

Technical Requirements for Electrical Equipment Rubrik/Title Environmental Specification for Accident Conditions	Beteckning/Document TBE 102:1
	Utgåva/Issue 6 (E)
	Datum/Date 2017-05-22
	Ersätter/Supersedes 5 (E)

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TBE 102:1	6 (E)	2017-05-22	5 (E)

1 Introduction

This document specifies the environmental service conditions in addition to the specifications for normal operation as described in TBE 101. These additional conditions are applicable to electrical equipment that are required to be operational during and following Design Base Event (DBE). The equipment will be exposed to the harsh environment caused by the accident conditions.

It has to be demonstrated that the safety-related equipment will, at the end of its qualified life or end of its qualified condition, with margin be able to perform all safety related functions during accident conditions for the time required in the Technical Specification. The required time of operation during accident conditions is specified for each application.

It is degradation with time (ageing) followed by exposure to the environmental extremes of temperature, pressure, humidity, ionising radiation, vibration, and chemical spray resulting from Design Basis Events that presents a potential for causing common cause failures of safety related equipment. For this reason it is necessary to establish a qualified life or a qualified condition for equipment with significant ageing mechanisms. Ageing mechanisms will be handled in condition based qualification with condition measuring or by periodic surveillance/maintenance.

Swedish requirements for environmental qualification are specified in KBE EP-154.

KBE EP-154 is based on IEC/IEEE 60780-323:2016 including some additional Swedish requirements.

2 Definitions

Environmental Qualification

”Environmental qualification is a verification of design limited to demonstrating that the electric equipment is capable of performing its safety function under significant environmental stresses resulting from design basis accidents in order to avoid common-cause failures.”
(Regulatory Guide 1.89, 1984)

Qualified life

”The period of time, prior to the start of a design basis accident, for which equipment was demonstrated to meet the design requirements for the specified service condition.”
(IEEE 323, 1983)

Condition-based qualification

”Qualification based on measurement of one or more condition indicators of equipment, its components, or materials for which an acceptance criterion can be correlated to the equipment’s ability to function as specified during an applicable design basis event” (IEEE 323, 2003)

Service conditions

”Environmental, loading, power and signal conditions expected as a result of normal operating requirements, expected extremes (abnormal) in operating requirements, expected and postulated conditions appropriate for the design basis events of the station.” (IEEE 323, 1974/1983/2003)

Beyond DBE

Very unlikely events Beyond Design Basis Events

Environmental requirements

The environmental integrity requirements have been divided in two basic categories, depending on the installed location:

Equipment installed outside the reactor containment

In rooms or compartments where the environmental conditions due to a possible high energy line break (HELB) have to be considered

The postulated accident environment is plant specific and matched to the possibility of isolation of high-energy medium.

Swedish nuclear plants with similar accident profiles are grouped as follows:

- | | |
|---------------------------|--|
| Profile 1-2 | Applicable to OKG 1-3 and Ringhals 1. |
| Profile 3 | Applicable to OKG 1-3 and Ringhals 1-4. |
| Profile 4, General | Applicable to all Swedish nuclear plants
(Profile 4 according to KBE-EP 154) The Temperature shall exceed 60°C during at least 24h. |

Profiles 1-2 are built on automatic isolation on line break. Profile 3 is built on manual isolation on line break.

Equipment installed inside the reactor containment

The postulated accident environment is plant specific. Swedish nuclear plants with similar accident profiles are grouped as follows:

- | | |
|----------------|--|
| BWR 1 | Applicable to Forsmark 1-2, OKG 1-2 and Ringhals 1 |
| BWR 2 | Applicable to Forsmark 3 and OKG 3 |
| BWR | Generic accident profile that envelopes the BWR 1 and BWR 2 profiles above |
| PWR | Applicable to Ringhals 2, 3 and 4 |
| BWR/PWR | Generic accident profile applicable to all Swedish Nuclear Power Plants |

Electrical equipment that might be exposed to accident environment and that is required to be operational during/following the accident is assigned one of the plant group specific accident profiles above. If the equipment cannot be assigned to one of the above listed categories, the different requirements are specified.

