Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 1505 (11/03)

Certification of Suitability of Radiation Measuring Equipment

(Nachweis der Eignung von Strahlungsmesseinrichtungen)

If there is any doubt regarding the information contained in this translation, the German wording shall apply.

Editor:

KTA-Geschaeftsstelle c/o Bundesamt fuer Strahlenschutz (BfS)

Willy-Brandt-Str. 5 • 38226 Salzgitter • Germany

Telephone +49-1888/333-(0) 1621 • Telefax +49-1888/333-1625

KTA SAFETY STANDARD

November 2003	**Certification of Suitability of Radiation Measuring Equipment**	KTA 1505

CONTENTS

PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 50-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger BAnz No. 26 a of February 7, 2004. Copies may be ordered through the Carl Heymanns Verlag KG, Luxemburger Str. 449, 50939 Koeln, Germany (Telefax +49-221-94373603).

All questions regarding this English translation should please be directed to:

KTA-Geschaeftsstelle c/o BfS, Willy-Brandt-Str. 5, 38226 Salzgitter, Germany

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.

Fundamentals

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the task of specifying those safety related requirements which shall be met with regard to precautions to be taken in accordance with the state of science and technology against the hazards arising from the construction and operation of the facility (Sec. 7 para. 2 no. 3 Atomic Energy Act) in order to attain the protective goals specified in the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV) and which are further detailed in "Safety Criteria for Nuclear Power Plants" and in "Guidelines for the Assessment of the Design of Nuclear Power Plants with Pressurized Water Reactors against Incidents pursuant to Sec. 28 para. 3 of the Radiological Protection Ordinance (StrlSchV) - Incident Guidelines".

(2) The protection of persons inside and outside of the facility from ionizing radiation as well as the monitoring of the specified normal functions of the equipment

- for the retention of solid, liquid and gaseous radioactive substances within the provided enclosure,
- for the handling and controlled routing of radioactive substances within the facility as well as
- for the monitoring of the release of radioactive substances

is achieved among others by the stationary and mobile radiation protection instrumentation. The safety standards series KTA 1500 specifies detailed safety-related requirements for this instrumentation.

(3) In accordance with, e.g., Sec. 67 para. 1 StrlSchV, the radiation measuring devices for measuring the personal dose, local dose rate, surface contamination and the radioactivity of air and water shall be suited to meet the requirements of the measurement objective.

(4) The safety standard KTA 1505 specifies the procedures and requirements for stationary radiation monitoring equipment with regard to

a) the device-specific qualification, i.e., certification of the device characteristics,
b) the plant-specific suitability test and
c) supplementary tests (cf. Section 6.3)

by which it is certified that the requirements in accordance with Sec. 67 para. 1 sentence 1 and sentence 2 No. 1 StrlSchV are met.

(5) Requirements with regard to quality assurance are specified in safety standard KTA 1401 “General requirements for quality assurance”.

1 Scope

(1) This standard applies to the certification of suitability in accordance with Sec. 67 para. 1 StrlSchV for radiation and radioactivity measuring equipment and for the functional modules contained therein as far as this equipment is permanently installed in nuclear power plants and research reactor facilities. This includes all monitoring equipment within the scope of safety standards KTA 1501, KTA 1502.1, KTA 1503.1, KTA 1503.2, KTA 1503.3, KTA 1504, KTA 1506 and KTA 1507.

(2) This safety standard does not apply to any parts of the supply systems and of the subsequent electric instrumentation and control systems not directly correlated to a measuring equipment as specified under para. 1.

2 Definitions

(1) Functional monitoring during the type test

The functional monitoring during the type test is a test procedure by which the functional capability of the test objects is continuously monitored during a test step.

(2) Interim functional test during the type test

The interim functional test during the type test is a test procedure by which the functional capability of the test objects is checked at particular hold points.

(3) Critical load test

The critical load test is a test by which the behavior of the device is determined for the worst combination of those operating and ambient conditions for which the device was designed.

(4) Monitoring equipment

Monitoring equipment encompasses all the measurement and auxiliary devices that are necessary for determining a measured quantity, for transmitting and adjusting the measuring signal and for displaying the measured value as a representation of the measured quantity.

(5) Plant-independent testers (radiation and radioactivity surveillance)

Plant-independent testers in the field of radiation and radioactivity surveillance are competent persons that, in accordance with legal requirements, standards, guidelines, provisions or instructions, are required to be consulted during a test. They shall not be involved in the manufacturing and marketing of the monitoring equipment to be tested and shall not represent the interests of the manufacturer.

3 Certification of Suitability

3.1 General Objective

(1) Within the framework of the nuclear licensing and supervising procedure it shall be certified that the radiation monitoring equipment is suited for the measurement objective.

(2) The certification of suitability for a monitoring equipment is achieved if it is documented that the individual monitoring equipment achieves the measurement objective at the location assigned to this equipment and for the particular operating and ambient conditions and if this is confirmed by an authorized expert (under Sec. 20 Atomic Energy Act).

