

Examination Procedure <small>Title</small> Environmental Verification for Normal Operating Conditions	Document KBE EP-151
	Issue 8
	Date 2022-11-17
	Supersedes 7

1 Scope

This examination procedure is applicable to Type Test of all electric and I&C equipment that will be exposed to environmental conditions according to TBE 101.

2 Objective

The objective is to verify the product specifications by performing sequential tests as outlined in this Examination Procedure. During the ongoing tests, the test specimen shall be demonstrated to be operational as required for each test. When all tests are completed, the test specimen has to meet all the requirements in the Technical Specification.

3 Method

All tests should be carried out according to the applicable part of IEC 60068 Standard. Tests without reference to standardised procedures should be performed according to best effort and established engineering practices for nuclear applications.

This examination and test procedure is applicable to type tests (design verification tests) only. The test specimen should be assembled and provided with all protective and mounting devices, cables, connectors and other interfaces, as required for the operation when installed in a system.

Details on test parameters are given in Table 1.

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

All tests are listed in the preferred test sequence.

4 Test Requirements

4.1 Ionising radiation

The ability of the equipment to withstand ionising radiation can be demonstrated by analysis or testing, or by analysis and testing combined. Analysis is applicable when the resistance against ionising radiation of included material is known.

Normally, the ability to withstand radiation can be verified by detailed information on all materials used in the test specimen, and by reference to past tests demonstrating their capabilities. All parts included in the equipment have to be considered, e.g. connectors, cables, seals, lubricants, etc.

The ability of the test specimen to withstand radiation should be verified for the accumulated dose from normal operation as specified in the Technical Specification.

The test duration shall be at least 240 hours.

Dose rate shall not exceed 5 Gy/h.

The test specimen is not required to be in operation during the test.

A test similar to this one is also included in KBE EP-154. If the equipment also will be qualified for operation during accident conditions according to KBE EP-154 and, provided that the same test specimen will be used both for tests according to KBE EP-151 and KBE EP-154, this test can be ignored.

4.2 Cold test

The test specimen shall be tested according to IEC 60068-2-1, Test Ab/Ad.

Temperature: +5°C severity A, B, C, E and –50°C severity D

Test duration: 16 h

The test specimen shall be in operation during test Ad but not during test Ab.

4.3 Dry heat test

The test specimen shall be tested according to IEC 60068-2-2, Test Bb or Bd.

Temperature shall be selected to suit the severity class, as shown in Table 1.

Test duration: 96 h

The test specimen shall be in operation during the test.

4.4 Temperature change test

The specimen shall be tested according to IEC 60068-2-14, Test Na or Nb.

Low and high temperatures as shown in Table 1

Preferred rate of temperature change is more than 3°C/min.

Test duration t_1 : 30 min

The test specimen shall be in operation during the test.

4.5 Moisture test

Test requirement for all equipment:

Method A: Constant temperature

Test according to IEC 60068-2-78, Test Ca.

Exposure time: 21 days

Temperature: +40°C

Relative humidity: 93±3 %

The test specimen is not required to be in operation during the test.

Method B: Cyclic Testing

Test according to IEC 60068-2-30, Test Db, 6 cycles.

Temperature in accordance with Table 1

The test specimen is not required to be in operation during the test.

Method A or B shall be chosen, using the guidelines set out in IEC 60068-3-4.

Normally Method B is preferred for equipment and components.

4.6 Additional moisture test applicable to severity C only

Equipment for which severity C is specified shall be subjected to a cyclic moisture test similar to IEC 60068-2-30, Test Db. The standard is stating an upper temperature of 55°C. However in this test the upper temperature shall be 90°C.

Number of cycles: 1

The test specimen shall be in operation during the test.

Performance tests shall be conducted after 3, 6, 12, and 24 hours during the test cycle.

A test similar to this one is also included in KBE EP-154. If the equipment also will be qualified for operation during accident conditions according to KBE EP-154 and, provided that the same test specimen will be used both for tests according to KBE EP-151 and KBE EP-154, this test can be ignored.

4.7 Vibration test

The specimen shall be tested according to IEC 60068-2-6, Test Fc.

Frequency Range: 10 - 150 Hz
Displacement amplitude: See Table 1
Acceleration: See Table 1
Cross Over Frequency: 60 Hz
Number of sweeps: 5 in each direction
Sweep rate: 1 octave/minute

Critical frequencies shall be monitored during the sweep tests. If any critical frequencies are identified that possibly could exist during normal operation, additional tests should be performed for these frequencies. Critical frequency test duration shall be 30 minutes at each critical frequency in each axis.

The test specimen shall be fastened to the vibration table with its normal mounting devices. If additional fastening devices are necessary, this shall be specified in the test program and noted in the test report.

The test specimen shall be in operation and meet its normal functional requirements during the initial resonance search and during the critical frequencies test. Input and output signals shall be typical of normal operation. Input levels shall be at 90% of the trip level, when applicable. Output signals shall be monitored during the test.

For electromechanical limit switches, a performance test shall be made at the end of each vibration test for each axis.

4.8 Degree of protection provided by enclosure

Compliance with the protection requirements in IEC 60529 shall be verified. In case design assessment and subsequent engineering reviews cannot clearly demonstrate that the requirements are met, a test has to be performed.

The applicable protection class is defined in Table 1.

