Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 3403 (2015-11)

Cable Penetrations through the Reactor Containment Vessel of Nuclear Power Plants

(Kabeldurchführungen im Reaktorsicherheitsbehälter von Kernkraftwerken)

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KTA SAFETY STANDARD

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Comments by the editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

shall	indicates a mandatory requirement,
shall basically	is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of **shall normally** - are specified in the text of the safety standard,
shall normally	indicates a requirement to which exceptions are allowed. However, the exceptions used, shall be substantiated during the licensing procedure,
should	indicates a recommendation or an example of good practice,
may	indicates an acceptable or permissible method within the scope of this safety standard.

Basic Principles

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the objective to specify safety-related requirements, compliance of which provides the necessary precautions in accordance with the state of the art in science and technology against damage arising from the construction and operation of the facility (Sec. 7 para. 2 subpara. 3 Atomic Energy Act - AtG) in order to achieve the fundamental safety functions specified in the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants as well as in the Interpretations of the Safety Requirements for Nuclear Power Plants.

(2) Basic requirements for the reactor containment are contained in the Safety Requirements for Nuclear Power Plants in Requirement No. 3.6, “Requirements for the Safety Enclosure” as well as in Sec. 6 “Containment” of Interpretation I-2 “Requirements for the design of the reactor coolant pressure boundary, the external systems as well as the containment”. Among others it is specified that cable penetrations through the reactor containment vessel shall meet the same design requirements that apply to the reactor containment vessel itself. Furthermore, the cable penetrations shall be protected against sequential damages from released media, reaction forces and debris. The functional capability of the electrical and optical conductors of safety related cable penetrations shall be ensured even under design basis accident conditions. The safety standard KTA 3403 serves the purpose of concretizing the measures that, within its scope, must be taken to meet the above requirements. In this context, a number of individually cited, conventional engineering standards, especially DIN standards, are referenced. The requirements of the Safety Criteria cited above are comprehensively covered with respect to steel containment vessels by the following safety standards

KTA 3401.1	Steel containment vessels Part 1: Materials,
KTA 3401.2	Steel containment vessels; Part 2: Design and analysis,
KTA 3401.3	Steel containment vessels; Part 3: Manufacture,
KTA 3401.4	Steel containment vessels; Part 4: Inservice inspections,
KTA 3405	Leakage testing of the containment vessel,

with respect to penetrations and airlocks by the following safety standards:

KTA 3402	Airlocks on the reactor containment vessel of nuclear power plants - personnel locks,
KTA 3403	Cable penetrations through the reactor containment vessel of nuclear power plants,
KTA 3407	Pipe penetrations through the reactor containment vessel,
KTA 3409	Airlocks on the reactor containment vessel of nuclear power plants - equipment airlocks,

and, with respect to the design life of components by the safety standard:

KTA 3706	Ensuring the loss-of-coolant-accident resistance of electrotechnical components and of components in the instrumentation and controls of operating nuclear power plants.

Furthermore, safety standard KTA 3404 applies to the isolation of operation-system related pipes penetrating the reactor containment vessel in the case of a release of radioactive materials into the reactor containment vessel.

(3) By fulfilling the requirements contained in the present safety standard regarding

a) spatial arrangement of the cable penetrations along the reactor containment vessel wall,
b) physical characteristics,
c) functional characteristics,
d) tests and examinations regarding mechanical properties,
e) tests and examinations of the electrical cable penetrations,
f) tests and examinations of the optical cable penetrations, and
g) qualification of the testing personnel,

it is ensured that the safety related requirements for cable penetrations through the reactor containment vessel will be fulfilled throughout the operating life of the power plant.

(4) General requirements regarding quality assurance are specified in safety standard KTA 1401. Requirements for quality assurance specific to cable penetrations including the respective tests and inspections are dealt with in Sections 6.2, 6.3, 7.2, 7.3, 8.2 and 8.3 of the present safety standard KTA 3403.

1 Scope

This safety standard applies to the design, analysis, materials, manufacture, assembly, inspection and testing, the storage and shipping of cable penetrations that penetrate the reactor containment vessel of stationary nuclear power plants (in the following: the *containment vessel*).

2 Definitions

(1) Cable penetration

A cable penetration is the technically gas-tight and pressure-resistant penetration of single or multiple conductors through the containment vessel.

Note:
With respect to the requirements in the present safety standard, a unit assembled from multiple individual cable penetrations is considered as being a single cable penetration.

A cable penetration is comprised of the following parts:

a) electrical or optical conductors (penetrating cable conductors) out to the nearest connection points inside and outside of the containment vessel,
b) component parts constituting the insulation of these conductors,
c) connector elements for the penetrating cable conductors,
d) component parts constituting the pressure-retaining, gas-tight and temperature-resistant enclosure of this conductor arrangement, and the component parts for installing the enclosure on the containment vessel wall,
e) built-in leak-tightness test equipment.

Note:
The following are not considered as being part of the cable penetration:
a) component parts of the containment vessel wall to which the cable penetrations are fastened, such as flange facings for bolt connections or pipe nozzles for weld connections,
b) cables and conductors to be connected to the penetrating cable conductors,
c) connector elements for the cables to be connected, such as plugs, cable lugs, sockets, soldering sleeves, crimping sleeves, and
d) leak-tightness test equipment or vacuum equipment only temporarily connected to the cable penetrations.

(2) Authorized Expert

The authorized expert for the tests and investigations under the present safety standard is the expert appointed in accordance with Sec. 20 Atomic Energy Act by the licensing or supervisory authority.

3 Spatial Arrangement of the Cable Penetrations on the Containment Vessel Wall

3.1 Installation Locations on the Containment Vessel

The cable penetrations shall be arranged in groups at dedicated locations on the containment vessel wall. They shall be arranged or protected in those regions such that neither escaping media, nor reaction forces, nor debris nor fire will cause any loadings that are not covered by the design.

3.2 Spatial Separation

The spatial arrangement of the cable penetrations shall be in accordance with the requirements for spatial separation of redundant systems as conceptually developed for the overall plant.

3.3 Spare Cable Penetrations

Spare cable penetrations or closed-off spare openings for a later installation of additional cable penetrations shall normally be provided for each redundancy in order to accommodate additional cable penetrations without modifications of the containment vessel itself.

3.4 Accessibility of the Cable Penetration for Testing and Repairs

The spatial arrangement of the cable penetrations shall be such that their accessibility is ensured, in particular, with regard to radiation exposure.

3.5 Identification Marking

An identification marking of the cable penetration shall make an unambiguous identification possible. For this purpose, the type specification and fabrication number shall be marked on the cable penetration and the respective code of the power plant identification system shall be marked at the location of installation of the cable penetration.