3.2 Procedure

3.2.1 Description of Measurement Task

(1) The measurement task shall be described in writing. This description shall include the measurement objectives, the measurement quantities to be determined, the requirements from the Radiological Protection Ordinance and from KTA safety standards as well as the safety related and radiological significance of the measurement results.

(2) The environmental conditions at the assigned location as well as the possible influence parameters affecting the measurements shall be determined for the individual monitoring equipment. The resulting special requirements for the monitoring equipment or for the contained functional units shall be specified.

3.2.2 Documents to be Prepared

(1) Device-specific and plant-specific documents shall be prepared for the determination of each of the characteristics that are necessary for the functional capability of the monitoring equipment at the assigned location. These documents shall contain the following information:

a) description of the construction and function of the monitoring equipment which shall include a data sheet (e.g., specification of the measured quantity, measurement range, detection limit, energy dependence),

b) description of the ambient conditions (e.g., temperature, humidity, pressure, dose rate, acceleration),

c) description of the measurement medium (e.g., temperature, humidity, pressure, flow rate, chemical composition, activity concentration),

d) description of the power and the auxiliary media supply (e.g., electrical power, control pneumatics, counter gas),

e) description of the interface with peripheral equipment, supply systems and media-containing systems (e.g., sample extraction, assembly, installation),

f) description of the reliability requirements taking into consideration any available redundancies or diversified equipment and any precautionary measures regarding admissible outage times (e.g., replacement measures, replacement part strategy).

(2) The extent of the individual documents and the depth of the descriptions shall be based on the safety related significance of the measurement task and the characteristics of the monitoring equipment.

Note:
The different extent and depth may result from

a) the individual monitoring equipment, particularly, with regard to the safety-related significance of the measurement objective for which the equipment qualification is intended,

b) the individual measurement objective, particularly, with regard to the quality characteristics (e.g., self-monitoring, plausibility checks, repair possibilities) of the monitoring equipment assigned for achieving this measurement objective,

c) the individual measurement objective, particularly, with regard to the available redundancies and diversified equipment.

3.2.3 Certification of Characteristics

3.2.3.1 List of Characteristics to be Certified (LCC)

(1) Based on the description of the measurement objectives and the documents specified under Section 3.2.2, a list (LCC) shall be compiled of all monitoring equipment characteristics that are necessary for achieving the measurement objective and which shall normally be certified in accordance with Section 4. In the case of software based monitoring equipment, the LCC shall contain the necessary functions and their proper implementation.

(2) For each characteristic, the LCC shall list the designated certification procedures chosen from those specified under Section 3.2.3.2.

3.2.3.2 Admissible Certification Procedures

The individual characteristics from the LCC shall be certified electively by

a) satisfactory performance in service,

b) individual test certifications,

c) type test,

d) acknowledgement of suitability certifications from other nuclear licensing procedures,

e) trial operation,

f) acknowledgement of tests performed within the framework of a design approval by Physikalisch-Technische Bundesanstalt (PTB),

g) acknowledgement of qualifications carried out in accordance with DIN IEC 60 780.

3.2.4 Document Review and Documentation

(1) The documents specified under Sections 3.2.1 through 3.2.3 shall be presented to and reviewed by the authorized expert (under Sec. 20 Atomic Energy Act). Completion of the document review shall be documented by a test report.

(2) The documents used in the document review and the test report shall be archived as test documentation.

4 Requirements for Certification Procedures

4.1 Satisfactory Performance in Service

(1) Satisfactory performance in service shall be certified by evaluating records for the term of past operation of the monitoring equipment to the present; this evaluation shall be based on the characteristics and ambient conditions during operation. The records shall cover at least one year.

(2) It shall be shown that the planned operating and ambient conditions are comparable to the particular operating and ambient conditions during the term of past operation specified under para. 1.

(3) The records from the term of past operation of the monitoring equipment shall be evaluated. This shall, particularly, take into consideration:

a) individual and overall duration of operation,

b) failure rates and rates of malfunctions,

c) servicing and test results,

d) drift behavior.

(4) The documentation on servicing, repairs and inservice inspections shall be evaluated with regard to:

a) type and extent,

b) causes,

c) evaluations of the failures or of the inadmissible deviations from a required condition.

(5) In the case of series-produced items, the evaluations specified under paras. 2 and 3 may be dispensed with in well founded cases.

(6) The determination of satisfactory service in operation of the designated monitoring equipment may be based on the results from devices that are not identical in design, provided, it is certified for these deviations that a comparable design and comparable components and structural elements are being used.

4.2 Individual Test Certifications

If individual test certifications are available for individual characteristics of the monitoring equipment, these shall be acknowledged, provided, the following requirements are met:

a) The tested monitoring equipment shall be identifiable with regard to type and stage of design development at the time of the tests.

b) The tests shall have been performed by a plant-independent tester or by a plant expert.

c) It shall be possible to reconstruct the tests with regard to the testing program, the test parameters, the applied measurement means and techniques, and the documentation of the test results.

