Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 1502.2 (06/89)

Monitoring Radioactivity in the Inner Atmosphere of Nuclear Power Plants
Part 2: Nuclear Power Plants with High Temperature Reactor

(Überwachung der Radioaktivität in der Raumluft von Kernkraftwerken
Teil 2: Kernkraftwerke mit Hochtemperaturreaktor)

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

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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 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 damage arising from the construction and operation of the facility (Sec. 7 para. 2 no. 3 Atomic Energy Act), in order to attain in particular the protective goals specified in the Atomic Energy Act and the Radiological Protection Ordinance.

(2) Relevant acts, ordinances and rules of the, Federation and the federal states as well as relevant technical codes are taken into account in developing KTA safety standards.

(3) Among other things, the radiation and activity monitoring serves to protect persons inside and outside the plant against ionizing radiation, for the surveillance of specified normal activity management of solid, liquid and gaseous radioactive substances inside the plant as well, as the monitoring of the discharge of radioactive substances.

(4) The monitoring of radioactive substances in the inner atmosphere during specified normal operation should make a contribution to the fulfillment of the provisions of Sec. 28 para. 1 and Sec. 46 para. 1 no. 2 StrlSchV by means of the following:

a) automatic activation of signals when alarm levels for the detection of increased activity concentrations in the inner atmosphere and for the initiation of the required measures are exceeded,

b) identification of the respective room groups in which an increased activity concentration leads to an activity increase in the stack discharge,

c) indication of leaking systems or components containing, radioactive substances (leakage monitoring of plant components),

d) registration of increased concentration in the inner atmosphere with a view to the protection of the personnel.

(5) The equipment required for these tasks are subdivided into:

- stationary measuring equipment and samplers, in particular for the monitoring of airborne radioactive substances in discharge air collection ducts,
- mobile measuring equipment (portable or transportable measuring devices as well as measuring devices with mobile sampling lines) and samplers for monitoring the atmosphere in rooms in particular with a view to radiological protection monitoring at workplaces.

(6) The monitoring of rooms or room groups is carried out by sampling from the discharge air collection ducts or directly from the inner atmosphere, if the purpose is to detect leaks from components and pipes conducting radioactive media and other releases of radioactive substances into the inner atmosphere. This task is primarily carried out by stationary measurement equipment. For discharges of radioactive substances through the stack, the monitoring in the discharge air collection ducts simplifies in locating the sources. The monitoring of rooms or room groups provides an indication of the average radioactivity concentration in the inner atmosphere and can thus help in making a decision regarding, the accessibility of rooms to the personnel and the deployment of further non-stationary measurement equipment. It also serves to identify radioactivity increase in the inner atmosphere to initiate the required measures in the case of radioactivity. releases from facilities and for the automatic activation of signals if alarm thresholds are exceeded. A determination of the radioactivity concentration at work locations, with possible locally increased radioactivity concentrations for radiological protection purposes is generally riot possible with this type of monitoring.

(7) In such cases, the monitoring of the atmosphere at workplaces is mainly effected by mobile measuring equipment or samplers. In individual cases, it may, however, also be effected by stationary measuring equipment installed at an appropriate location (directly near suction opening) if it is ensured that this equipment furnishes a measuring result that is representative of the atmosphere at the workplace. Besides, mobile measuring equipment and samplers are also used, for example, for the detection of leaks and for the determination of data for planning purposes prior to the performance of work.

1 Scope

(1) This safety standard for monitoring the radioactivity of the inner atmosphere applies to specified normal operation at stationary nuclear power plants.

Note:

At least 'in the initial phase of an incident, the stationary measuring equipment designed under the premises of specified normal operation in accordance with this safety standard still permits statements as outlined in para. (4) of the Basic Principles.

If, in the course of an incident, local measurements' with mobile equipment are, no longer possible, it may still be possible to make a laboratory evaluation of the samples taken locally.

(2) This Part 2 of the safety standard deals with nuclear power plants with high temperature reactors. Part 1 deals with nuclear power plants with light water reactors.

Note:

Within the scope of. this safety standard, high temperature reactors are meant to be helium-cooled graphite-moderated reactors.

2 Definitions

(1) Discharge air duct

A discharge air duct is a ventilation duct through which the discharge air from a room is conducted.

(2) Discharge air collection duct

A discharge air collection duct is a ventilation duct trough which the discharge air from a room group is conducted to the stack.

(3) Monitoring

Monitoring is a collective term covering all types of a controlled determination of physical parameters, including a comparison with specified values.

