

Examination Procedure Rubrik / Title Electrical Containment Penetrations	Beteckning / Document KBE EP-146
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1 Scope

This Examination Procedure is applicable to all electrical containment penetrations but has to be modified if necessary to suit conditions encountered at the plant in question.

2 Objective

To verify that electrical containment penetration assemblies meet the functional requirements as well as the environmental requirements.

3 Routine testing (Production Testing)

3.1 Leakage-rate test

Each electric penetration assembly must be Gas-leak Rate tested according to IEEE 317.

3.2 Pneumatic pressure test

Each penetration assembly shall be exposed to a static pressure test according to IEEE 317.

The pressure shall be 1.3 times the design pressure.

3.3 Dielectric strength test

Each penetration assembly, with pigtailed, shall be tested according to IEEE 317.

Test voltage according to IEEE 317

3.4 Insulation resistance test

The insulation resistance of each penetration assembly conductor shall be measured according to IEEE 317.

3.5 Conductor continuity and identification test

The electrical continuity and marking of each penetration assembly conductor shall be checked according to IEEE 317.

3.6 Partial-discharge (Corona) test

Each penetration assembly with pigtails, rated > 1kV, shall be subjected to a corona test according to IEEE 317.

3.7 Material quality certification

In addition to requirements under TBM/KBM material quality certificates are required for parts and substances listed below:

- Cable and conductor insulating materials
- Cable supports
- Coating and casting compounds
- O-rings
- Shrink tubing
- Module tube

Certificates shall comply with KBE EP-109.

3.8 Visual and final inspection

In addition to requirements under TBM/KBM visual and final inspection shall include at least the following check-points:

Hardware:

- CE-marking
- Main dimensions of complete assembly
- Number, size and location of penetrations
- Conductor types and sizes
- Cable and wire marking in accordance with drawings
- Conductor length (pigtails)
- Type, number, location and orientation of accessories (instrument, connections, lifting eyes, cable support)
- Type of insulation materials, thickness in mm, installation and coverage of insulating material including cable insulation
- Size and position of protective earth connections
- Workmanship (cuts, kinks, cracks on cables, fittings tightened with correct tools, surface damage, soldering etc.)
- Cleanliness
- Assembly pressurised and ready for delivery if applicable (depending on transporting)
- Preparation for shipping (conductor protection, desiccant)
- Rating plate/Nameplate

Documentation:

- Rating plate/Nameplate
- Material quality certificates
- Manufacturer's routine inspection (production testing) certificate
- Certificate concerning pre-delivery pressurisation (date, pressure, medium)
- CE-marking (Declaration of Conformity)
- Requirements according to KBM

4 Type Inspection

4.1 Test value margins and test sequence

In order to compensate for measurement and instrumentation errors, the following minimum margins shall normally be applied:

Rated current	+ 5 %
Rated voltage	+ 10 %
Temperature	+ 8°C
Pressure	+ 10 %
Vibration (input acc. value)	+ 10 %
Radiation dose	+ 10 %

Type testing shall be carried out in the sequence specified below.

4.2 Design test

4.2.1 Leakage rate test

The gas leak rate of the complete penetration assembly or its separate modules shall be measured according to IEEE 317.

4.2.2 Pneumatic pressure test

Each completed penetration assembly shall be pneumatic pressure tested according to IEEE 317.

The pressure shall be 1.3 times the design pressure and maintained for at least 10 minutes.

4.2.3 Alternating voltage test

Each penetration assembly conductor, with pigtails, shall be tested according to IEEE 317.

Test voltage frequency, 50 or 60 Hz with voltage according to IEEE 317.

4.2.4 Impulse voltage test

Each complete penetration assembly with pigtails, rated > 1kV, shall be subjected to an impulse voltage test according to IEEE 317.

4.2.5 Insulation resistance test

The insulation resistance of each penetration assembly conductor including pigtailed shall be measured according to IEEE 317.

Coaxial and triaxial penetration assemblies shall meet the minimum requirements stated below.