4.3 Type Testing

(1) The objective of a type test is the certification of individual characteristics that are in conformance with the LCC. The procedure of the type test is described in **Appendix A**. Requirements regarding the testing for physical characteristics and corresponding test implementation examples are presented in **Appendix B**.

(2) If the monitoring equipment has already been subject of a type test then the results of this type test shall be recognized.

4.4 Acknowledgement of Suitability Certifications from Other Nuclear Licensing Procedures

If monitoring equipment or parts of a monitoring equipment have already, in another nuclear licensing procedure, been certified to be suitable in accordance with this safety standard, then this certification shall be acknowledged.

4.5 Trial Operation

In case the suitability certification for the monitoring equipment cannot be performed by a procedure as specified under Sections 3.2.3.2 items a through d, then individual characteristics may be certified by a trial operation. These characteristics shall be evaluated and documented on the basis of operating records over a time period to be specified.

4.6 Tests Performed by PTB

Available test results documented within the framework of a design approval by PTB shall be acknowledged as a suitability certification in accordance with this safety standard.

4.7 Qualification in Accordance with DIN IEC 60 780

A qualification performed in accordance with DIN IEC 60 780 shall be acknowledged as suitability certification in accordance with this safety standard.

5 Device Documents

5.1 Device Specific Documents

5.1.1 General Requirements

(1) The device documents shall include the identity of the manufacturer, the type and state of revision. Also included shall be a document catalog and the documents specified under Sections 5.1.2 through 5.1.4.

(2) With regard to software identification, the program code itself and the data carrier used (e.g., EPROM, diskette) shall be marked with an identification of the program code (code name or abbreviation and the release number). The identification and version number of the tested program code and the required operating system shall be documented.

5.1.2 Description of Functionality

(1) The description of functionality of the device shall present information on the field of application, the objective and operating principle of the device.

(2) conceptual flow diagrams, wiring diagrams, construction drawings, listing of the modules as well as positioning plans of the components shall be used to describe the physical and functional design of the device in such a way that, under the specified boundary conditions, the measurement objective becomes perceptible.

(3) In the case of software based monitoring equipment, the realized functions shall be described. This shall include, e.g., the functions with regard to measuring, calibrating, assigning of parameters, controlling, self-monitoring, evaluating and testing.

(4) Regarding the measurement functions of software based monitoring equipment, the applied algorithms as well as the case discriminations and special cases shall normally be described.

5.1.3 Data Sheet

(1) The data sheet shall contain all data characterizing the device and shall include the bandwidth of admissible deviations. These data shall include, e.g.,

a) input variables,
b) output variables,
c) data formats of the input data and output data,
d) auxiliary power,
e) admissible ambient conditions, environmental influences,
f) transfer bahavior, calibration factors,
g) interference from radiation fields,
h) electrical characteristics,
i) electromagnetic compatibility.

(2) The superordinate system data may be listed in a system data sheet.

5.1.4 Device Manual and System Manual

(1) The device manual shall normally include the following information:

a) operating instruction including a user-oriented documentation of the software,
b) installation instruction,
c) initial start-up instruction,
d) adjustment instruction,
e) testing instructions,
f) indication of special accessories,
g) indications regarding servicing, possibilities for testing,
h) packaging and storage instructions.

(2) The component related data may be compiled in a system manual for the monitoring equipment.

5.2 Additional Information

5.2.1 Reliability

Information shall be presented on the reliability of decisive components including an estimation of the expected outage probability for the monitoring equipment under nominal conditions. It is admissible to employ data derived from operating experience. The drift and wear behavior as well as the concept for servicing and for inservice inspections shall be taken into consideration.

Note:
Decisive components with regard to reliability are, e.g., photo multipliers, hard disks, semi-conductor detectors, moving parts, functionally important seals.

5.2.2 Evaluation of the Design

(1) The electrical and physical design of the monitoring equipment shall be described with special emphasis on the loading of critical components.

(2) A certified stress analysis shall be presented for the pressurized parts.

5.2.3 Material Specification

The materials used shall be listed for those parts that come in contact with the measurement medium. The kind of interaction with the measurement medium shall be indicated.

5.2.4 Inservice Inspections

Documents shall be presented that describe the procedures for the functional tests of the devices during later operation under consideration of radiological protection and the possible influence on the plant condition.

6 Document Review and Tests

6.1 Documents to be Reviewed

The documents specified under Sections 3.2, 4.1 through 4.5 and 5 shall be subjected to a document review.

6.2 Objective of Document Review

The objective of the document review is the certification of suitability. This requires

a) evaluating the monitoring equipment and the measurement principle with respect to achieving the measurement objective,
b) certifying on the basis of a comparison of documents that the characteristics specified in the LCC have been achieved,
c) confirming that the monitoring equipment is suited for the measurement objective in the designated facility,
d) in the case of software based monitoring equipment, confirming the correct installation and assignment of parameters for the realized functions.