Note:

Monitoring is carried out by

a) continuous measuring, or

b) intermittent evaluation of samples (e.g. at a laboratory), or

c) the calculation of measuring results by means of an analytical combination of measured values, each in conjunction with a comparison of set values of physical parameters (e.g. limits).

(4) Measuring equipment

Measuring equipment comprises all measuring devices and auxiliary devices which are needed to register a measured value transfer and adapt a measured signal and to display measured data *as* images of the parameters measured.

(Source: VDI/VDE 2600, Sheet 3, November 1973).

3 Rooms and Room Groups to be Monitored

3.1 General Requirements

The inner atmosphere of rooms into which radioactive substances may be released shall be monitored. Monitoring shall be carried out as follows:

a) With stationary, continuously operating measuring equipment using samples from the discharge air collection ducts of the room groups or at representative locations from the inner atmosphere.

Note:

The requirements for the equipment for monitoring the radioactivity in the inner atmosphere depend on the possibilities of a release of radioactive substances (noble gases, aerosols, tritium) into the inner atmosphere and the design of the ventilation systems (e.g. recirculation air filtration, air change constants).

The monitoring of radioactive substances in the air of a discharge air collection duct makes .it possible to detect well in time an increase in the contamination of the air in the associated rooms.

b) With mobile measuring equipment and samplers
   - at workplaces for the protection of personnel if the possibility of a relevant incorporation in the context of radiological protection exists,
   - if it is necessary to localize a leakage.

c) By sampling at the sampling nozzles to be provided in accordance with Section 4.1.1.4.

3.2 Monitoring with Stationary; Continuously, Operating Measuring Equipment

3.2.1 Room Groups to be Monitored

For monitoring purposes, the rooms are allocated to certain room groups. This allocation depends on the nuclides or nuclide groups which serve as measuring objects for the detection of an increased radioactivity, in the room air. The following room groups shall be monitored separately:

a) Room Group 1:

Rooms confining those plant components which contain or may contain unpurified primary coolant.

Note:

These include the pressure boundary of the primary circuit, the refueling machine, the primary coolant purification system from the pressure boundary up to behind the dust filter system and the gas analyzer.

b) Room Group 2:

Rooms confining these plant components which contain primary coolant after it has been passed through dust filters.

Note:

These include the primary coolant purification system behind the dust filter system, the regeneration system; the tritium collection system and the off-gas storage system.

c) Room Group 3:

Turbine building (water/steam circuit).

3.2.2 Items to be Measured

Monitoring with stationary ,measuring equipment *in* accordance with Section 3.1 a) shall comprise the nuclide groups listed in **Table 3-1** with respect to the various room groups n accordance with Section 3.2.1.

Room Group	Aerosols	Noble Gases	Tritium
Group 1	x	x	-
Group2	-	x	x
Group 3	-	-	x

Table 3-1: Groups of radionuclides to be monitored with stationery, continuously operating measuring equipment

3.3 Monitoring with Mobile Measuring Equipment or Samplers

If monitoring by means of mobile measuring equipment or samplers in accordance with Section 3.1 b) is required, it shall be effected to detect noble gases, aerosols or tritium, depending on the kind of air contamination expected.

4 Measuring Methods

4.1 General Requirements

4.1.1 Sampling

4.1.1.1 Inflow Velocity into the Sampling Pipe

When taking aerosol samples; the inflow velocity. into. the sampling pipe shall be equal to the flow velocity in the discharge air collection duct during normal operation of the ventilation system.

4.1.1.2 Sampling Location

As a rule, the taking of air samples at the axis of the discharge air collection duct is sufficient.

4.1.1.3 Sampling Lines

Sampling lines for mobile measuring equipment which serve the measurement of aerosol and tritium activity should be as short as possible; their radii should be large in relation to the diameter of the. lines; and they should consist of a material on which the sedimentation of tritium and aerosols is very low. When monitoring tritium it shall be ensured that no condensation will occur inside the sampling line. Prior to commissioning, the activity losses in the sampling fine shall be estimated and described by means of a loss factor. As soon as the operating conditions permit after the commissioning of the plant, an experimental verification of the loss factor should be performed unless the results measured at other plants can be transferred. There shall also be a possibility of checking the loss factor experimentally at a later time in order to be able to take into account changes which may result e.g. from deposits in the sampling lines.

Note:

Quantitative data for a theoretical estimate of the activity losses can be taken from DIN 25 423, Annex 1.

4.1.1.4 Sampling Nozzles at the Discharge Air Collection Ducts

For an intermittent sampling from the discharge air collection ducts, sampling nozzles shall be provided for taking air samples.