Measurement	Insulation resistance ohms
100 V DC	10E12, Conductor to outside screen 10E12, Conductor to inside screen 10E8, Outside to inside screen

4.2.6 Partial-discharge (Corona) test

Each complete penetration assembly with pigtailed, rated > 1kV, shall be subjected to a corona test according to IEEE 317.

4.2.7 Rated continuous current test

Each complete penetration assembly, rated >100 V, shall be subjected to a current test according to IEEE 317.

4.2.8 Rated short-time overload current test

Each complete penetration assembly, rated >100 V, shall be subjected to a current test according to IEEE 317.

4.3 Qualified-life tests

TBE 100 and Technical Specification must be complied

4.3.1 Initial tests

Each penetration in the qualified-life test must pass the 100%-testing according to item 3.

4.3.2 Shipping and storage simulation

Each complete penetration shall be tested to simulate conditions encountered during shipment, storage and operation according to IEEE 317.

4.3.3 Thermal age conditioning

Each penetration in the qualified-life test must be thermally aged to simulate operation at design normal service temperature for the installed life according to IEEE 317.

Temperature and ageing time must be chosen in accordance with KBE EP-154.

4.3.4 Radiation exposure simulation

Each penetration in the qualified-life test must be exposed to radiation simulating the design normal service environmental radiation for the installed life. See IEEE 317.

The maximum dose rate according to KBE EP-154. Accumulated radiation is stated in Technical Specification.

Before further tests each complete penetration assembly must pass gas leak rate test and electrical tests according to IEEE 317 section 8.

4.3.5 Short-circuit current and short-circuit thermal capacity tests

Each complete penetration, rated >100 V shall be tested for short-circuit current and short-circuit thermal capacity according to IEEE 317.

4.3.6 Seismic test

The complete penetration must be tested according to TBE 102:2 and KBE EP-147.

Requirements stated in Technical Specification about excitation and frequencies must be met.

4.3.7 Design basis event test (DBE-test)

DBE testing of complete penetration assembly must be carried out according to KBE EP-154 and under the environmental conditions (pressure, temperature and humidity) specified in Technical Specification.

During the DBE-test the following tests shall be performed:

- Rated short-time overload current test according to IEEE 317.
- Rated short-circuit current test according to IEEE 317.
- Rated short-circuit thermal capacity test according to IEEE 317.
- Continuous measurement of insulation resistance.

The following tests may be carried out separately under conditions equivalent to DBE conditions:

- Rated short-time overload current test according to IEEE 317.
- Rated short-circuit current test according to IEEE 317.
- Rated short-circuit thermal capacity test according to IEEE 317.

4.3.8 Signal transmission test

Penetrations intended for neutron flux measurement equipment shall pass interference test, signal transmission test or other equivalent tests to confirm that they fulfil the Nucleonic Manufacturers requirements.

4.3.9 Post-DBE test

A post-DBE test must be applied for the time specified in Technical Specification, in order to check the penetrations for leakage and insulation resistance.

Post-DBE environment is specified in Technical Specification.

Final inspection

After the test a leakage rate test and electrical tests according to IEEE 317 section 8 must be performed.

4.3.10 H5-incident test

A final test shall be carried out on the complete penetration assembly at a temperature of 300°C and a pressure of 1 MPa for 60 minutes if not otherwise is agreed upon in Technical Specification.

During the test, the modules shall be pressurised and supervised. During and after the test there are no requirements on electrical functions.

4.3.11 Final inspection

Leakage rate test according to IEEE 317 section 8 must be carried out.

4.4 Fire resistance test

Requirements on fire resistance according to IEEE 317 must be fulfilled.

After the fire resistance test the integrity of the penetration must remain, i.e. the leakage rate must not be greater than prescribed values in IEEE 317 section 8. During and after the test there are no requirements on electrical functions.

5 Acceptance Criteria

Throughout all tests specified above, the penetrations must meet the requirements given in this document or other documents referred to in the Technical Specification.

6 Documentation

Control documentation shall for applicable parts comply with TBE 100 and KBM.