6.3 Supplementary Tests

If the document review shows that the documents specified under Sections 4.1 through 4.5 are not sufficient for the certification of all characteristics in accordance with the LCC, these characteristics may then be certified by a supplementary test or an additional qualification (e.g., extended factory test, enlarged initial start-up test or trial operation).

6.4 Test Report

(1) The document review shall be written up in a test report that shall describe the decisive facts and enable a reconstruction of the evaluation. The results of previous document reviews shall be taken into consideration.

(2) By evaluating the test records, the test report shall substantiate that the test objective specified under Section 6.2 has been achieved. The individual test records concerned are:

a) document specifying the measurement objective as specified under Section 3.2.1 para. 1,
b) plant specific documents as specified under Section 3.2.1 para. 2,
c) LCC including the indication of the designated certification procedure for each of the characteristics as specified under Section 3.2.3,
d) certifications for each of the characteristics listed in the LCC. Depending on the designated certification procedures these are:
   da) documents regarding the satisfactory performance in service as specified under Section 4.1,
   db) available individual test certificates as specified under Section 4.2 including the related test documentation,
   dc) results of the executed type test as specified under Section 4.3 including test certification and test report,
   dd) results of a trial operation as specified under Section 4.5,
   de) acknowledgement of the suitability certification from other nuclear licensing procedures as specified under Section 4.4,
   df) acknowledgement of suitability certifications from tests performed by PTB,
   dg) acknowledgement of suitability certifications performed in accordance with DIN IEC 60 780.
e) device documents as specified under Section 5,
f) documents of the results of the tests as specified under Section 6.3.

(3) The test report shall contain at least the following information:

a) manufacturer of the tested device,
b) device identification and device type including the state of revision,
c) identification of the tested software version and of the operating system used,
d) collation of the test documents used,
e) list of certified characteristics including indication of the certification procedures,
f) confirmation that the suitability has been certified,
g) place and date,
h) organization, name and signature of expert.

6.5 Test Certificate

The completed tests shall normally be confirmed by a test certificate.

7 Test Documentation

7.1 Test Documents Used in the Test

All documents used in the tests and cited in the test report specified under Section 6.4 shall be compiled in the test documentation.

7.2 Documents of the Tests

The test report specified under Section 6.4 and the test certification specified under Section 6.5 shall be included in the test documentation.

7.3 Place and Duration of Document Storage

(1) The documents specified under Sections 7.1 and 7.2 shall be stored by the license applicant / licensee.

(2) Unless otherwise specified by the proper authority, the required storage period for the documents specified under para. 1 ends with the end of deployment of the monitoring equipment in the nuclear power plant.

(3) It is admissible to store the documents specified under para. 1 as originals, copies, microfilms or as computer files.

Appendix A

Type Testing of Radiation Monitoring Equipment

A 1 General Requirements

A 1.1 Objective

(1) The objective of the type test is the plant-independent certification of specified characteristics of a radiation monitoring equipment. This entails performing theoretical and practical test with regard to the measurement objective to be achieved.

(2) The specification of characteristics is considered theoretical proof that the monitoring equipment is suited to fulfill the measurement objectives in accordance with the relevant KTA safety standards and that the monitoring equipment meets the requirements regarding the measurement objective in accordance with Sec. 67 para. 1 sentence 1 item 1 StrlSchV.

(3) The certification of specified characteristics shall be carried out by a plant-independent tester.

A 1.2 Procedure

(1) Type testing shall be performed in the following sequential phases:

Phase 1: Preparations for the theoretical and practical tests

Phase 2: Theoretical test

Phase 3: Practical test

(2) In Phase 1, the documents required for the theoretical and practical tests are prepared. These documents are, essentially,

a) description of the measurement objective (documents specified under Section 3.2.1),
b) description of the monitoring equipment (documents specified under Sections 3.2.2 and 5),
c) List of characteristics to be certified (LCC, specified under Section 3.2.3.1),
d) schedule with the corresponding test instructions for performing the practical test.

(3) In Phase 2, a plant-independent tester shall check the documents prepared in Phase 1 for their completeness and accuracy by comparing the characteristics to be tested with the requirements from the measurement objective and by performing a plausibility check of the specifications.

(4) In Phase 3, the characteristics specified in the LCC are certified by carrying out practical tests. The objective, here, is to prove experimentally that the monitoring equipment will function under the specified ambient conditions. If the individual characteristics listed in the LCC have already been confirmed in practical tests performed under participation of a plant-independent tester, or if their satisfactory performance in service has already been certified, then these test results shall be acknowledged.

A 2 Theoretical Test

(1) The theoretical test in Phase 2 includes reviewing the equipment documents specified under Sections 5.1, reviewing the additional information specified under Section 5.2, as well as reviewing the test instructions for performing the practical tests. Thereby, the documents shall be evaluated with regard to plausibility and detectable weak point under consideration of the test objective specified under Section 6.2.