Note:

For the localization of activity release locations, an installation of sampling nozzles at the individual discharge air ducts may be appropriate.

4.1.1.5 Representativity of Sampling at the Workplace

In the process of workplace monitoring, the air contamination at the sampling location should correspond to the air contamination at the workplace.

4.1.1.6 Filter Mount and Sampling System

Care shall be taken to make sure that the measured results are not invalidated by a contamination of the sampling system and in particular of the filter mount. The filters used in aerosol

sampling shall be easy to exchange. The leak air flow shall remain negligible as compared with the sampling part flow.

4.1.2 Installation of the Measuring Equipment

The measuring equipment shall be installed in such a way that it will be sufficiently protected against influences preventing its perfect functioning, such as background radiation at the location, of the detector. The measuring equipment shall be easily accessible as far as testing, maintenance and repair are concerned.

Note:

Especially for the measuring of aerosols the requirements for easy accessibility: and good shielding of the measuring equipment is to be weighted against the requirement for short sampling lines in accordance with Section 4.1.1.3.

4.1.3 Design of the Measuring Equipmentagainst Ambient Influences

(1) Both the stationary and the mobile measuring equipment shall be designed to cope with the ambient conditions and those of the measuring medium as specified in **Table 4-1** as well as with the range of operating voltages quoted there.

(2) In the case of a variation of one influence parameter at a time within the nominal ranges quoted in **Table 4-1**, the measured value shall, only vary by t 30% as compared with the measured value which results with respect to the reference value of the parameter under review if all the‘ other parameters (including filter loading and background radiation) with the exception of the pressure of the ambient air near the reference values remain unchanged as far as possible. In this context, however, a pressure difference of 200 hPa between the measuring medium and the ambient should not be exceeded, and those conditions are excluded in which the moisture in the measuring medium would condensers.

(3) The reference values for the parameters quoted: in **Table 4-1**, Column 1, are specified in **Table 4-1**, Column 3. The reference value fox the filter loading is the unloaded condition, and fox background radiation a value specified by the manufacturer.

4.1.4 Sensitivity for Other Types of Radiation

In the case of gamma-sensitive detectors, the sensitivity for the beta radiation of strontium 90 and/or yttrium 90, and in the case of beta-sensitive detectors, that for the gamma radiation of cobalt 60 or cesium 137, shall be known.

4.1.5 Adjustment Devices

Equipment which has to be readjusted during operation shall be provided with adjustment devices. All. adjustment devices of the electronic equipment of the measuring equipment shall be arranged and secured in such a way that changes by unauthorized persons are rendered difficult. Any selfinduced change shall be excluded.

4.1.6 Counting Rate Losses and Overmodulation Restistance

Possible counting rate losses of the measuring equipment (e.g. as a result of dead times) within the measuring range shall be known as a function of the counting rate and shall be taken into consideration. A decrease of the display with an increase in the variable to be measured (overmodulation) shall not occur.

4.1.7 Limit Value Indicators and Alarm Units

(1) The measuring equipment shall be provided with one limit value indicator for equipment failure and at least one limit value indicator for an upper alarm level.

(2) In the case of stationary measuring equipment, values below the lower limit shall result in an annunciation of an equipment failure, and any exceeding of the upper alarm level to a visual and audible signal in the control room. Group alarms may be used in the control room if it can be determined either in the control room or in an ancillary room from which measuring point the signal comes. If the acoustic signals are cancelled, either individually or collectively, before their causes are removed, the visual displays shall continue to indicate the respective signal status, i.e. failure signal or the exceeding of the upper alarm level, in the control room.

(3) It shall be possible to connect audible and visual alarm units to mobile measuring equipment.

4.1.8 Continuous Supply of Power and Operating Media

(1) If an operating medium such as counter gas is needed for stationary measuring location, supply of the operating medium shall be designed in a failproof way and shall be monitored.

(2) Electric loads of stationary measuring equipment shall be connected to the emergency power supply system. Stationary measuring equipment shall be designed to be self-monitoring It shall be made sure (e.g. by connection to the continuous emergency power supply) that the operability of the measuring equipment will not be affected in an inadmissible way after changeover to an emergency power supply system.

4.1.9 Detection Limits, Statistical Confidence Level

(1) The detection limits specified in Sections 4.2.1, 4.2.2.1 (2) and 4.2.2.2 (2) shall be attained with a statistical confidence level of 2 sigma.