3 Environmental Conditions

3.1 General

The environments for normal service conditions are described in TBE 101. The applicable equipment verification requirements for normal service conditions are specified in KBE EP-151.

This document specifies the service conditions during and following accident conditions. The applicable product verification requirements are specified in KBE EP-154.

The accident conditions are specified in Table 1 and 2. The applicable accident profile is specified in enclosed diagrams, one for each plant group.

The ionising radiation dose rate and accumulated dose is specified for each application depending on the installed location and the required time for operation during accident and post-accident conditions.

Optional environmental conditions may apply, depending on the required function or installed location, example: risk for submerging or rinsing. The applicable requirements for each type of equipment are specified in the Technical Specification.

Environmental conditions Beyond Design Basis Event is specified in TS.

4 Tables

4.1 Table 1 - Parameters for accident Conditions - Inside Reactor Containment

Location	Inside Reactor Containment					Remarks
Plant Group	BWR 1	BWR 2	BWR generic	PWR Ringhals	BWR/PWR generic, all plants	
Temperature	173°C 0-10 min 150°C 10 min-6h 120°C 6-96 h 90°C >96 h	173°C 0-3 h 160°C 3-6 h 120°C 6-96 h 90°C >96 h	173°C 0-3 h 160°C 3-6 h 120°C 6-96 h 90°C >96 h	150°C 0-10 min 140°C 10 min-3 h 101°C 3-30 h 67°C >30 h	173°C 0 - 3 h 160°C 3-6 h 120°C 6-96 h 90°C >96 h	
Pressure abs	500kPa 0-6 h	500kPa 0-6 h	500kPa 0-6 h	455kPa 0-3 h	500kPa 0-6 h	
Humidity	100%, p<500kPa	100%, p<500kPa	100%, p<500kPa	100%, p<455kPa	100%, p<500kPa	Saturated steam
Ionising radiation	To be specified for each application Note 1	To be specified for each application Note 1	To be specified for each application Note 1	To be specified for each application Note 1	To be specified for each application Note 1	
Water Spray	yes	yes	yes	yes	yes	

Notes

1) The ionising radiation dose rate and accumulated dose shall be specified for each application depending on the installed location and the required time for operation during accident and post-accident conditions.

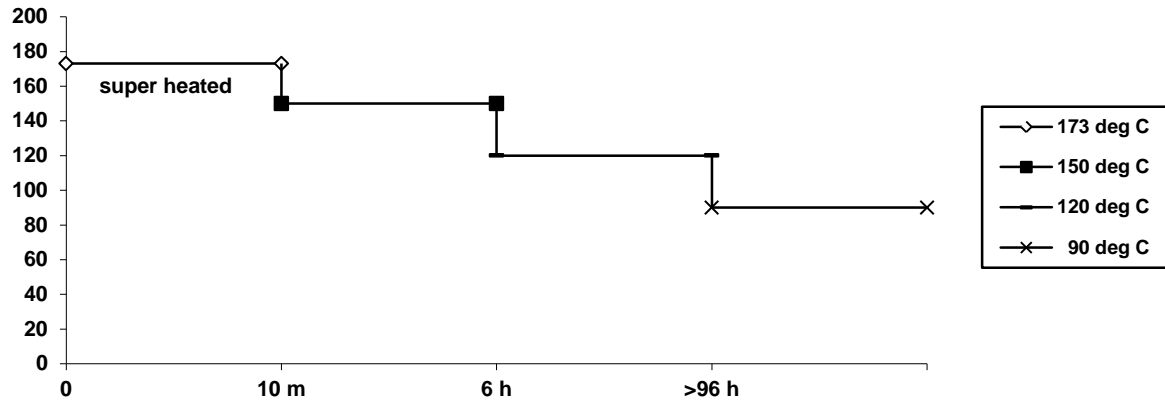
4.2 Table 2 - Parameters for Accident Conditions - Outside Reactor Containment