(2) The safety related significance of the measurement objective and the characteristics of the monitoring equipment shall be taken into consideration as specified under Section 6.1.

A 3 Practical Test

A 3.1 General Requirements

(1) The objective of the practical test is to certify the functionality of the equipment by experiments under prescribed conditions. Basis for the test is the LCC.

(2) The tests shall be performed at the reference values of the parameters, provided, theoretical analyses have not uncovered more unfavorable values for the test parameters regarding interference.

Note:
The reference values of parameters are standard values, e.g., in accordance with Table 5.1 KTA 1503.1.

A 3.2 Selection of Monitoring equipment to be Tested (Test Objects)

(1) At least one monitoring equipment shall be selected for the type test. This shall be a factory tested unit. All testing steps of the practical test shall normally be performed on the same test object.

Note:
In order to be able to better assess possible defects during the practical tests, it is recommended that three test objects be selected.

(2) The test objects shall be marked accordingly.

(3) The test objects may be selected from the pilot lot. In case of a small-series production, an individually fabricated unit may be selected as test object.

(4) The type test may also be performed parallel to the development process.

(5) A summary shall be prepared describing the individual history of the test objects. This summary should include information regarding fabrication facility, date of fabrication, dates of factory tests, storage times and other load conditions of the test objects incurred prior to the type test.

A 3.3 Testers and Test Instructions

(1) The manufacturer of the monitoring equipment shall normally prepare the corresponding documents for the tests as well as the test instructions. The responsibility for performing the practical tests lies with the manufacturer of the monitoring equipment.

(2) The plant-independent tester shall coordinate the test instructions for the practical tests specified under Section A 3.5 with the manufacturer of the monitoring equipment and specifies the extent of participation for the individual test steps.

A 3.4 Test Locations and Test Equipment

The test locations and the testing equipment and instrumentation for carrying out the practical tests shall be of a sufficiently high quality that the test requirement specified under this safety standard are met.

A 3.5 Test Instructions for Practical Tests

The test instructions shall describe the type of the test, the testing equipment and the execution of the tests (sequence and extent of the test steps).

A 3.6 Identity Check

An identity check shall be performed to assure that the test objects including associated software are in conformance with the device documents specified under Section 5.

A 3.7 Functional Tests

(1) The functioning of the device shall be checked using the test instructions specified under Section A 3.5.

(2) In case the test objects contain multiple functional modules, each of these functional modules may be tested individually. Overlapping tests are required with regard to their interfaces.

A 3.8 Intermediate Functional Tests

The adjustment conditions for the intermediate functional tests shall be selected such that changes of the equipment characteristics from the directly previous test step can be detected.

A 3.9 Functional Monitoring

(1) The function of the test object shall be monitored during those tests in which the test object shall normally be in operation,.

(2) The relationship between the input and the output signals characteristic for the measurement objective shall be monitored. In case the radiation detector is integral part of the test object, then the detector shall be subjected to a suitable radiation field during functional monitoring.

(3) The functional monitoring shall be carried out such that, as far as they are relevant to the tested function, even short-term changes in the output variables or functional failures of the equipment can be detected.

A 3.10 Sequence of the Practical Tests

(1) The practical tests of equipment which is not subject to requirements regarding resistance to ambient conditions from design basis accidents shall normally be performed in the following sequence:

a) identity check of the finished equipment as specified under Section A 3.6,
b) functional tests and tests of the electrical characteristics,
c) climate tests,
d) tests regarding resistance to radiation during specified normal operation,
e) mechanical loading,
f) long-term tests,
g) repeating selected test steps of the functional tests.

(2) The practical tests of equipment which is subject to requirements regarding resistance to ambient conditions from design basis accidents shall normally be performed directly after the tests of mechanical loading and before the long-term tests and repeating of the functional tests.

A 3.11 Measures in Case of Failures during Practical Tests

In case of a failure, the time of the failure and the failure effects shall be determined. An investigation report shall be prepared which shall contain information on the investigation performed and on the determined cause of the failure. If the investigation indicates a systematic failure, then corresponding strengthening measures shall be taken. If no systematic failure is indicated, the equipment shall be repaired and then, after to the corresponding identity check and functional tests, the test steps of the practical test shall be continued beginning with the interrupted test step. However, the extent of practical tests to be repeated shall be decided in cooperation with the plant-internal tester.

A 3.12 Deployment of Tested Monitoring equipment

(1) The test objects may be used in a nuclear power plant, provided, the type test was successfully completed and the test objects are certified as not having been pre-damaged.

(2) This certification may be based on a final functional test as specified under Section A 3.7.

A 4 Test Certification and Test Documentation

A 4.1 Test Report

The test shall be written up in a test report that shall describe the decisive facts and the gained insights and, thus, shall enable a reconstruction of the evaluation. The results of previous type tests shall be taken into account.