4 Physical Requirements

4.1 Basic requirements

(1) Cable penetrations shall comply with the design requirements for the containment vessel. This pertains to, e.g., static and dynamic loading, temperature resistance, service life, radiation resistance, decontaminability, fire resistance, pressure resistance, leak-tightness, earthquake resistance, and corrosion resistance. In this respect, protection measures as indicated under Section 3.1 may be taken into account.

(2) Any potential (e.g., thermal) loadings that may occur during storage and shipping shall be taken into account.

(3) Cable penetrations with weld seams shall normally be designed such that it is possible to perform non-destructive examinations on the pressure-retaining welds.

(4) Blind flanges shall be designed in accordance with the same mechanical requirements that apply to cable penetrations.

4.2 Materials

The materials, weld fillers, soldering, brazing and insulation materials of all parts of the cable penetrations required with regard to the pressure resistance and leak-tightness of the containment vessel shall be chosen in accordance with the requirements specified

a) for the design of the containment vessel, and

b) for the intended application of the cable penetration.

Notes:

(1) Requirements for the containment vessel are specified in the safety standards KTA 3401.1, KTA 3401.2, KTA 3401.3 und KTA 3401.4.

(2) In addition to the materials specified in these safety standards, special materials are used in cable penetrations to ensure their proper functioning (e.g., conductor materials, insulation materials, sealants, soldering and brazing materials). The suitability of these materials is to be verified by the tests and examinations specified under Sections 6 through 8 of the present safety standard.

4.3 Thermal Resistance in Special Cases

If the mechanical function of the cable penetration cannot be ensured for the design temperature, a suitable protection of the cable penetration region shall be provided. In this case, the maximum possible temperature within this protected region shall be considered as the respective design requirement.

4.4 Effects of Current Flow

The cable penetrations shall be designed such that, during specified normal operation and in case of design basis accidents, they will withstand all thermal and mechanical loads from the specified currents (e.g., nominal current, short circuit current) in the penetrating cable conductors and cables.

4.5 Radiation Resistance

Changes of the material characteristics due to ionizing radiation shall be considered in choosing the materials for the cable penetrations. The radiation dose considered in this context shall be that on which the design of the containment vessel is based. If necessary, a radiation shielding of the cable penetration region shall be provided.

4.6 Decontaminability

The cable penetrations, together with the respective outer casings, shall be decontaminable in accordance with the respective requirements for the containment vessel.

4.7 Fire Protection

(1) The cable penetration shall be designed using suitable materials such that, in the case of a fire, the necessary integrity of the containment vessel is not adversely affected to an impermissible degree. In this context, the possible fire effects at the location of installation shall be taken into account. The fire load shall be kept as small as possible.

(2) As far as the containment vessel must comply with requirements regarding fire resistance, the respective characteristics shall not be impaired to an impermissible degree by the design and construction of the cable penetration. In this context, the certifications of applicability required by the building authorities shall be submitted.

(3) In the case of cable penetrations with non-metallic materials (e.g., insulation materials), it shall be verified that the materials are classified, at least, as flame retardant, e.g., Class B1 in accordance with DIN 4102-1. With respect to smoke emission, the materials shall comply with Class B1 in accordance with DIN 4102-1. Certain special insulation materials may be neglected as fire load and with respect to smoke emission, provided, it is verified that they will have only a negligible effect on the fire scenario due to their type, amount and condition of installation.

Note:

Such special insulation parts are, e.g., insulation components of plugs or of other connectors with specific electrical characteristics, where a detailed verification would afford an unreasonable effort, or that are not able to fulfill the requirements but are, however, negligible with regard to the fire load.

(4) If the electrical function of a cable penetration is required during or after a fire event, appropriate certifications shall be submitted.

4.8 Pressure Resistance

The design of cable penetrations shall be based on the design pressure and design temperature of the containment vessel where the design pressure and the design temperature shall be assumed as being simultaneously effective.

4.9 Gas-tightness

(1) The leakage rate of a cable penetration shall, with respect to helium and at a pressure difference of 1 bar (0.1 MPa), not exceed 10^{-6} bar × cm^3 × sec^{-1} (10^{-7} Pa × m^3 × sec^{-1}). The leakage rate of the sealing system between the cable penetration and the containment vessel shall, with respect to helium and at a pressure difference of 1 bar (0.1 MPa), not exceed 10^{-3} bar × cm^3 × sec^{-1} (10^{-4} Pa × m^3 × sec^{-1}).

(2) The cable penetration shall be designed, e.g. with a double seal, such that, after its installation in the containment vessel wall, an individual leak-tightness test of the flange sealing system as specified under Section 6.3.7 is possible.

4.10 Outer Casings

(1) The loading forces from a design basis accident shall not cause any impermissible deformations (e.g., with respect to assembly clearances) of the outer casings. In this respect, pressure equalization may be provided for. In addition, it shall be ensured that water from condensation is either avoided or drained.

(2) The protection category shall be at least IP 54 in accordance with DIN EN 60529.

4.11 Fastening the Cable Penetrations to the Containment Vessel Wall

4.11.1 Basic requirements

The cable penetrations shall normally be fastened from the inside of the containment vessel wall; this has the advantage that

a) in the case of a pressure increase caused by a design basis accident inside the containment vessel the fastening system is not additionally loaded, and

b) the connector region of cable penetrations resistant to design basis accident conditions are easily accessible with regard to assembly and inspection.

4.11.2 Bolted connections

If cable penetrations are fastened by bolted connections, the maximum fastening torque shall be calculated taking the individual type of seal into account. Measures shall be taken to maintain the pre-stress and to prevent self-loosening of the bolts. Both of the two sealing surfaces shall be machined to a quality that meets the requirements of the type of seal employed.

4.11.3 Weld connections

If cable penetrations are fastened by weld connections, the cable penetrations shall be designed to facilitate welding and constructed such that, when they are welded to the containment vessel wall, neither the cable penetrations nor, in particular, their insulation materials can be damaged.

4.12 Electrical and Optical Connectors

Screwed and pluged connectors shall be secured such that self-loosening is not possible.

4.13 Gaseous Auxiliary Media

If gaseous media under overpressure are applied for a continuous leak-tightness monitoring, then the gas pressure shall be displayed at each cable penetration. A drop in pressure to under the pressure limit value may be signaled as a group alarm for all cable penetrations of a redundancy group. The dew point of the testing gas shall be lower than the minimum operating temperature.

5 Functional Requirements

5.1 Requirements for Cable Penetrations with Electrical Conductors

5.1.1 Basic requirements

(1) The electrical design of the cable penetrations shall be such that their electrical functional capability is ensured during specified normal operation and under the respective ambient conditions affecting the cable penetrations.