Location	Outside Reactor Containment							
Plant Group	Oskarshamn 1-3, Ringhals 1		Oskarshamn 1-3, Ringhals 1		Oskarshamn 1-3, Ringhals 1-4		BWR/PWR Generic, all plants	
	Profile 1		Profile 2		Profile 3		Profile 4,Generic	
Temperature	100°C	0-2 min	70°C	0-2 min	100°C	0-45 min	112°C	0-10 min
	100°C till 60°C	2 min-4h	70°C till 60°C	2 min-2h	100°C till 60°C	45 min-4h	100°C	10 min-3h
	60°C	4h-24h	60°C	2 h-24h	60°C	4 h-24h	90°C	>3 h
							Note 1	
Pressure abs	150kPa	0-2 s			150kPa	0-2 s	150kPa	0-10 min
Humidity	100 %		100 %		100 %		100 %	
Radiation	To be specified for each application		To be specified for each application		To be specified for each application		To be specified for each application	
Water Spray	No		No		No		No	

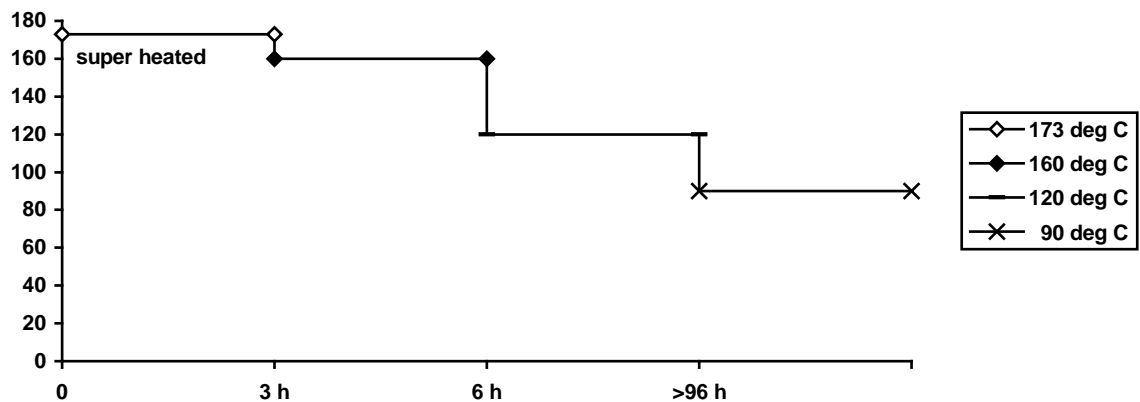
Note 1) The temperature shall exceed 60°C during at least 24h.

5. Accident Profile

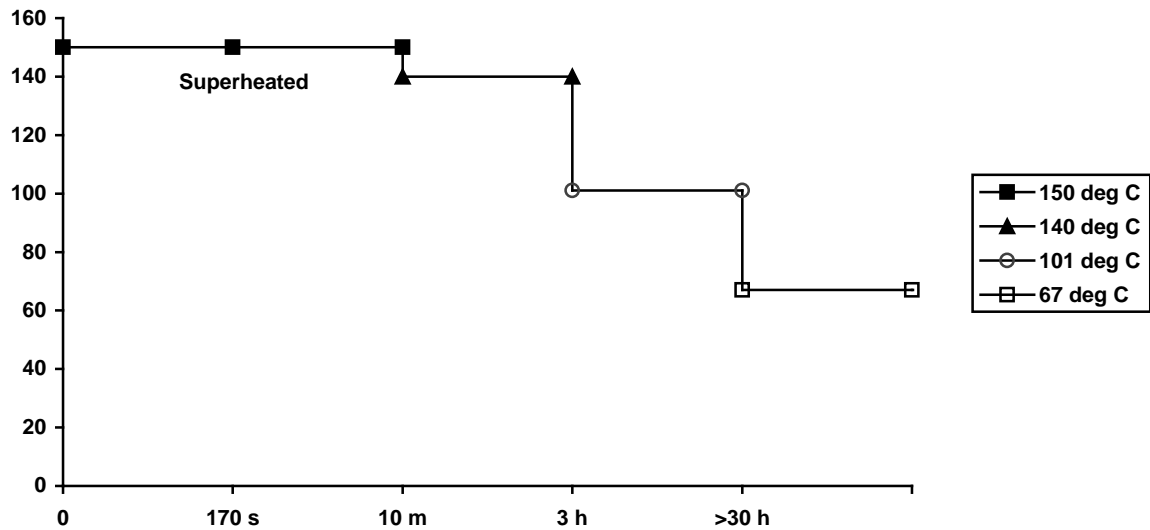
5.1 BWR 1 - Inside Containment Accident Profile