(2) The detection limits in accordance with Section 4.2.1, Section 4.2.1.1 (2) and Section 4.2:2.2 (2) as well as the requirements contained in Section 4.2.1.3 (3) and (4) and in Section 4.2.2.3 (3) and (5) apply if all the parameters and reference values have been set in accordance with Section 4.1.3.

(3) The requirements contained in Section 4.2:1.1 (2) and (3), Section 4.2:1.2 (2) and (3), Section 4.2.1.3 (3) through (5); Section 4.2.2.1 (2) and (3), Section 4.2.2.2 (2) and (3) as well as Section 4.2.2.3 (3) through (6) apply to the parameter settings of the measuring equipment which have been preset for specified normal operation:

4.2 Special Requirements for the Monitoring of Radionuclide Groups

4.2.1 Monitoring with Stationary Measuring Equipment

4.2.1.1 Noble Gases

(1) The continuous monitoring of the activity concentration of radioactive noble gases with stationary measuring equipment shall be effected by an integrated beta measurement. To prevent any invalidation of the data measured by aerosol contamination, the measuring equipment shall be provided with an upstream Class S HEPA filter in accordance with DIN 24 184.

(2) The detection limit of the measuring equipment shall be lower than 10^4 Bq • m^{-3} in relation to xenon 133.

(3) The upper limit of the measuring range shall be at least $5 \cdot 10^8$ Bq•m^{-3}.

(4) The volume flow of the sampling system shall be monitored. In the case of stationary measuring equipment, the failure shall be indicated by audible and visual signals in the control room.

4.2.1.2 Tritium

When measuring tritium, disturbances by radioactive noble gases may occur and shall be taken into account when interpreting the data measured.

(1) The continuous monitoring of the activity concentration of tritium by means of stationary measuring equipment shall be effected by a flow counter using beta measurement. To prevent any invalidation of measured data by aerosol contamination, the measuring equipment shall be provided with an upstream Class S HEPA filter in accordance with DIN 24 184.

(2) The detection limit of the measuring equipment shall be lower than 10^3 Bq•m^{-3}. The reference nuclide shall be tritium.

(3) The upper limit of the measuring range of the stationary measuring equipment shall be at least $5 \cdot 10^5$ Bq•m^{-3} for Compartment Group 3, or otherwise 10^8 Bq•m^{-3}.

(4) The volume flow of the sampling system shall be monitored. Any failure shall be indicated by audible and visual signals in the control room.

4.2.1.3 Aerosols

Note:

When measuring aerosols, disturbances may occur, for example by natural aerosols separated in the filters and by noble gases; these disturbances shall be taken into account when interpreting the data measured.

(1) The continuous monitoring of radioactive aerosols shall be carried out with an accumulation of the aerosols from a constant part flow on a Class S HEPA filter in accordance with DIN 24 184 and simultaneous measurement of the activity of the radioactive aerosols accumulated on the filter.

(2) The ionizing radiation originating from the filter load shall be used to establish a value which is a measure of the activity load of the HEPA filter (e.g. detector pulse rate) or a measure of the activity concentration in the air monitored (e.g. velocity of change of the detector pulse rate, if necessary with decay compensation). The background of the detector signal and the influence of natural radioactive aerosols on the detector signal may be suppressed when transforming the detector signal.

(3) The measuring equipment shall be designed in such a way that, with a previously unloaded HEPA filter, a short-term activity concentration with a time integral of 10 Bq•m^{-3}•h will cause, within one hour, a change of the indication by at least two times the standard deviation of the value measured in the case of an unloaded filter (for checking this requirement, see Section 5.2.4.2 (2)). If both the measured value for the activity loading and the measured value, for the activity concentration are indicated, this condition need only be met with respect to one of the measured values.

(4) Any exceeding of a preset activity loading of the HEPA filter shall be indicated by a clearly perceptible signal. The value of this level shall be chosen in such a way that, in the case of the associated activity loading, a short-term activity concentration with a time integral of 500 Bq•m^{-3}•h will cause, within one hour, a perceptible change of the indication by at least two times the standard deviation of the measured value in the case of an activity loading corresponding to the level mentioned (for checking this requirement, see Section 5.2.4.2 (2)). If both the measured value for the activity loading and the measured value for the activity concentration are indicated, this condition need only be met with respect to one of the measured values.

(5) The measuring equipment shall permit the formation of the measured value in accordance with pare. (2) and its indication and recording up to an activity concentration of $5 \cdot 10^4$ Bq•m^{-3} with a time integral of the activity concentration of 10^5 Bq•m^{-3}•h.