(2) Cable penetrations which are required, during and after those design basis accidents to be considered, for the mitigation of those accidents, shall retain their electrical functional capability under the respective ambient conditions (e.g., pressure, temperature, radiation, vibrations, moisture). This shall be achieved by the design of the cable penetrations including the connector elements on the cables and by the choice of suitable insulation materials. If during the installation of the cables special measures must be taken to achieve the required function during design basis accidents, these measures shall be specified already in the design phase and such that it is ensured that they can be performed as specified and that, even after installation of the cables, the required insulation values and voltage resistance are maintained. It shall be possible to test these special measures.

(3) Changes of the electrical characteristics due to ionizing radiation shall be taking into account when choosing the materials (cf. Section 4.5).

(4) Electrical cable penetrations not resistant to design basis accidents may only be used, e.g., for normal operational loads, if it is verified that, under design basis accident conditions, short-circuits and false signals in and between their electrical circuits cannot lead to an impermissible reduction of the functional capability of the safety system.

5.1.2 Short-circuit resistance

It shall be verified that the cable penetrations specified under Sections 5.1.4 and 5.1.5 are designed at least for the thermal and dynamic short-circuit loads expected at the location of installation taking the connected cable lengths, the installed upstream short-circuit protection equipment and worst-case ambient conditions into account.

5.1.3 Permissible ambient temperature, and current-carrying capacity

The permanently permissible maximum ambient temperature during specified normal operation and the temporarily permissible maximum temperature under design basis accident conditions shall be specified. On the basis of these values, the permissible nominal currents and permissible short-term overload currents (e.g. from start-up procedures, short circuits) shall be determined for the cable penetrations specified under Sections 5.1.4 and 5.1.5. The ageing and heating-up from nominal currents of the bilateral connector elements and the temperature effect on the connected cables shall be taken into account. When all conductors are simultaneously subjected to the nominal current, the permissible maximum temperatures specified for the materials employed and for the location of installation shall not be exceeded.

5.1.4 Special requirements for cable penetrations with nominal voltages above 1 kV

(1) The insulation materials shall be chosen such that the requirements of the electrical systems are lastingly fulfilled. The influence of ambient conditions (e.g., temperature, high-energy radiation, electrical field) shall be taken into account.

(2) The design of the insulation system shall be based on DIN EN 60071-1. The insulation level shall be maintained at the level specified for the “maximum voltage of operating components” of the associated switch gear.

5.1.5 Special requirements for cable penetrations with nominal voltages up to 1 kV

The clearances and creepage distances shall be designed such that, subsequent to connecting the intended cables, at least the requirements for Pollution Level 3 and Overvoltage Category III in accordance with DIN EN 60664-1 are fulfilled. The design of the clearances and creepage distances shall be based on a nominal insulation voltage of at least 60 V (effective value).

5.1.6 Special requirements for cable penetrations dedicated to signal transmission including controls and measurements

(1) The cable penetrations dedicated to signal transmission (including, e.g., measurement and control conductor penetrations, especially coaxial and triaxial cable penetrations) shall be designed to match the required characteristics of the transmitter system (e.g., insulation resistance, shielding, impedance) such that the cable penetration or cable connection will not impermissibly affect the overall transmission behavior.

(2) The clearances and creepage distances shall basically be designed in accordance with DIN EN 61010-1 based on a pollution level 3. In the case of those cable penetrations dedicated to signal transmission where the specified characteristics of the signal transmission require a deviation from Pollution Level 3, the sufficiency of the design shall be individually verified. The design of the clearances and creepage distances shall be based on a nominal insulation voltage of at least 50 V.

5.1.7 Special requirements for thermo-couple measurement cable penetrations

(1) The cable penetrations shall be matched to the required characteristics of the measuring circuits such that these circuits are not impermissibly affected by the cable penetration. In case the cable penetration is located between a thermo-couple and its reference point it shall be ensured by proper choice of the conductor material that no distortion of the measurement value occur.

(2) The design of the clearances and creepage distances shall be based on a nominal insulation voltage of at least 50 V.

5.1.8 Outer casings

(1) The distances of the outer casings and terminal boxes to any live circuit parts shall be designed in accordance with the same principles that apply to the associated cable penetration. In this context, the connector elements of the cables and the possible deformations specified under Section 4.10 shall be taken into account.

(2) When specifying distances, the positioning and fitting inaccuracies shall be taken into account such that it is ensured that the required minimum distances are maintained after installation.

5.1.9 Protection measures regarding cable penetrations and their outer casings

(1) The grounding measures shall be designed such that the protection of personnel is ensured and that electrical disturbances are avoided.

(2) In the case of cable penetrations with a nominal voltage above 1 kV as specified under Section 5.1.4, ground connections of the penetration shall be bolted down at the outer casing with a bolt thread size of at least M 12. The cross-section of the ground conductors shall be chosen in accordance with DIN EN 50522.

(3) In the case of cable penetrations with a nominal voltage up to 1 kV as specified under Section 5.1.5, measures protecting against electric shock shall be taken in accordance with DIN VDE 0100-410. In this context, sufficiently conductive structural components (e.g. welds, secured bolts and metal seals) may be used instead of separate protective ground conductors.

(4) In designing the protective ground conductors or structural component parts used instead, it shall be considered, that low voltage systems shall comply with the requirements in accordance with DIN VDE 0100-540.

(5) In the case of cable penetrations dedicated to signal transmission as specified under Sections 5.1.6 and 5.1.7, measures protecting against electric shock shall be taken in accordance with DIN EN 61010-1. No protective grounding is required in the case of systems with nominal voltages against ground lower than 50 V alternating voltage or 120 V direct voltage, provided, the requirements in accordance with DIN VDE 0100-410 are met. The examination of the final construction shall normally verify conformity with the design-reviewed documents specified under Section 7.1.

5.2 Requirements for Cable Penetrations with Optical Conductors

(1) Cable penetrations for optical cables shall be designed such that their optical functional capability is ensured during specified normal operation and under the respective ambient conditions affecting the cable penetrations.

(2) Cable penetrations which are required during and after the design basis accidents to be considered for the mitigation of those accidents, shall retain their optical functional capability under the respective ambient conditions (e.g., pressure, temperature, radiation, vibrations, moisture). This shall be achieved by the design of the cable penetrations including the connector elements on the cables. If during installation of the fiber-optical connection special measures must be taken to achieve the required resistance to design basis accidents, these measures shall be specified already in the design phase and such that it is ensured that they can be performed as specified and that, even after installation of the cables, the required maximum damping values are maintained. It shall be possible to test these special measures.

(3) The cable penetrations shall be adjusted to the required characteristics of the signal circuits such that the cable penetrations will not lead to an impermissible deterioration of the signals.

(4) The type of optical fiber shall be chosen such that the requirements for the transmission system are continuously met. The influence of ambient conditions (e.g., temperature, radiation) shall be taken into account.