A 4.2 Test Certificate

The completed type test shall be certified by issuing a test certificate.

A 4.3 Test Documentation

All documents used for the tests, the test results, the test report and the test certificate shall be included in a test documentation.

Appendix B

Requirements Regarding the Tests for Technical Characteristics, Implementation Examples

B 1 General Requirements

(1) The following sections contain requirements for the tests of a number of technical characteristics and include examples for the implementation of these tests.

(2) The requirements for the tests shall be met within the framework of the chosen certification procedure, provided, the corresponding characteristic is contained in the LCC.

(3) The implementation examples describe established methods within the framework of practical tests of the type test; although these methods fulfill the associated requirements, their use is not imperative. They may be replaced by equivalent methods.

B 2 Tests

B 2.1 Response Capability (Calibration)

(1) The response capability shall be determined for the specified radionuclides and energy ranges. For example, the response of the monitoring equipment shall be determined under reference conditions representing at least two measured values that are apart by at least a factor of ten and under a measurement geometry corresponding to the actual case of application. Deviations from these requirements are admissible in well-founded cases.

(2) A calibration certificate of the radioactivity sources shall identify their radioactivity in terms of a national technical standard.

B 2.2 Calibration Transfer

In order to enable transferring the calibration, transfer values shall be determined with at least one solid calibration source in a defined geometry. These transfer values shall normally enable checking the response of design-identical equipment.

B 2.3 Detection Limit

The detection limit of the monitoring equipment shall be determined under those reference conditions as specified in the corresponding KTA safety standards.

B 2.4 Minimum Background Level

The minimum background level of the equipment shall be determined. Those parameter values affecting the minimum background level shall be specified.

B 2.5 Characteristic

The relationship between input value and output value shall be checked over the entire measurement range.

B 2.6 Time Behavior

The time behavior of the output signal with respect to a sudden increase or decrease of the measurement value or input value shall be tested.

B 2.7 Resistance to Overshooting

It shall be ascertained by tests that a measured value exceeding the full-scale value of the measurement range is not displayed at a value smaller than the full-scale value of the measurement range. For example and provided the data sheet does not specify otherwise, a measured value of up to ten times the full-scale value of the measurement range shall not be displayed at a value smaller than the full-scale value of the measurement range.

B 2.8 Adjustable Parameters

The adjustment accuracy of adjustable parameters and the effects of the adjustment of these parameters shall be tested. This test shall involve setting the parameters to at least the beginning value and the end value of the admissible range. Additional check points may result from the description of the measurement objective.

B 2.9 Ripple Content

The periodic and near-periodic fluctuations of the output signal shall be tested.

B 2.10 Characteristics of the Output Signal

The characteristics of the output signal shall be tested (e.g., impedance, pulse shape, amplitude).

B 2.11 Critical Load Tests

Individual values of the test parameters

a) input signal,
b) output load,
c) ambient temperature, and
d) auxiliary power

shall be combined at the limits of the nominal ranges of use. Restrictions with respect to the combinations of parameter values shall be substantiated.

B 2.12 Climate Tests

(1) Within the framework of the climate test it shall normally be certified that the functionality of the monitoring equipment is not harmed in any way by any admissible climatic loading during transport, storage and operation.

(2) A visual examination and an intermediate functional test should be performed after each climate test.

(3) In the case that maximum admissible temperature gradients are specified for the monitoring equipment, these gradients shall be taken into consideration when specifying the test conditions.

(4) Depending on the type and objective of the monitoring equipment, the following loadings shall be applied in individual steps.

B 2.12.1 Constant Low Temperatures

It shall normally be certified that the monitoring equipment is suited for transport or storage at low temperatures.

Implementation Example:

Starting at room temperature, the monitoring equipment in a shutdown condition shall be subjected for 24 hours to the minimum admissible storage temperature at a constant low temperature.

B 2.12.2 Constant Dry Heat

It shall normally be certified that the monitoring equipment is suited for transport or storage in dry heat.

Implementation Example:

Starting at room temperature, the monitoring equipment in a shut-down condition shall be subjected for 24 hours to the maximum admissible storage temperature at a constant dry heat.

B 2.12.3 Constant Heat and Humidity

It shall normally be certified that the monitoring equipment is suited to being operated at constant heat and high humidity.

Implementation Example:

Unless otherwise specified, the monitoring equipment for 24 hours shall be subjected to the following loading:

temperature: 40 °C ± 2 K

relative humidity: 93 ± 3 %

Operating condition: equipment in operation with the supply voltage cyclically changing between U_{max} and U_{min} after every 6 hours in the test.

B 2.13 Long-term Testing

It shall normally be certified that the monitoring equipment is suited for long-term operation with particular attention paid to the drift behavior of the equipment.

Implementation Example:

(1) The procedure specified under paras. 2 through 4 and the procedure under para. 5 are both suited for this certification.