(6) The reference nuclides for the requirements in accordance with pares. (3) through (5) shall be cobalt 60 for gamma measurements and strontium 90 / yttrium 90 for beta measurements.

(7) The volume flow of the part flow from which the accumulation occurs shall be monitored. Any deviation from the required value by more than 20% shall be indicated by visual and audible means in the control room.

4.2.2 Monitoring with Mobile Measuring Equipment

4.2.2.1 Noble Gases

(1) Monitoring of the activity concentration of radioactive noble gases with mobile measuring equipment shall be carried out by an integrated beta measurement. To prevent any invalidation of the data measured by aerosol contamination, the measuring equipment shall be provided with an upstream Class S HEPA filter in accordance with DIN 24 184.

(2) The detection limit of the measuring equipment shall be lower than 10^4 Bq•m^{-3} in relation to xenon 133.

(3) The upper limit of the measuring range shall be at least $5 \cdot 10^7$ Bq•m^{-3}.

(4) The volume flow of the sampling system shall be monitored. Any failure shall be indicated by audible and visual signals on the measuring equipment.

4.2.2.2 Tritium

Note:

When measuring tritium, disturbances by radioactive noble gases may occur and shall be taken into account when interpreting the data measured.

(1) The monitoring of the activity concentration of tritium with mobile measuring equipment shall be carried out by a flow counter using beta measurement. To prevent any invalidation of measured data by aerosol contamination, the measuring equipment shall be provided with an upstream Class S HEPA filter in accordance with DIN 24 184.

(2) The detection limit of the measuring equipment shall be lower than 10^3 Bq•m^{-3}. The reference nuclide shall be tritium.

(3) The upper limit of the measuring range shall be at least 10^8 Bq•m^{-3}.

(4) The volume flow of the sampling system shall be monitored. Any failure shall be indicated by audible and visual signals on the measuring equipment.

4.2.2.3 Aerosols

Note:

When measuring aerosols, disturbances may occur, for example by natural aerosols separated is the filters and by noble gases; these disturbances shall be taken into account when interpreting the data measured.

(1) The monitoring of radioactive aerosols with mobile measuring equipment shall be carried out by means of an accumulation of the aerosols from a constant air flow on a Class

S HEPA filter in accordance with DIN 24 184 and measurement of the activity of the radioactive aerosols accumulated on the filter, either during the accumulation process (direct measurement) or by subsequent laboratory evaluation of the loaded filter. If the end of the dial is reached during direct measurements it shall be checked whether or not a laboratory evaluation of the filters will be necessary.

(2) In the case of direct measurements, the ionizing radiation originating from the filter load shall be used to establish a value which is a measure of the activity load of the HEPA filter (e.g. detector pulse rate) or a measure of the activity concentration in the air monitored (e.g. velocity of change of the detector pulse rate, if necessary with decay compensation). The background of the detector signal and the influence of natural radioactive aerosols on the detector signal may be suppressed when transforming the detector signal. During the laboratory evaluation, the ionizing radiation originating from the filter load shall be measured, and the activity loading of the HEPA filter shall be determined on the basis of the detector pulse rate.

(3) The measuring equipment for direct measurements shall be designed in such a way that, with a previously unloaded HEPA filter, a short-term activity concentration with a time integral of 10 $Bq \cdot m^{-3} \cdot h$ will cause, within one hour, a change of the indication by at least two times the standard deviation of the value measured in the case of an unloaded filter (for checking this requirement, see Section 5.2.4.2 (2)). If both the measured value for the activity loading and the measured value for the activity concentration are indicated, this condition need only be met with respect to one of the measured values.

(4) In the case of laboratory evaluations, the sampling equipment shall be designed in such a way that in connection with the measuring equipment available at the laboratory an activity concentration of 5 $Bq \cdot m^{-3}$ can be recorded within two hours of the beginning of sampling with a confidence level of 2 sigma (for checking this requirement, see Section 5.2.4.2 (2)).

(5) If direct measurements are used locally to supplement laboratory evaluations for workplace monitoring purposes, the respective equipment shall be designed in such a way that, with a previously unloaded HEPA filter, a short-term activity concentration with a time integral of 10^2 $Bq \cdot m^{-3} \cdot h$ causes, within one hour, a change of the measured value by at least twice the standard deviation of the value measured in the case of an unloaded filter (for checking this requirement, see Section 5.2.4.2 (2)).

(6) For direct measurements in accordance with para. (3) the measuring equipment shall permit the formation of the measured value and its indication up to an activity concentration of $5 \cdot 10^4$ $Bq \cdot m^{-3}$ with a time integral of the activity concentration of 10^5 $Bq \cdot m^{-3} \cdot h$.