6 Physical Tests and Examinations

6.1 Design Review

6.1.1 Documents

The following documents shall be submitted to the authorized expert:

a) technical specification, cf. Section 6.1.2,

b) construction documents, cf. Section 6.1.3,

c) verification of stress analysis, cf. Section 6.1.4,

d) verification of design against dynamic loads, cf. Section 6.1.5,

e) material and construction testing schedules, cf. Section 6.1.6,

f) schedules for welded, soldered and adhesively joined connections, cf. Section 6.1.7, and

g) assembly schedules, cf. Section 6.1.8.

6.1.2 Technical specification

The technical specification (delivery and acceptance conditions) shall normally contain, in particular:

a) descriptive information,

b) information about mechanical requirements,

c) information on the detailed design and analytical methods employed, and

d) test schedules, test instructions, acceptance conditions.

6.1.3 Construction documents

The construction documents shall comprise:

a) technical drawings including information on design dimensions,

b) description of the product characteristics,

c) data regarding materials and corrosion protection, and

d) documents regarding spatial arrangement (spatial arrangement plan).

6.1.4 Verification of stress analysis

It shall be demonstrated that pressure retaining parts of the cable penetrations will withstand the static, dynamic and thermal loads in accordance with the requirements specified under Section 4.1. This shall normally be based, in particular, on the requirements for the containment vessel. Certifications regarding the specified operating life shall be submitted.

6.1.5 Verification of design against dynamic loads

It shall be demonstrated that the mechanical, electrical and optical functions of the cable penetrations are not detrimentally affected by the respective frequency range of those vibrations, e.g., due to earthquakes, which must be assumed to occur at the location of installation.

6.1.6 Material and construction testing schedules

The extent of testing of the selected materials shall be specified in accordance with the requirements specified for the intended purpose and the associated load of the materials. The extent of the final testing shall be specified in accordance with the requirements under Section 6.2.

6.1.7 Schedules for welded, soldered and adhesively joined connections

For those welded, soldered and adhesively joined connections relevant to the pressure resistance and gas-tightness of the cable penetrations, welding and soldering schedules as well as other task plans shall be drawn up in accordance with the requirements for the containment vessel. A suitable test schedule with respect to ensuring the fabrication quality shall be a part of these plans.

6.1.8 Assembly schedules

The individual tasks and tests necessary at the building site during assembly of the cable penetrations shall be specified together with the time sequence for these tasks.

6.2 Final Testing

6.2.1 Basic requirements

The final inspection shall verify compliance of the finished product with the design-reviewed documents specified under Section 6.1.

6.2.2 Type and suitability tests

6.2.2.1 Basic requirements

(1) Type tests shall be performed to verify the functional capability of the type of cable penetration. In this context a test program consisting of test schedule and test instructions shall be worked out in agreement with the authorized expert. The sequence of the tests and the participation of the authorized expert at the individual tests shall be specified in the test schedule.

(2) If the installation in nuclear power plants requires safety related properties (e.g., resistance to design basis accidents) that are not covered by the type tests, then special suitability tests shall be performed. The type and suitability tests shall be performed on production samples after the development of the type has been finalized.

(3) The type and suitability tests shall be performed on three test objects for every type of cable penetration. In case of a replicated design for several types of cable penetrations, it is permissible to perform the type and suitability tests on a reference test object that covers all of the types. The reference test object shall be chosen in agreement with the authorized expert. With regard to requirements under operating conditions and during design basis accidents, the reference test objects shall cover every type of the replicated design.

(4) Type and suitability tests are valid only for products of the replicated design and only if the fabrication of the products is monitored by a quality assurance system regarding materials, fabrication procedures and design dimensions.

(5) The test results shall be confirmed by the authorized expert.

(6) A test step shall be considered as failed, if the prescribed minimum values specified in the test instructions are not achieved. A failure analysis shall be worked out for the failed test object and shall be submitted to the authorized expert for assessment.

(7) If the failure analysis reveals for the individual test step that there is no common-cause failure, the failed test object may be repaired and the test step repeated. The further test steps may then be continued with the three test objects. If more than one of the three test objects fails in one test step, then further

steps shall be taken under the assumption of a common-cause failure.

On the other hand, if the failure analysis reveals that there is a common-cause failure, the respective type of cable penetration shall be modified in a suitable manner and a renewed type test shall be performed.

(8) In the case of current flow-heating tests with the nominal currents and overcurrents as specified under Section 5.1.3 or in the case of vibration tests, if the specified requirements are not met, a repetition of the test step with modified limit values may be agreed upon with the authorized expert. The modified limit values shall be documented in the respective technical specification and test instruction.

(9) None of the cable penetrations used in the type and suitability tests may be installed in the containment vessel.

(10) Within the framework of the type and suitability tests, the first tests performed shall be the routine tests specified under Section 6.2.3 (regarding electrical and optical cable penetrations) and Section 7.2.3 (regarding electrical cable penetrations) or Section 8.2.3 (regarding optical cable penetrations).

(11) The validity of the type test certifications shall be limited to a period of three years beginning at the time of the successful conclusion of the analytical and experimental tests. The test certifications shall maintain their validity for components fabricated after this period of three years, provided, it is confirmed

a) within the framework of the plant-specific design review, or
b) plant independently, in regular intervals of three years by e.g., quality audits in accordance with safety standard KTA 3507,

that no modifications have been made with regard to the test certifications (including the test report) that would impair the tested characteristics.

6.2.2.2 Tests for thermal ageing resistance

(1) The cable penetrations to be tested shall be subjected to a thermal ageing process that corresponds to the specified design life.

(2) If materials are put to use whose thermal ageing behavior is not known, they shall be subjected to thermal ageing experiments. In this context it shall be verified that, under the conditions which can occur during deployment of the cable penetration, the mechanical and electrical properties of the materials will not be impermissibly impaired.

(3) A test for resistance to thermal ageing may be waived, provided, materials are exclusively used whose thermal ageing behavior with regard to the specified design life has no negative effect on the required properties.

6.2.2.3 Tests for radiation resistance

(1) All cable penetrations to be tested shall be subjected to a radiation test, the dose of which shall correspond to that of the specified design life plus the dose from the design basis accidents to be assumed.

(2) If materials are put to use whose radiation resistance is not known, they shall be subjected to a radiation test. In this context it shall be verified that, under the conditions which can occur during deployment of the cable penetration (including the dose of the design basis accidents to be assumed), the mechanical and electrical properties of the materials will not be impermissibly impaired.

(3) The dose rate of this artificial irradiation shall be specified taking the dose rate from operation and the dose rate from the design basis accident to be assumed into account. With respect to the operating dose rate, the applied dose rate shall normally not exceed 500 Gy/h.

6.2.2.4 Tests for corrosion resistance

It shall be verified that due to chemical reactions during operation and under design basis accident conditions, no corrosion will occur which would impermissibly modify the functional capability of the cable penetration.