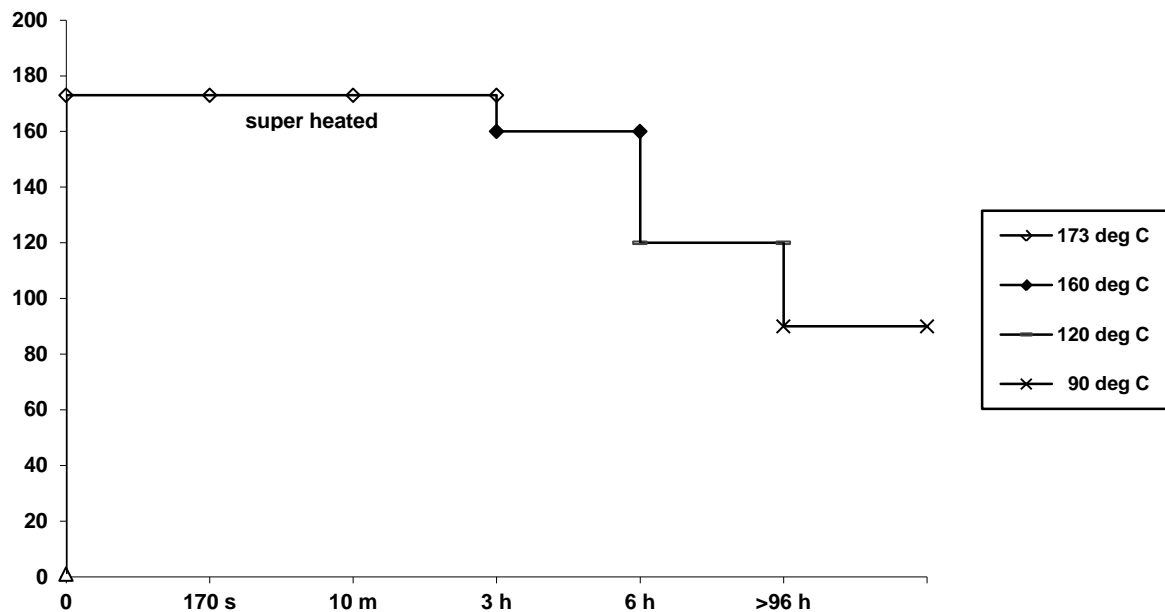
5.2 BWR 2 / BWR generic - Inside Containment Accident Profile