(2) The initial temperature of the monitoring equipment shall be adjusted to the initial temperature, 25 °C ± 3 K, of the testing chamber.

(3) Within the next hour, the temperature in the testing chamber shall be increased to the maximum admissible ambient temperature for operating the monitoring equipment, T_{max}, in accordance with the data sheet.

(4) The monitoring equipment shall then be cyclically loaded as follows:

a) The cycle period shall be 24 hours.

b) In each cycle, the stress at the upper temperature (T_{max}) shall last at least 20 hours, and at the lower temperature, 25 °C ± 3 K, at least two hours.

c) The monitoring equipment shall be in operation and the supply voltage shall change periodically between U_{max} and U_{min} every time 24 hours of the test duration have passed. Intermediate values of the supply voltage in accordance with the data sheet are admissible during the change of the supply voltage.

d) The test duration shall be at least 1000 hours.

(5) The monitoring equipment shall be operated for 24 months under conditions that are characteristic for its assigned location (e.g., trial operation inside a nuclear power plant). It is admissible to perform this trial operation after completion of the type test.

B 2.14 Mechanical Loading

(1) If the measurement objective so requires, the functional certification shall also encompass induced vibrations from

a) vibrations at the assigned location (e.g., near a pipe line),

b) earthquakes,

c) aircraft crash.

(2) It shall be certified that the functionality of the monitoring equipment is not impaired by the specified mechanical loadings.

Implementation Example:

(1) The test object shall be in operation and in its regular mounting position when being loaded.

(2) The loading shall normally be applied in both directions on all three coordinate axes. The monitoring equipment shall be mounted to the test facility such that it is as specified in the equipment documentation for the assigned location. In the case of rotationally symmetric monitoring equipment, the loading needs only be applied in axial and radial directions.

(3) An interim functional test shall normally be carried out before and after the individual type of loading.

B 2.15 Certification of Radiation Resistance

In the case that monitoring equipment is intended for operation under radiation exposure during specified normal operation, the resistance to radiation in accordance with the LCC shall be certified. If, in addition, an integrally absorbed dose is specified for the monitoring equipment, it shall be certified that the monitoring equipment remains functional even after an absorption of this dose. These certifications shall be performed experimentally or theoretically. The sources of the data used in the theoretical analysis shall be cited.

B 2.16 Tests under Ambient Conditions from Design Basis Accidents

(1) In the case that monitoring equipment is intended for operation under ambient conditions from design basis accidents, its behavior under pressure, temperature, humidity and radiation shall be investigated for the values specified in the LCC for ambient conditions from design basis accidents including their duration.

(2) In the case that monitoring equipment is intended for operation under radiation exposure during design basis accidents, the resistance to radiation in accordance with the LCC shall be certified. This shall be carried out by performing a radiation test or an analytical analysis. The sources for the data used in the theoretical analysis shall be cited.

(3) An interim functional test shall normally be performed before and after the individual loading type.

Implementation Example
regarding the behavior under pressure, temperature and humidity:

(1) The load-over-time sequence of the test shall be specified in a diagram (test curve). This diagram shall normally include the values for pressure, temperature and humidity, the rising and falling gradients and dwelling times, as well as their admissible deviations. The test object shall be subjected to these loadings.

(2) The monitoring equipment shall be in operation and in the orientation of its regular mounting position. The input and output values shall be recorded.

(3) The testing facility shall be designed such that

a) the steam exits are positioned such that the test objects will not be subjected to a steam jet or, at least, that a dispersion barrier is inserted, and

b) the temperature sensors to determine the temperature of the testing chamber are neither positioned in the steam jet nor on the test object.

Implementation Example
regarding the behavior under radiation exposure:

(1) If an irradiation test is performed to certify radiation resistance, then the testing parameters regarding absorbed dose and absorbed dose rate shall be specified as a function of the particular operating conditions.

(2) The monitoring equipment shall be in operation when subjected to the irradiation test. The input and output values shall be recorded.

(3) The following requirements shall be met by the test::

a) The monitoring equipment may be irradiated with gamma rays and under atmospheric conditions (oxygen content of the air).

b) It shall be assured that the measurement uncertainty of the dosimetric measurement procedure does not exceed ± 30 % of the measured value. The choice of the measurement procedure may be left up to the division performing the test.

c) The test object shall normally be subjected to an ambient climate of a temperature from 18 °C to 28 °C (tolerance ± 2 K) and a humidity up to 75 %. If the required temperature constancy cannot be achieved, then the ambient temperature shall be recorded during irradiation.

B 2.17 Electrical Characteristics

B 2.17.1 Current Drain

The maximum current drain of the equipment shall be determined.

B 2.17.2 Power Dissipation

The maximum occurring power dissipation of the equipment shall be determined with regard to heat radiation.

B 2.17.3 Behavior of the Test Object During Plug-Insertion

If the electrical input and output current circuits are designed as plug-in connections, they shall be plugged in and unplugged many times.