6.2.2.5 Vibration tests

(1) The cable penetration including outer casing, connector elements and cables out to the nearest cable lug shall be subjected to a vibration test which shall cover the requirements specified under Section 6.1.5.

(2) With respect to the electrical or optical functional capability, it shall be verified during this test that the connection between cable penetration conductors and connected cables is not impaired nor that short circuits occur. During the vibration testing of electrical cable penetrations, a test for electrical shorts at 1.2 times the nominal voltage and a test for disruption of current flow shall basically be performed. The testing for electrical shorts may be waived, provided, it is verified by a theoretical analysis that, on account of the design, electrical shorts cannot occur.

(3) Subsequent to the vibration tests, a visual inspection for mechanical damage, a leak-tightness test as specified under Sections 6.2.3.5 and 6.3.7, and the routine test specified under Section 7.2.3 or 8.2.3 shall be repeated.

6.2.2.6 Leak-tightness and pressure tests under design basis accident conditions

(1) It shall be verified for the cable penetration and for the sealing system between the cable penetration and the containment vessel wall that the leakage rate specified under Section 4.9 is not exceeded. In this context, pressure in the form of saturated steam shall be applied for a duration of at least 1 hour at 1.3 times the design over-pressure of the containment vessel and at the maximum temperature the cable penetration and seals could be subjected to under design basis accident conditions.

(2) The pressure and temperature gradient in the testing device shall normally correspond to that of the course of the design basis accident to be assumed. In cases with particularly high, although only shortly effective temperature peaks, the temperature course may be simulated; the corresponding conditions shall be specified in agreement with the authorized expert.

(3) The leakage rate shall be measured at least at the end of the loading and at the end of the cooling-off period.

6.2.3 Routine test

6.2.3.1 Purpose and extent of the test

The routine test serves to detect possibly existing material and fabrication defects. It shall be performed at room temperature on each unit of a delivery batch. The test result shall be certified by the authorized expert. Each tested unit shall be marked accordingly.

6.2.3.2 Material Marking

The verification of the required material characteristics as well as the material marking shall be performed in accordance with the corresponding requirements for the containment vessel.

6.2.3.3 Non-destructive examination of weld connections

(1) Pressure retaining weld connections shall be subjected to a surface crack examination and an ultrasonic examination. A radiographic examination shall be performed if geometric conditions do not permit performing an ultrasonic examination. This is, however, only permissible in exceptional cases and requires the consent of the authorized expert.

(2) These examinations shall be performed in accordance with the requirements for the tests and examinations of the containment vessel.

6.2.3.4 Pressure Test

Subsequent to completion of fabrication, the cable penetrations shall be subjected to a pressure test at 1.3 times the design over-pressure of the containment vessel.

6.2.3.5 Leakage-rate test

Subsequent to completion of fabrication, the cable penetrations shall be subjected to a leakage-rate test, e.g., a helium leakage test in accordance with DIN EN 1779. At a pressure difference of 1 bar (0.1 MPa), the leakage rate shall not exceed 10^{-6} bar × $cm^3 \times s^{-1}$ (10^{-7} Pa × $m^3 \times s^{-1}$) with respect to helium.

6.3 Assembly and Testing at the Construction Site

6.3.1 Spatial arrangement

The spatial arrangements of the cable penetrations in the containment vessel shall be checked to ensure that they are in compliance with the design-reviewed documents specified under Section 6.1.

6.3.2 Fastening locations

The fastening points on the containment vessel wall shall be checked to ensure that they are in compliance with the permissible tolerances for the fastening system as specified in the design-reviewed documents.

6.3.3 Installation of the cable penetrations

(1) The cable penetrations shall be checked for damages during shipping.

(2) The installation shall be performed in compliance with the design-reviewed assembly sequence schedules, with the assembly instructions and the spatial arrangement plan.

(3) Subsequent to installation, the cable penetrations (except for those designed with appropriate plugs) shall be protected by the respective outer casings, and all openings, e.g., for insertion of the cables, shall be closed off.

6.3.4 Bolted connections

The fastener components (e.g., bolts, nuts, tightening springs, seals) and the fastening torque shall be checked to verify that they are in compliance with the design-reviewed documents.

6.3.5 Weld connections

The assembly parts, the welding procedure and the weld filler materials shall be checked to ensure that they are in compliance with the design-reviewed documents.

6.3.6 Integral pressure and leakage rate test

The pressure resistance and leak tightness of the cable penetrations installed in the containment vessel shall be tested within the framework of the pressure test and leakage rate test of the containment vessel. Cable penetrations installed into the containment vessel after these tests shall be subjected to an individual leak-tightness test as specified under Section 6.3.7.

6.3.7 Individual leak-tightness test

The cable penetrations installed after the pressure test and leakage rate test of the containment vessel shall be subjected to an individual leak-tightness test in accordance with DIN EN 1779 either, specifically, of the sealing system between cable penetration and containment vessel, or alternatively, of the entire cable penetration system including the sealing system to the containment vessel. The permissible leakage rate of a cable penetration including the sealing system to the containment vessel depends on the permissible leakage rate of the containment vessel; however, at a pressure difference of 1 bar (0.1 MPa) the leakage rate shall normally not exceed 10^{-3} bar × $cm^3 \times s^{-1}$ (10^{-4} Pa × $m^3 \times s^{-1}$) with respect to helium.

(2) The following testing methods may, e.g., be used:

a) sniff test (helium gas overpressure test) with the sniff test detector on the opposite side of the wall,

b) vacuum test (halogen gas underpressure test) with the test gas sprayed onto the opposite side of the wall,

c) pressure increase test (underpressure time test), and

d) pressure decrease test (overpressure time test).

6.3.8 Testing procedure

(1) The tests shall be performed by qualified testing personnel witnessed by the authorized expert.

(2) In case of the tests specified under Section 6.3.4, a random check by the authorized expert is sufficient.

6.4 Inservice Inspections

6.4.1 Extent of inservice inspections

(1) Inservice inspections shall be performed on those pressure retaining weld and bolt connections for which Section 6.1.1 specifies that documents shall be provided.

(2) The bolt connections shall basically be checked for their proper seating and for the specified fastening torque (using a torque wrench). This test may be waived if securing devices show that no changes have occurred with respect to the condition at installation.

(3) The leak-tightness test of the weld or flange connections shall be performed either by appropriate methods in accordance with DIN EN 1779, or as specified in Section 6.3.7 para. 2, or as an integral test within the framework of the leak-tightness test of the containment vessel.

6.4.2 Testing procedure

The inservice inspections shall be performed in accordance with a test schedule in which each test step is specified. The tests shall normally be performed in agreement with the authorized expert.

6.4.3 Extent of testing and test intervals

The extent of testing and the test intervals shall be specified in connection with those of the containment vessel.