(7) The reference nuclides for the requirements in accordance with paras. (3) through (6) shall be cobalt 60 for gamma measurements and strontium 90 / yttrium 90 for beta measurements.

(8) The volume flow of the air flow from which the accumulation occurs shall be monitored. Any deviation, from the required value by more than 20% shall be indicated locally by visual and audible means.

4.3 Display, Registration and Storage of Measured Values

Note:

If it is sufficient within the scope of the measuring task, an indication of the pulse rate in s^{-1} or of the pulse rate change in s^{-2} may be provided instead of an indication of the filter loading in Bq and the activity concentration in $Bq \cdot m^{-3}$.

4.3.1 Monitoring with of Stationary Measuring Equipment

(1) In the case of stationary measuring equipment, the values measured shall be displayed and recorded in the control room and shall be capable of being displayed in the area of the measuring equipment.

(2) In the case of analog registration, multichannel recorders or dot matrix printers may be used. These shall be occupied with a maximum of 6 values to be measured. The values recorded on the recording paper shall be easily legible and shall be. directly visible over a period of at least 4 hours.

(3) In the case of equipment with multi-range displays, the current display range shall be indicated on the recording paper.

(4) If the indication of the measured values is effected exclusively with linear scale marks, an automatic range selection shall be provided.

(5) The recording paper shall be kept for at least 2 years.

4.3.2 Monitoring with Mobile Measuring Equipment

(1) In the case of monitoring with mobile measuring equipment, the measured values shall be displayed on the measuring equipment.

(2) If, with respect to aerosol monitoring with mobile equipment within the scope of workplace monitoring, the activity in a cubic meter of air exceeds 1/15 of the annual activity intake in accordance with Annex IV, Tables IV 1 and IV 2 StrlSchV, the values measured shall be recorded.

Note:

If the measurements are for purposes of personnel monitoring, the records shall be kept in accordance with Sec. 66 StrlSchV.

5 Maintenance and Testing

5.1 Maintenance

5.1.1 Execution

Maintenance work on the measuring equipment shall be carried out by qualified persons in accordance with the relevant operating and maintenance instructions.

5.1.2 Documentation

The maintenance work shall be documented. The records shall contain at least the following information:

a) unambiguous identification of the measuring equipment,
b) type of maintenance carried out,
c) date of maintenance,
d) names and signatures of the persons carrying out the maintenance.

5.2 Tests

5.2.1 Testability

The measuring equipment shall be designed and constructed in such a way that the proper functioning of the individual devices can be determined in the course of initial testing in accordance with Section 5.2.4 and tests after commissioning in accordance with Section 5.2.5. The tests shall be possible without any interference with the circuitry (e.g. soldering).

5.2.2 Test Schedule,

Type and extent of the tests shall be specified in a test schedule.

5.2.3 Test Certification

All the tests carried out, with the exception of visual inspections during inspection rounds, shall be demonstrated by test certificates. The test certificates shall be stored in accordance with Sec. 72 para. 2 StrlSchV. They shall contain at least the following information:

a) date of the test,
b) test object,
c) type of test,
d) test records,
e) test results;
f) name and signature of the tester.

5.2.4 Initial Tests

5.2.4.1 General Requirements

The following tests shall be carried out on measuring equipment or its components:

a) demonstration of suitability in accordance with Section 5.2.4.2,
b) calibration in accordance with Section 5.2.4.3,
c) manufacturer's test in accordance with Section 5.2.4.4, and
d) commissioning test in accordance with, Section 5.2.4.5.

5.2.4.2 Demonstrations of Suitability

(1) Prior to its first-time use in a nuclear power plant, the measuring equipment shall be demonstrated to fulfill its tasks and comply with the specified requirements.

(2) Testing of the properties of the equipment in accordance with Sections 4.2.1.3 (3) and (4) and 4.2.2.3 (3), (4) and (5) may be carried out by means of solid preparations, computer simulation or analytically.

5.2.4.3 Calibration

(1) Prior to its first-time use, the measuring equipment shall be calibrated as follows (e.g. at a laboratory):

a) for noble gas monitoring: with xenon 133: with xenon 133 and krypton 85,
b) for aerosol monitoring:
   ba) beta measurements - with strontium 90/yttrium 90,
   bb) gamma measurements - with cobalt 60,
c) for tritium monitoring: with tritium.

(2) For calibration purposes, the reference values shall be set in accordance with Section 4.1.3 (3).