Implementation Example:

(1) If the plug-insertion is designed, e.g., for inservice inspections then the number of plugging cycles shall normally equal 100.

(2) In the case of plug-in connections to be used only on special occasions, e.g., during repair of the equipment, they shall be plugged in and unplugged ten times.

(3) The tests shall be performed under load, unless this is prohibited by the manufacturer.

B 2.17.4 Power Interruption

A test shall be performed to check whether or not a power interruption would cause a malfunction of the equipment.

Note:
In the case of alternating-current-operated equipment, a design allowing for a power interruption of up to 150 ms would be advantageous with regard to a busbar switching.

B 2.17.5 Power Loss and Return of Power

The restart capability of the system after an equipment failure caused by power loss shall be determined in practical tests. Which combination of partial failures have to be considered in these practical tests shall be determined within the framework of reviewing the device documents specified under Section 5. It shall also be determined whether or not a malfunction can occur on account of a non-specified sequence of the return to function of partial systems.

B 2.17.6 Short-Circuit Resistance

The short-circuit resistance of signal output sockets and power supply sockets shall be tested with regard to safety against cause of fire and destruction of the equipment.

B 2.17.7 Non-Interaction

It shall certified that there is no interaction between the individual output sockets.

B 2.17.8 Insulation Resistance

The insulation resistance shall be checked experimentally to be in accordance with the specifications in the LCC.

B 2.17.9 Tendency for Electrical Oscillations

In case there is a tendency for electrical oscillations, this shall be checked under consideration of the specifications in the data sheet.

B 2.17.10 Input Signal-to-noise Ratio

The signal-to-noise ratio at the input shall be checked to be in accordance with the data in the LCC.

B 2.17.11 Electromagnetic Compatibility (EMC)

The electromagnetic compatibility of the monitoring equipment shall be checked experimentally. The requirements for this test shall be in accordance with the legal regulations. Certain requirements of the industrial EMC standards (DIN EN 61 000-6-2, DIN EN 61 000-6-4) may be deviated from, provided, this is well-founded based on the field of application.

B 2.18 Radiological Interference

The influence of background radiation on the sensor signal shall be determined. The designated shielding of the detector should be used when performing these measurements. The ambient radiation may be simulated by radiation sources. Typical radiation sources are Co 60 and Cs 137.

Implementation Example:

In case of an iodine monitor, the influence from background radiation caused by the measurement medium and by the preliminary filter and from radiation not caused by the measurement medium shall be determined. Aside from the local dose rate, other interfering radiation sources shall also be taken into account, e.g. the preliminary filter and internal radiation sources.

Appendix C

Regulations Referred to in this Safety Standard

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

Atomic Energy Act		Act on the peaceful utilization of atomic energy and the protection against its hazards (Atomic Energy Act) of December 23, 1959 (BGBl. I, p. 814) in the version of July 15, 1985 (BGBl. I, p. 1565), most recently changed by Act of April 22, 2002 (BGBl. I, 2002, No. 26)
StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance - StrlSchV) of July 20, 2001 (BGBl. I, p. 1714, 2002 p. 1459), most recently changed by Article 2 of the Ordinance of June 18, 2002 (BGBl. I, p. 1869)
KTA 1401	(06/96)	General requirements regarding quality assurance
KTA 1501	(06/91)	Stationary system for monitoring local dose rates within nuclear power plants
KTA 1502.1	(06/86)	Monitoring radioactivity in the inner atmosphere of nuclear power plants; Part 1: Nuclear power plants with light water reactors
KTA 1503.1	(06/02)	Surveillance of the release of gaseous and aerosol-bound radioactive substances; Part 1: Surveillance of the release of radioactive substances with the stack exhaust air during specified normal operation
KTA 1503.2	(06/99)	Surveillance of the release of gaseous and aerosol-bound radioactive substances; Part 2: Surveillance of the release of radioactive substances with the stack exhaust air during design basis accidents
KTA 1503.3	(06/99)	Surveillance of the release of gaseous and aerosol-bound radioactive substances; Part 3: Surveillance of radioactive substances not discharged with the stack exhaust air
KTA 1504	(06/94)	Monitoring and assessing of radioactive substances in liquid effluents
KTA 1506	(06/86)	Measuring local dose rates in exclusion areas of nuclear power plants
KTA 1507	(06/98)	Monitoring and assessing of the discharge of radioactive substances from research reactors
DIN EN 61 000-6-2	(08/02)	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards: Immunity for industrial environments (IEC 61000-6-2:1999, modified); German version EN 61000-6-2:2001
DIN EN 61 000-6-4	(08/02)	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards; Emission standard for industrial environments (IEC 61000-6-4:1997, modified); German version EN 61000-6-4:2001
DIN IEC 60 780	(12/00)	Nuclear power plants - Electrical equipment of the safety system - Qualification (IEC 60780:1998)