6.5 Testing after Repairs

On completion of repairs or assembly tasks on cable penetrations, tests as specified under Section 6.3 shall be performed unless the work tasks were limited exclusively to functional elements which could have no influence on leak tightness.

6.6 Documentation

All tests and test results shall be documented.

7 Tests on Cable Penetrations with Electrical Conductors

7.1 Design Review

7.1.1 Documents

The following documents shall be submitted to the authorized expert :

a) technical specification (cf. Section 7.1.2),

b) construction documents (cf. Section 7.1.3),

c) verification of the electrical functional capability under design basis accident conditions (cf. Section 7.1.4),

d) verification of suitability of the insulation materials employed (cf. Section 7.1.5).

7.1.2 Technical specification

The technical specification (delivery and acceptance conditions) shall normally contain, in particular:

a) descriptive information,

b) details regarding electrical requirements during specified normal operation and under design basis accident conditions,

c) details regarding the design and analysis procedures,

and

d) test schedules, test instructions, acceptance conditions.

7.1.3 Construction documents

(1) The construction documents shall contain details regarding

a) electrical ratings and permissible connecting cross-sections, and

b) connection techniques (e.g., bolted, plugged or soldered connection).

(2) The construction documents shall normally be identical to the documents that are required for the design review as specified under Section 6.1.3.

7.1.4 Verification of the electrical functional capability under design basis accident conditions

If an electrical function is required under design basis accident conditions, documents shall be submitted verifying that the requirements regarding the electrical functional capability as specified under Section 5.1 are fulfilled under these conditions.

7.1.5 Verification of the suitability of the insulation materials employed

It shall be verified that the insulation materials employed – after the maximum thermal and radiological ageing to be assumed – will remain sufficiently resistant with respect to the electrical loading under the expected ambient operating conditions for the entire design life of the components and, if so required, also with respect to the loading under design basis accident conditions.

7.2 Final Testing

7.2.1 Purpose

The assembly test shall normally verify compliance of the assembled product with the design-reviewed documents specified under Section 7.1.

7.2.2 Type and suitability tests at the manufacturing plant

7.2.2.1 Basic requirements

(1) The requirements specified under Section 6.2.2.1 shall apply.

(2) If special measures are necessary to maintain the functional capability in the case of design basis accidents, then the requirements specified under Section 5.1.1 shall be taken into account.

7.2.2.2 Cable penetrations with nominal voltages above 1 kV

(1) The insulation capacity against voltage pulses shall be verified by a test with a nominal lightning-pulse voltage in accordance with Table 2 of DIN EN 60071-1.

(2) A current-induced temperature-rise test shall be performed at room temperature to verify that the requirements specified under Section 5.1.3 are fulfilled under nominal operating conditions as well as in the overload case and the short-circuit case.

7.2.2.3 Cable penetrations with nominal voltages up to 1 kV

A current-induced temperature-rise test shall be performed at room temperature to verify that the requirements specified under Section 5.1.3 are fulfilled under nominal operating conditions as well as in the overload case and the short-circuit case.

7.2.2.4 Cable penetrations dedicated to signal transmission including controls and measurements

If the cable penetration is used for a discharge counter (Geiger counter), then the inner conductor with one connected routine of cable shall be verified to be free of corona effects (e.g., noise impulses smaller than 50 µV at 5 kV, measured peak-to-peak) and to have an insulation resistance of at least 10^{11} Ohm between inner and outer conductor at a measuring voltage of 1000 Volt. This test shall be performed under the ambient conditions of the containment vessel wall during specified normal operation, however, at a temperature of at least 50 °C and a relative humidity of at least 80 %.

7.2.2.5 Electrical tests under design basis accident conditions

7.2.2.5.1 Basic requirements

(1) Cable penetrations which are required to retain their electrical functional capability during and after design basis accidents shall be subjected to tests to verify the electrical functional capability. For these tests the test objects, on their steam-exposed side, shall be equipped

a) with the outer casing, unless it can be proven that a test without outer casing does not lead to more favorable test conditions,

b) with the cables that shall be connected by the connection techniques as specified.

(2) The positioning of the test objects during the tests shall be representative for the mounting position on the containment vessel wall.

(3) If the electrical functional capability is achieved only by measures taken after installation of the cables, then these conditions shall be simulated in the type tests specified under Sections 7.2.2.5.2 and 7.2.2.5.3.

(4) The pressure and temperature curves and the humidity shall be representative for the course of the design basis accident and, together with the test duration, shall be specified in agreement with the authorized expert. The chemical composition of the steam or its effects shall be simulated in these tests.

7.2.2.5.2 Demonstration of the insulation capability under design basis accident conditions

(1) By means of a voltage test and measurement of the electrical resistance under design basis accident conditions, the insulation capability of the cable penetrations shall be verified. In this context, the conductors shall be subjected to 1.2 times the nominal voltage for the entire test duration – not, however, during the temperature test specified under Section 7.2.2.5.3.

(2) The insulation resistance of all conductors shall be measured at least at the start and at the end of the test. In case of cable penetrations with more than nine conductors, the insulation resistance shall be measured on one conductor continuously for the entire testing period. The insulation resistance shall correspond to the minimum requirements of the connected systems, however, shall normally not be lower than 1000 Ohm per Volt of the specified nominal voltage. The measuring direct voltage shall be at least 100 V for cable penetrations with nominal alternating voltages smaller than or equal to 60 V or with nominal direct voltages smaller than or equal to 75 V, and shall be at least 500 V for cable penetrations with higher nominal voltages.

(3) In the case of the cable penetrations specified under Sections 5.1.4 and 5.1.5

a) it shall be verified that the thermal and radiological ageing behavior as well as the durability of the employed insulation materials will not, under the specified operating and design basis accident conditions, impair the functional capability of the cable penetrations,

and

b) it shall be ensured that the required clearances and creepage distances can be checked with sufficient accuracy in the installed operational condition with.

If the requirements under items a) or b) cannot be fully verified, then a voltage-pulse test shall be performed in accordance with Sec. 6.1.2.2.1 of DIN EN 60664-1. This voltage-pulse test shall be performed, once, under design basis accident conditions at the maximum values for pressure, temperature and humidity and, secondly, directly after the design basis accident loading. The voltage-pulse test may, alternatively, be replaced by an alternating-voltage or direct-voltage test in accordance with Sec. 6.1.2.2.2 of DIN EN 60664-1.

(4) The durability required under para. 3 item a) for the insulation materials used shall be considered as unambiguously verified if the material-specific properties needed for modeling the effects of the radiological and thermal ageing are known or were determined on the basis of function-related properties and if the boundary conditions specified under Sections 6.2.2.2 and 6.2.2.3 are maintained.