4.9 Pressure change test applicable to severity C only

This requirement is only applicable to severity class C. The objective of the test is to verify the resistance of the test specimen to external pressure change, and shall be carried out when design assessment and subsequent engineering reviews cannot clearly verify that the requirement is met.

Test pressure: 700 kPa abs, duration 24 h at full pressure
Pressure change rate: >50 kPa/h

The rate of pressure change is applicable for both the positive and negative slope of the pressure change. After testing, the test specimen shall be verified to meet all the requirements in the Technical Specification.

The test specimen is not required to be in operation during the test.

4.10 Solar radiation

As an alternative for testing the “Dry heat test” can be increased with 15°C and an evaluation of the materials ability to withstand sun radiation can be done.

Test standard for sun radiation is IEC 60068-2-5: Sa, procedure C.

This requirement only applies for severity D when IP2X is not fulfilled.

4.11 Final examination

When all applicable tests listed in previous sections are finalised and when the test specimen has recovered to normal operating conditions, it shall meet all requirements in the Technical Specification.

After final performance testing, the test specimen shall be visually inspected, and other tests applied (e.g. dielectric tests, insulation resistance measurements, etc.), as applicable in order to identify any degradation of the test specimen.

5 Acceptance Criteria

All measured values shall, within reasonable margins for production tolerances, meet the requirements set out in the Technical Specification and associated documents, for example the Manufacturers/Suppliers specification/data sheet. A margin of 10% is normally acceptable.

Table 1- Parameters for environmental tests

Ref. in KBE EP-151	Environmental parameter	Examination Procedure	Specimen in operation	Exposure time	TBE 101 Severity A	TBE 101 Severity B	TBE 101 Severity C	TBE 101 Severity D	TBE 101 Severity E
4.1	Radiation	KBE EP-151, Section 4.1	Not required	>240 h	N/A	1 kGy ¹	50 kGy ²	N/A	1 kGy ³
4.2	Low temperature	IEC 60068-2-1 Test Ab/Ad	No/Yes	16 h	+5°C	+5°C	+5°C	-50°C	+5°C
4.3	High temperature	IEC 60068-2-2 Test Bb or Bd	Yes	96 h	+40°C	+55°C	+70°C	+50°C	+45°C
4.4	Temperature change	IEC 60068-2-14 Test Na or Nb	Yes	t _i : 30 min	+5-40°C >3°C/min	+5-55°C >3°C/min	+5-70°C >3°C/min	+5-55°C >3°C/min	+5-45°C >3°C/min
4.5 Meth.A	Humidity Steady state	IEC 60068-2-78 Test Ca	Not required	21 days	+40°C 93±3 % RH	+40°C 93±3 % RH	+40°C 93±3 % RH	+40°C 93±3 %RH	+40°C 93±3 %RH
4.5 Meth.B	Humidity Cyclic	IEC 60068-2-30 Test Db	Not required	6 cycles	+40°C	+55°C	+55°C	N/A	+40°C
4.6	Humidity	IEC 60068-2-30 Test Db	Yes	1 cycle	N/A	N/A	+90°C ⁴ 100% RH	N/A	N/A
4.7 ⁵	Vibration	IEC 60068-2-6 Test Fc	Yes	Sweep: ⁶ 1 octave	N/A	0,075 mm 10 m/s ²			
4.7 ⁷				/minute	0,15 mm 20 m/s ²	0,15 mm 20 m/s ²	0,15 mm 20 m/s ²	N/A	0,15 mm 20 m/s ²
4.8	Degree of protection	EN 60529	Not required	N/A	IP21	IP54 ⁸	IP55	IP65	IP65
4.9	Pressure	KBE EP-151, Section 4.9	Not required	24 h	N/A	N/A	700 kPa	N/A	N/A
4.9	Pressure change	KBE EP-151, Section 4.9	Not required	N/A	N/A	N/A	>50 kPa/h	N/A	N/A
N/A	Rain-intensity	IEC 60068-2-18 Test Rb, met.2.	Yes	Min. 10 minutes	N/A	N/A	N/A	400 mm/h ⁹	N/A
4.10	Solar radiation	IEC60068-2-5: Sa test C	Yes	72 h	N/A	N/A	N/A	1090W/m ² 70°C	N/A
N/A	Ice & Frost	KBE EP-151 chapter 4.12	Not required	N/A	N/A	N/A	N/A	TBE 101 ¹⁰	N/A

¹ These accumulated doses are default values if no other requirements are stated in the technical specification.

² These accumulated doses are default values if no other requirements are stated in the technical specification.

³ These accumulated doses are default values if no other requirements are stated in the technical specification.

⁴ The temperature 90°C is a non-standard temperature, not considered in IEC 60068-2-30.

⁵ Applicable to equipment mounted to the building structure.

⁶ For each critical frequency: 30 min.

⁷ Applicable to equipment mounted to process systems.

⁸ IP55 if there is a potential risk for high pressure washing and/or decontamination.

⁹ This requirement only applies for severity D when IP65 is not fulfilled.

¹⁰ See TBE 101 section 3.2 for information.

6 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/Suppliers 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

- Environmental Conditions

A record of the environmental conditions during each test

- Performance Testing

Description of the performance tests during and after each environmental condition

- 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 shall be reported. 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. Date of inspections and name of responsible inspectors are to be included.

- 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/Suppliers or the laboratory's internal QA/QC routines.