5.3 PWR - Inside Containment Accident Profile

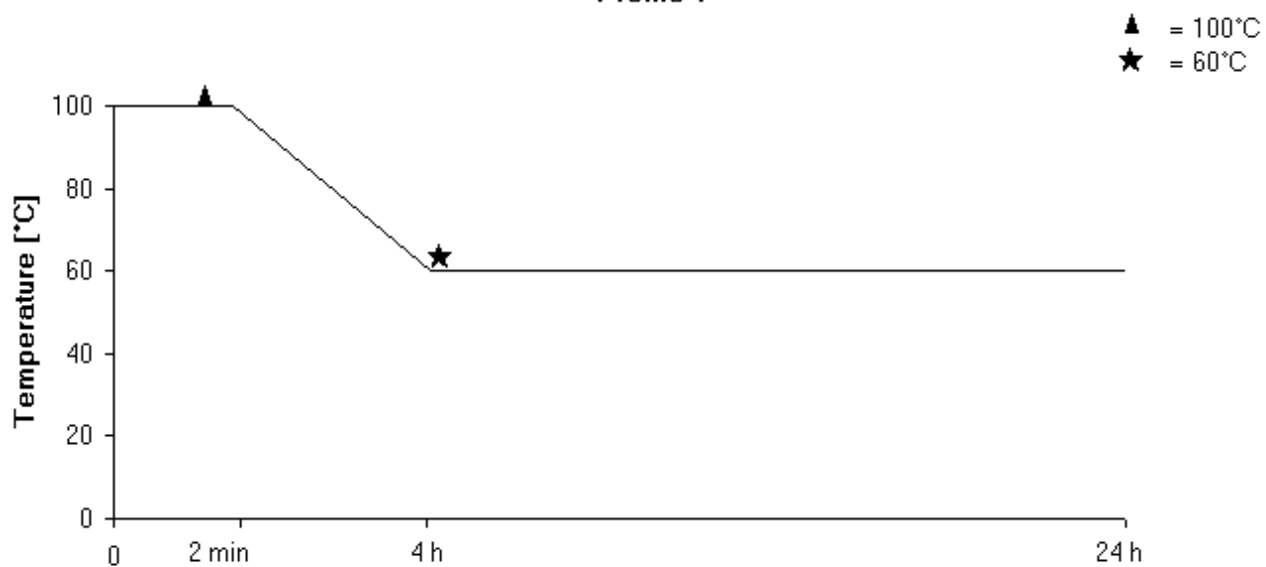


5.4 BWR / PWR all plants - Inside Containment Generic Accident Profile

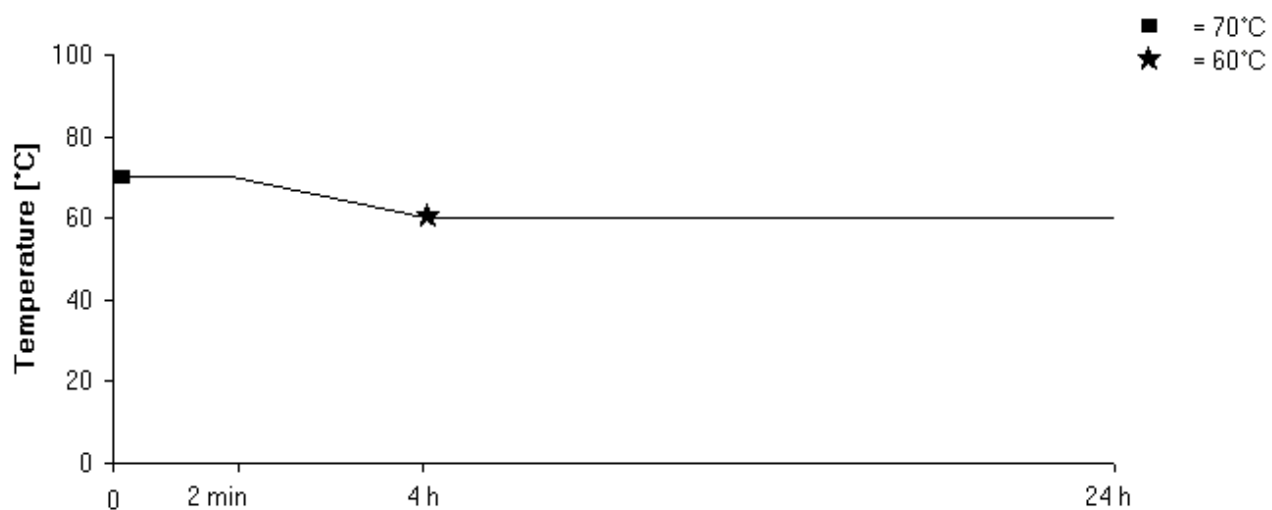


5.5 OKG 1-3 and Ringhals 1 - Outside Containment Accident Profiles