7.2.2.5.3 Temperature-rise test under design basis accident conditions

(1) The cable penetrations specified under Sections 5.1.4 and 5.1.5 shall be subjected to a current-induced temperature-rise test. It shall be performed after the maximum temperature has been reached in the testing facility. For this test, all conductors (with the exception of the conductor dedicated to the continuous insulation resistance measurement) shall carry the nominal currents.

(2) Directly after the current-induced temperature-rise test, the cable penetrations specified under Sections 5.1.4 and 5.1.5 shall be subjected to the overload-current determined as specified under Section 5.1.3.

(3) The maximum temperatures determined as specified under Section 5.1.3 shall not be exceeded.

7.2.3 Routine test at the manufacturing plant

7.2.3.1 Purpose and extent of testing

(1) The routine test serves to detect possibly existing material and fabrication defects. It shall be performed at room temperature on each unit of a delivery batch. After completion of the routine test the authorized expert shall certify that every specified test was performed.

(2) Each tested unit shall be marked accordingly.

(3) Voltage tests to verify the insulation capability shall be performed. This entails measuring the voltage

a) between each conductor and the surrounding grounded structural component part

and additionally, if the conductors are not separated from each other by a grounded structural component part,

b) between each conductor and the neighboring conductors.

7.2.3.2 Cable penetrations with nominal voltages above 1 kV

The insulation capacity shall be verified by a test with the nominal short-term alternating voltage in accordance with Table 2 of DIN EN 60071-1. Additionally, it shall be verified that the creepage current per conductor does not exceed a value of 0.5 mA for every 1000 V of test voltage. The insulation resistance between two conductors and between a conductor and ground shall normally not be less than 10^9 Ohm. The dc test voltage for measuring the insulation resistance shall be at least 1000 Volt.

7.2.3.3 Cable penetrations with nominal voltages up to 1 kV

The insulation capability shall be verified by a voltage test (insulation test) in accordance with Table 12A of DIN EN 60947-1. Additionally, it shall be verified that the creepage current per conductor does not exceed a value of 0.5 mA for every 1000 V of measurement voltage. The insulation resistance between two conductors and between a conductor and ground shall normally not be less than 10^8 Ohm. The dc test voltage for measuring the insulation resistance shall normally be at least 500 Volt in the case of cable penetrations with nominal voltages up to 500 V and at least 1000 Volt in the case of cable penetrations with nominal voltages over 500 Volt.

7.2.3.4 Cable penetrations dedicated to signal transmission including controls and measurements

(1) The insulation capability shall basically be verified by a direct current voltage test at the following test voltage values:

a) In the case of a nominal voltage up to 1000 Volt:
test voltage: 3 times the operating voltage, however, at least of 500 Volt.

b) In the case of a nominal voltage over 1000 Volt:
test voltage: 1.5 times the operating voltage, however, at least of 3000 Volt.

(2) Alternatively, the insulation capacity may be verified in accordance with DIN EN 61010-1.

(3) The insulation resistance shall normally not be less than 10^8 Ohm. The dc test voltage for measuring the insulation resistance shall be at least 100 Volt.

(4) If the cable penetration is used for a discharge counter (Geiger Mueller counter) or an ionization chamber, then the insulation resistance between inner and outer conductor shall be at least 1011 Ohm. The measurement of the insulation resistance shall be performed at a relative humidity of at least 50 %, at a temperature of at least 23 °C and with a measurement (direct) voltage of 1000 V.

7.2.3.5 Thermo-couple and measurement cable penetrations

(1) The insulation capability shall basically be verified by a direct voltage test at 3 times the nominal voltage, however not less than 500 Volt; alternatively, the insulation capacity may be verified in accordance with DIN EN 61010-1.

(2) The insulation resistance shall normally not be less than 10^8 Ohm. The dc test voltage for measuring the insulation resistance shall be at least 100 Volt.

7.3 Assembly and Tests at the Construction Site

(1) The cables shall be connected to the conductors of the cable penetrations in accordance with the design-reviewed assembly instructions and by using the specified connection elements. In this context, the specified assembly clearances shall be adhered to. The required grounding measures specified under Section 5.1.9 shall be taken into account.

(2) The electrical functional capability of the cable penetrations shall be verified by acceptance and functional tests that shall be performed within the framework of the acceptance and functional tests of the respective electrical system. This requires that the cables are connected at both their ends, and that the respective electric circuit, control circuit or testing circuit is completely wired and connected.

(3) The special measures to be taken (as specified under Section 5.1.1) after cable installation shall be verified.

7.4 Inservice Inspections

If the functional capability of a cable penetration is not monitored during operation of the respective electrical system, the functional capability shall be verified by the inservice inspections specified for the electrical system. The measures taken to ensure functional capability under design basis accident conditions shall be verified. This shall normally be achieved by visual inspections.

Note:
Further details are specified in KTA 3401.4.

7.5 Testing after Repairs

After completion of a repair task, the measures taken to ensure the functional capability of the cable penetration under operating and, if necessary, design basis accident conditions shall be verified.

7.6 Documentation

All tests and test results shall be documented.

8 Tests and Inspections of Cable Penetrations with Optical Conductors

8.1 Design Review

8.1.1 Documents

The following documents shall be submitted to the authorized expert :

a) technical specification (cf. Section 8.1.2),
b) construction documents (cf. Section 8.1.3), and
c) verification of the optical functional capability under design basis accident conditions (cf. Section 8.1.4.

8.1.2 Technical specification

The technical specification (delivery and acceptance conditions) shall normally contain, in particular:

a) descriptive information,
b) details regarding optical requirements (e.g., maximum permissible optical transmission damping),
c) details regarding the design and analysis procedures, and
d) test schedules, test instructions, acceptance conditions.

8.1.3 Construction documents

(1) The construction documents shall contain details regarding

a) type of optical fiber and nominal optical characteristics,
b) connection techniques (e.g., screwed or plugged connection).

(2) The construction documents shall normally be identical to the documents which are required for the design review as specified under Section 6.1.3.

8.1.4 Verification of the optical functional capability under design basis accident conditions

If the optical functional capability is required under design basis accident conditions, documents shall be submitted verifying that the requirements regarding the optical functional capability as specified under Section 5.2 are fulfilled under these conditions.

8.2 Final Testing

8.2.1 Purpose

The assembly test shall normally verify compliance of the finished product with the design-reviewed documents specified under Section 8.1.

8.2.2 Type and suitability tests at the manufacturing plant

8.2.2.1 Basic requirements

(1) The requirements specified under Section 6.2.2.1 shall apply.

(2) If special measures are necessary to maintain functional capability in the case of design basis accidents, then the requirements specified under Section 5.2 shall be taken into account.

8.2.2.2 Optical transmission quality

(1) A test shall be performed to verify that the optical transmission characteristics fulfill the requirements specified under Section 5.2.

