \text{ m/s}^2$	Applicable to equipment mounted to process systems
Ionising radiation			None	

## 4.2 Table 2 - Severity B - Environmental conditions for normal operation

<b>SEVERITY B - Environmental conditions for normal operation</b>				
<b>Environmental Classes according to IEC 60721-3-3</b>				
<b>Environment</b>	<b>Class</b>	<b>Description</b>	<b>Level</b>	<b>Remarks</b>
Temperature	3K3	Low	+5°C	Normal ambient temperature is 25°C unless other is given in the Technical Specification
	3Z11	High	+55°C	
Temperature change	3K3	Ramp	0.5°C / min	
Humidity	3K3	RH	5-85 %	Non-condensing
Water	3Z7	Spraying		
Chemically active substances	3C2	Salt and sulphur pollutions	Average: 0.1 mg/m <sup>3</sup> Max: 0.5 mg/m <sup>3</sup>	Applies only to Ringhals
Mechanically active substances	3S1	Sand	N/A	
		Dust: Air borne Sediment	0.01 mg/m <sup>3</sup> 0.4 mg/m <sup>2</sup> ·h	
Stationary & non-stationary vibration including shock	3M3	Displacement Acceleration Frequency Chock	1.5 mm 5 m/s <sup>2</sup> 2-9 / 9-200 Hz â = 70 m/s <sup>2</sup>	Only applicable to floor standing equipment or equipment mounted to the building structure
Stationary & non-stationary vibration including shock	3M5	Displacement Acceleration Frequency Chock	3.0 mm, 10 m/s <sup>2</sup> 2-9 / 9-200 Hz â = 250 m/s <sup>2</sup>	Applicable to equipment mounted to process systems
Ionising radiation			Specified in the Technical Specification	Location specific

### 4.3 Table 3 - Severity C - Environmental conditions for normal operation

<b>SEVERITY C - Environmental conditions for normal operation</b>				
<b>Environmental Classes according to IEC 60721-3-3</b>				
<b>Environment</b>	<b>Class</b>	<b>Description</b>	<b>Level</b>	<b>Remarks</b>
Temperature	3K3	Low	+5°C	Temperature transient +90°C, 8 hours / year. Normal ambient temperature is specified in the Technical Specification. The Conditions for BWR Wet well are described in Technical Specification.
	3Z11	High	+55°C	
Temperature change	3K4	Ramp	0.5°C / min	
Humidity	3K4	RH	5-95 %	Non-condensing. 100% RH, 8 hours per year. The Conditions for BWR Wet well are described in Technical Specification.
Water	3Z8	Spray		
Chemically active substances	3C2	Salt and sulphur pollutions	Average: 0.1 mg/m <sup>3</sup> Max: 0.5 mg/m <sup>3</sup>	Applies only to Ringhals
Mechanically active substances	3S1	Sand	N/A	
		Dust: Air borne Sediment	0.01 mg/m <sup>3</sup> 0.4 mg/m <sup>2</sup> ·h	
Stationary & non-stationary vibration including shock	3M3	Displacement Acceleration Frequency Chock	1.5 mm 5 m/s <sup>2</sup> 2-9 / 9-200 Hz â = 70 m/s <sup>2</sup>	Only applicable to floor standing equipment or equipment mounted to the building structure
Stationary & non-stationary vibration including shock	3M5	Displacement Acceleration Frequency Chock	3.0 mm, 10 m/s <sup>2</sup> 2-9 / 9-200 Hz â = 250 m/s <sup>2</sup>	Applicable to equipment mounted to process systems
Ionising radiation			Specified in the Technical Specification	Location specific
Pressure			500 kPa (abs)	
Pressure change			0 - 50 kPa/h	

#### 4.4 Table 4 - Severity D - Stationary use at non-weather protected locations

<b>SEVERITY D - Stationary use at non-weather protected locations</b>				
<b>Environmental Classes according to IEC 60721-3-4</b>				
<b>Environment</b>	<b>Class</b>	<b>Description</b>	<b>Level</b>	<b>Remarks</b>
Temperature	4K2	Low	-33°C	
	4K2	High	+40°C	
Temperature change	4K2	Ramp	0.5°C / min	
Humidity	4K2	RH	15-100 %	
Water	4K2	Rain	6 mm/min	
Solar radiation	4K2		1120 W/ m <sup>2</sup>	
Ice and frost	4K2	N/A	N/A	See section 3.2
Chemically active substances	4C2	Salt and sulphur pollutions	Average: 0.1 mg/m <sup>3</sup> Max: 0.5 mg/m <sup>3</sup>	Applies only to Ringhals
Mechanically active substances	4S1	Sand	30 mg/ m <sup>3</sup>	
		Dust: Air borne Sediment	0.5 mg/m <sup>3</sup> 15 mg/m <sup>2</sup> ·h	
Stationary & non-stationary vibration including shock	4M5	Displacement Acceleration Frequency Chock	3.0 mm, 10 m/s <sup>2</sup> 2-9 / 9-200 Hz â = 250 m/s <sup>2</sup>	

## 4.5 Table 5 - Electrical Environment – Immunity

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

<sup>2</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 during 3 s.

<sup>3</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

**Table 5 continued - Electrical Environment – Immunity**

<b>Immunity–Requirements according to IEC 61000-6-2, generic standard for industrial environment</b>			
<b>Table Reference</b>	<b>EMC Environmental Phenomena</b>	<b>Parameter Specification</b>	<b>Remarks</b>
<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)	
3.2	Fast transients	±2 kV (charge voltage) 5/50 Tr/Th ns 5 kHz repetition frequency	
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>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)	
4.2	Fast transients	±2 kV (charge voltage) 5/50 Tr/Th ns 5 kHz repetition frequency	
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)	
4.4	Voltage dips	30 % reduction 0,5 periods	
		60 % reduction 5 periods	
		60 % reduction 50 periods	
4.5	Voltage interruptions	>95 % reduction 250 periods	
<b>Immunity – Functional earth ports</b>			
5.1	Radio-frequency common mode.	0,15 - 80 MHz 10 V (rms, unmodulated) 80 % AM (1 kHz)	
5.2	Fast transients	±1 kV (charge voltage) 5/50 Tr/Th ns 5 kHz repetition frequency	