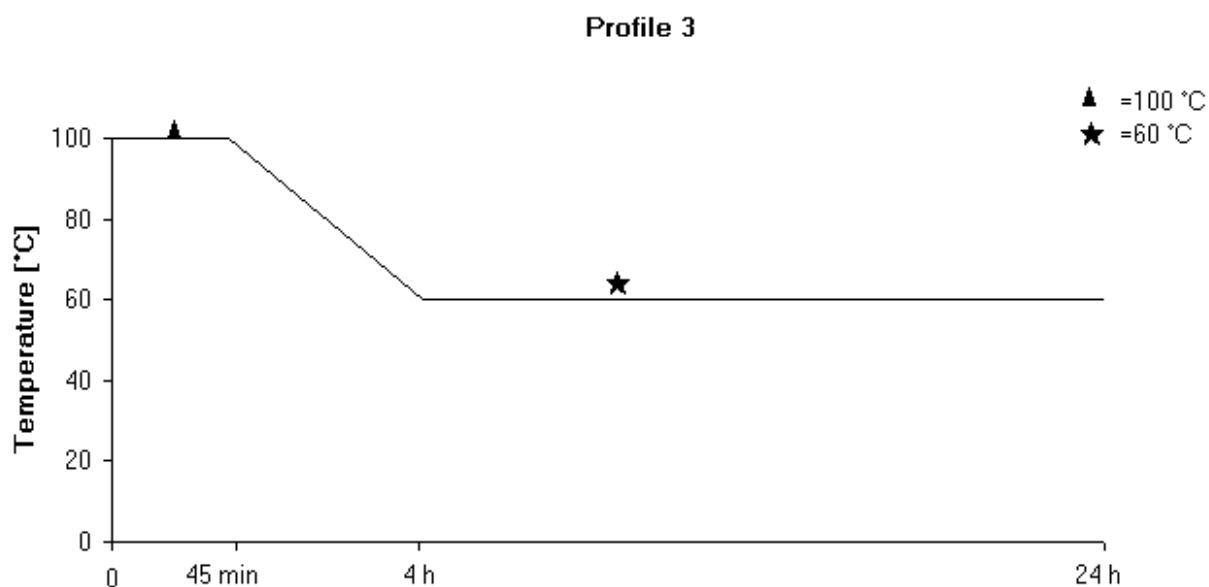
Profile 1



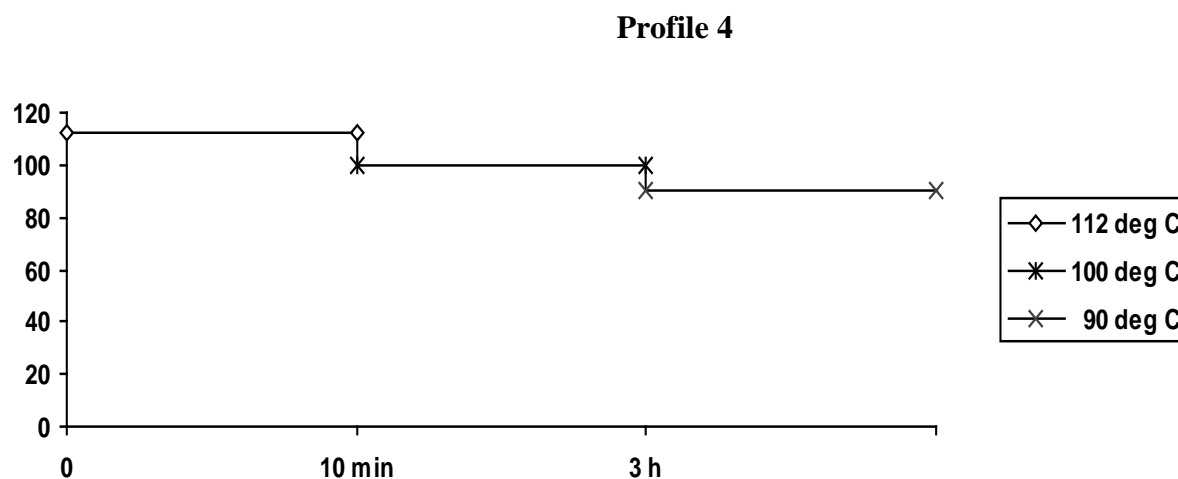
Profile 2



5.6 OKG 1-3 and Ringhals 1-4 - Outside Containment Accident Profile



5.7 Generic: - Outside Containment Accident Profile



Note 1) The temperature shall exceed 60°C during at least 24h