(2) This test of the optical transmission damping shall basically be performed at design temperature. The test procedure (e.g., in accordance with DIN EN 61300-3-4) shall be specified during the design review.

(3) This test may be performed at room temperature, provided, the respective optical cable penetration is used exclusively for normal operational purposes.

8.2.3 Routine test at the manufacturing plant

8.2.3.1 Purpose and extent of testing

(1) The routine test serves to detect possibly existing material and fabrication defects. It shall be performed at room temperature on each unit of a delivery batch. After completion of the routine test the authorized expert shall certify that every specified test was performed.

(2) Each tested unit shall be marked accordingly.

8.2.3.2 Test of the optical transmission quality

(1) A test shall be performed to verify that the optical transmission characteristics are sufficient such that the required functional characteristics are achieved.

(2) This test of the optical transmission damping shall be performed at room temperature. The test procedure (e.g., in accordance with DIN EN 61300-3-4) shall be specified in the course of the design review.

8.3 Assembly and Tests at the Construction Site

(1) The cables shall be connected to the conductors of the cable penetrations in accordance with the design-reviewed assembly instructions and by using the specified connection elements.

(2) The optical functional capability shall be verified by acceptance and functional tests that shall be performed on the cable penetrations within the framework of the acceptance and functional tests of the respective optical system. This requires that the cables are connected at both their ends.

8.4 Inservice Inspections

If the functional capability of a cable penetration is not monitored during operation of the respective optical system, the functional capability shall be verified by the inservice inspections specified for the optical system. The measures taken to ensure functional capability under design basis accident conditions shall be verified. This shall normally be achieved by visual inspections.

Note:
Further details are specified in KTA 3401.4.

8.5 Testing after Repairs

After completion of a repair task, the measures taken to ensure the functional capability under operating and, if necessary, design basis accident conditions shall be verified.

8.6 Documentation

All tests and test results shall be documented.

9 Qualification of the Personnel Regarding Nondestructive Examinations

(1) With respect to the examination procedures applied in the individual product or industrial sectors, the examination supervisor shall be qualified at least as Level 2 in accordance with DIN EN ISO 9712 and shall be so certified.

(2) The testing personnel shall be able to perform the required examinations. With respect to the examination procedures applied in the individual product or industrial sectors, they shall be qualified in accordance with DIN EN ISO 9712 and shall be so certified.

Appendix A

Regulations Referred to in this Safety Standard

Regulations referred to in this safety standard are valid only in the versions cited below. Regulations which are referred to within these regulations are valid only in the version that was valid when the latter regulations were established or issued.

AtG		Act on the Peaceful Use of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) dated 23 December 1959 (BGBl. I, p. 814) revised version of July 15, 1985 (BGBl. I, p. 1565), last amended by Article 307 of the Ordinance of August 31, 2015 (BGBl. I 2015, No. 35, p. 1474)
StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance – StrlSchV) of July 20, 2001 (BGBl. I, p. 1714; 2002 I, p. 1459), last amended by Article 5 of the Ordinance of December 11, 2014 (BGBl. I, p. 2010)
SiAnf	(2015-03)	Safety Requirements for Nuclear Power Plants (SiAnf) of 22 November 2012 (BAnz AT 24.01.2013 B3), revised version of March 3, 2015 (BAnz AT 30.03.2015 B2)
Interpretations on the SiAnf	(2015-03)	Interpretations of the "Safety Requirements for Nuclear Power Plants of 22 November 2012" (BAnz AT 24.01.2013 B3), revised version of March 3, 2015 (BAnz AT 30.03.2015 B2)
KTA 1401	(2013-11)	General Requirements Regarding Quality Assurance
KTA 3401.1	(1988-09)	Steel Containment Vessels; Part 1: Materials
KTA 3401.2	(1985-06)	Steel Containment Vessels; Part 2: Analysis and Design
KTA 3401.3	(1986-11)	Steel Containment Vessels; Part 3: Manufacture
KTA 3401.4	(1991-06)	Steel Containment Vessels; Part 4: Inservice Inspections
KTA 3402	(2014-11)	Airlocks on the Reactor Containment of Nuclear Power Plants - Personnel Airlocks
KTA 3405	(2015-11)	Leakage Test of the Containment Vessel
KTA 3407	(2014-11)	Pipe Penetrations through the Reactor Containment Vessel
KTA 3409	(2009-11)	Airlocks on the Reactor Containment of Nuclear Power Plants - Equipment airlocks
KTA 3507	(2014-11)	Factory Tests, Post-repair Tests and Certification of Satisfactory Performance in Service of Modules and Devices of the Safety-Related Instrumentation and Control System
KTA 3706	(2000-06)	Ensuring the Loss-of-Coolant-Accident Resistance of Electrotechnical Components and of Components in the Instrumentation and Controls of Operating Nuclear Power Plants
DIN VDE 0100-410 * VDE 0100-410	(2007-06)	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock (IEC 60364-4-41:2005, modified); German implementation HD 60364-4-41:2007
DIN VDE 0100-540 * VDE 0100-540	(2012-06)	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements, grounding conductor (IEC 60364-5-54:2002, modifiziert); German implementation HD 60364-5-54:2007
DIN EN 1779	(1999-10)	Non-destructive testing - Leak testing - Criteria for the method and technique selection; German version EN 1779:1999

DIN 4102-1	(1998-05)	Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests
DIN EN ISO 9712	(2012-12)	Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012); German version EN ISO 9712:2012
DIN EN 50522 * VDE 0101-2	(2011-11)	Earthing of power installations exceeding 1 kV a.c.; German version EN 50522:2010
DIN EN 60071-1 * VDE 0111-1	(2010-09)	Insulation coordination - Part 1: Definitions, principles and rules (IEC 60071-1:2006 + A1:2010); German version EN 60071-1:2006 + A1:2010
DIN EN 60529 * VDE 0470-1	(2014-09)	Degrees of protection provided by enclosures (IP code) (IEC 60529:1989 + A1:1999 + A2:2013); German version EN 60529:1991 + A1:2000 + A2:2013
DIN EN 60664-1 * VDE 0110-1	(2008-01)	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests (IEC 60664-1:2007); German version EN 60664-1:2007
DIN EN 60947-1 * VDE 0660-100	(2011-10)	Low-voltage switchgear and controlgear - Part 1: General rules (IEC 60947-1:2007 + A1:2010); German version EN 60947-1:2007 + A1:2011
DIN EN 61010-1 * VDE 0411-1	(2011-07)	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements (IEC 61010-1:2010 + Corigendum:2011); German version EN 61010-1:2010
DIN EN 61300-3-4	(2013-11)	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-4: Examination and measurements - Attenuation (IEC 61300-3-4:2012); German version EN 61300-3-4:2013