(3) The deviation of the displayed values from linearity shall be determined by means of test emitters at three measuring points of the range of filter loading. For this purpose, one such measuring point shall be located in the lowest, in the highest and in the middle decade of the range of filter loading. The deviation shall not exceed 30% of the respective required value.

(4) When calibrating the measuring equipment, a test emitter of a defined and reproducible geometry shall be used to determine a calibration value which will permit a later verification of the calibration and the use of other equipment of the same design. For this purpose, the following test emitters shall be provided:

a) for the equipment for noble gas monitoring: cesium 137 or strontium 90 / yttrium 90,
b) for the equipment for aerosol monitoring
   (ba) beta measurements: strontium 90 / yttrium 90 or cesium 137,
   (bb) gamma measurements: cobalt 60 or cesium 137,
c) for the equipment for tritium monitoring: tritium.

(5) The energy dependence.of the sensitivity of the measuring equipment shall be known for the following energy ranges:

a) for noble gases (beta radiation)	0.15 - 2.5 MeV
b) for aerosols (beta radiation)	0.15 - 2.5 MeV
c) for aerosols (gamma radiation).	0.2 = 1.5 MeV

5.2.4.4 Manufacturer's Test

(1) A manufacturer's test shall demonstrate due and proper manufacture and functioning of the measuring equipment.

(2) The manufacturer's test shall be carried out as production test and shall comprise at least the following:

a) visual inspection,
b) test of the initial value as a function of the specific operating voltage fluctuation,
c) test of the display by means of a pulse or current generator with at least one test value per decade of measuring range.

(3) The manufacturer's test shall be carried out by manufacturer's experts as well as with the participation of authorized experts as determined by the authority (in accordance with Sec. 20 of the Atomic Energy Act).

5.2.4.4 Commissioning Test

(1) For stationary measuring equipment, the commissioning test after installation in the nuclear power plant shall demonstrate the proper construction and functioning of the measuring equipment. The following minimum tests shall be performed:

a) construction of the sampling system,
b) installation of the measuring equipment,
c) dynamic behavior on the basis of at least one test value per decade of measuring range by means of test emitters in accordance with Section 5.2.4.3. (4) or by means of a pulse or current generator,
d) calibration by means of a test emitter in accordance with Section 5.2.4.3. (4),
e) limit value monitor,
f) connection to the emergency power system,
g) flow monitoring,
h) measured value processing (signals, actions), and
i) service media supply (e.g. counter gas).

(2) For the tests in accordance with para. 1 c) and d), the deviation from the required value shall not exceed ± 50%.

(3) For mobile measuring equipment, the commissioning test shall be limited to para. 1 c) through e).

(4) The commissioning test shall be carried out by the licensee and with the participation of authorized experts chosen by the authority (in accordance with Sec. 20 of the Atomic Energy Act).

5.2.5 Tests after Commissioning

5.2.5.1 General Requirements

(1) The following tests shall be carried out on to the measuring equipment:

- periodic in-service inspections
- tests after repairs.

(2) These tests shall be carried out on the basis of test records compiling the test methods allocated to the various tests. The test records should contain the following information:

a) test specification or test instruction,
b) item tested and location of test,
c) testing equipment to be used,
d) testing conditions,
e) required values, and,
f) testing intervals.

5.2.5.2 Periodic In-service Inspections

(1) The proper functioninG of the measuring equipment shall be demonstrated by periodic in-service inspections. The tests to be carried out and the testing frequencies to be adhered to are specified in **Table 5-1**.

(2) The tests shall be carried out in accordance with **Table 5-1** by the licensee and by authorized experts in accordance with Sec. 20 of the Atomic Energy Act. The results shall be documented.

5.2.5.3 Test after Repair

If as a result of a repair functions of measuring equipment may have been affected as far as the items tested in accordance with Section 5.2.4.5 are concerned, the corresponding tests shall be carried out.

5.3 Removal of Defects

Defects detected and the measure taken to remove them shall be documented. The defects shall be removed immediately in the case of stationary measuring equipment and prior to the next application in the case of mobile equipment.

	Nominal Range of Use	Reference Value
Operating voltage		
AC voltage supply	85 % - 110 % of nominal operating voltage	manufacturer's specification
DC voltage supply	Specified voltage range of the DC voltage grid	manufacturer's specification
Ambient temperature[2]	15 °C to 40 °C	20 °C
Pressure of ambient air	900 hPa to 1100 hPa	1013 hPa
Relative humidity of ambient air[2]	10 % to 95 %	60 %
Temperature of measuring medium[2]	15 °C to 50 °C	20 °C
Pressure of measuring medium[2]	700 hPa to 1100 hPa	1013 hPa
Relative humidity of measuring medium[2]	10 % to 95 %	60 %
[1] Pressure difference between environment and measuring medium not exceeding 200 hPa.		
[2] Conditions where the moisture in the measuring gas condensates are excluded.		

Table 4-1: Nominal ranges of use arid reference values for influence parameters (cf. Section 4.1.3 (2)).

	Noble Gases		Tritium	
	stationary[1]	mobile[2]	stationary[3] room group 3	mobile[4] and stat. room group 2
Detection limit	10^4 Bq•m^{-3}.	10^4 Bq•m^{-3}	10^3 Bq•m^{-3}.	10^3 Bq•m^{-3}
Upper limit of measuring range	$5•10^8$ Bq•m^{-3}	$5•10^7$ Bq•m^{-3}	$5•10^7$ Bq•m^{-3}	10^8 Bq•m^{-3}
Reference nuclide	Xe 133		H 3	
[1] in accordance with Section 4.2.1.1 (2) and (3)			[3] in accordance with Section 4.2.1.2 (2) and (3)	
[2] in accordance with Section 4.2.2.2 (2) and (3)			[4] in accordance with Section 4.2.2.2 (2) and (3)	

Table 4-2: Characteristics of the noble gas measuring equipment and the directly operating tritium measuring equipment (non-accumulative measuring methods)

Aerosols			
	Direct Measurement[1]	Direct Measurement and Additional Laboratory Evaluation[2]	Sampling and Laboratory Evaluation[3]
Detectable minimum	10 $Bq \cdot m^{-3} \cdot h$	10^2 $Bq \cdot m^{-3} \cdot h$	5 $Bq \cdot m^{-3}$
Reference measuring time	1 h		2 h[4]
Maximum measurable up to a time interval of	$5 \cdot 10^4$ $Bq \cdot m^{-3}$ 10^5 $Bq \cdot m^{-3} \cdot h$		- -
Reference nuclides	Gamma measurement:		Co 60
	Beta measurement:		Sr 90 / Y 90

[1] in accordance with Section 4.2.1.3 (2) and (3) and (5) and Section 4.2.2.3 (3) and (6)

[2] in accordance with Section 4.2.2.3 (5)

[3] in accordance with Section 4.2.2.3 (4)

[4] from the beginning of sampling until availability of the result

Table 4-3: Characteristics of mobile aerosol measuring equipment as well as of sampling with laboratory evaluation for aerosols (accumulative measuring methods)

No.	Item Tested	Testing Method	Testing Frequency		
			stationary measuring equipment		mobile equipment
			by licensee	by experts under Sec. 20 of the Atomic Energy Act	by licensee*
1	Measuring Equipment	Visual Inspection	during inspection rounds	annually	during use
		Check of calibration with a test emitter in accordance with Section 5.2.4.5 d); for counter tubes, additional check of plateau	semi-annually	annually	at least annually
2	Testing and Maintenance Records	Inspection of records	-	annually	-
3	Electronic Assemblies	Inspection with test emitters or input of electric test signals into the transducers (at least one signal per decade of measuring range in accordance with Section 5.2.4.5 c) and d); comparison of all displays and recordings in relation to the input signal	annually	annually	annually
4	Signaling				
	Operability:	visual inspection	during inspection rounds	annually	during use
	Lower limit:	interruption of voltage input	semi-annually	annually	annually
	Upper alarm limit:	With test emitter or artificial excitation	semi-annually	annually	annually
5	Flow rate monitoring and supply of operating media				
	without automatic check of functions	visual inspection	during inspection rounds	annually	during use
	With automatic check of functions	comparison between desired value and actual value	semi-annually	annually	annually

* The testing frequency of mobile equipment by authorized experts in accordance with Sec. 20 of the Atomic Energy Act is specified by the authority on a case-by-case basis.

Table 5-1: Recurrent inservice inspections

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 versions that were valid when the latter regulations were established or

Atomic Energy Act		Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act); as amended on July 15, 1985 (BGB1. I, p. 1565)
StrlSchV		Ordinance on the Protection against Damage and Injuries Caused by Ionizing Radiation (Radiological Protection Ordinance) of October 13, 1976 (BGB1. I, p. 2905; 1977 I, p. 184, 269), as last amended by the Ordinance of May 22, 1981 (BGB1. I, p. 445)
DIN 24 184	(10/74)	Type Testing of Aerosol Filters