Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 1503.2 (2022-11)

Monitoring the Discharge of Radioactive Gases and Airborne Radioactive Particulates
Part 2: Monitoring the Discharge of Radioactive Matter with the Vent Stack Exhaust Air During Design-Basis Accidents

(Überwachung der Ableitung gasförmiger und an Schwebstoffen gebundener radioaktiver Stoffe
Teil 2: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei Störfällen)

The previous versions of this safety standard were issued in 1999-06, 2013-11 and 2017-11

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KTA SAFETY STANDARD

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Contents

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, 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 damage arising from the construction and operation of the plant (Sec. 7, para. (2), subpara. (3) Atomic Energy Act - AtG) in order to attain the protective goals specified in the AtG, the Radiation Protection Act (StrlSchG) and the Radiation Protection Ordinance (StrlSchV) as well as further detailed in the Safety Requirements for Nuclear Power Plants (SiAnf) and the Interpretations of the SiAnf.

(2) The stationary and the mobile radiation protection instrumentation serves, among others, in protecting the persons inside and outside of the facility from ionizing radiation, and in ascertaining the specified normal functioning order of the equipment

a) for keeping solid, liquid and gaseous radioactive substances within the provided enclosures,

b) for handling and the controlled conducting of radioactive substances within the facility, and

c) for monitoring the discharge of radioactive substances.

Concrete safety related requirements with regard to this instrumentation are specified in the safety standards of the series KTA 1500.

(3) The parts of safety standard KTA 1503 comprise the requirements regarding the technical equipment and additional organizational measures considered necessary with respect to monitoring the emissions of airborne radioactive substances into the environment of the power plant. These parts are, specifically:

Part 1: Monitoring the discharge of radioactive substances with the vent stack exhaust air during specified normal operation,

Part 2: Monitoring the discharge of radioactive substances with the vent stack exhaust air during design-basis accidents,

Part 3: Monitoring the non-stack discharge of radioactive substances.

(4) Monitoring the discharge of radioactive substances contributes to fulfilling the requirements specified under Sec. 8 StrlSchG, and Secs 99, 102 and 103 StrlSchV, in accordance of which it is required

a) that any exposure or contamination of man and environment must be minimized even to levels below the respective limit values specified in StrlSchG by taking into consideration the state of the art and by taking into account all circumstances of the individual situations (Sec. 8, para. (2) StrlSchG),

b) that no radioactive substances are discharged uncontrolled into the environment (Sec. 99, para. (4), StrlSchV), and

c) that discharges are monitored and reported to the proper authority at least once a year specifying their kind and activity (Sec. 103, para. (1) StrlSchV).

The monitoring equipment must fulfill the requirements under Sec. 90 StrlSchV.

(5) In accordance with Sec. 107 StrlSchV, it is required that, in the event of design-basis accidents and emergencies, all necessary measures are initiated without delay in order to minimize the danger to life, health and material goods. In accordance with Sec. 106, para (2) StrlSchV, it is required that, in preparation for an effective damage control and mitigation, the necessary auxiliary aids are kept in readiness. Basis for the decision to take these measures as well for their type, extent and duration is, among others, the monitoring performed with the accident measurement equipment for detecting radioactive substances discharged with the exhaust air from nuclear power plants. This monitoring of the discharge of radioactive substances serves in fulfilling the following tasks:

a) Providing data regarding the type and activity of the radioactive substances discharged as a consequence of a design-basis accident, and

b) Providing information needed for the decisions regarding necessary protective measures.

(6) It is decisive for the design of the instrumentation to know what information must be available during design-basis accidents and for what conditions the necessary measurement equipment must be designed. With respect to specified normal operation, this means that the required display ranges and the ranges of the influencing parameters must be expanded.

(7) By monitoring the activity of the discharged radioactive substances (emission monitoring) in combination with meteorological measurements and dispersion analyses on the one hand and direct measurements in the environment (immission monitoring) on the other, statements can be made about the radiological effects on the environment of the power plant. Whereas, during specified normal operation, the essential data is acquired by emission monitoring – here the data derived from immission monitoring lie within the margin of fluctuation of the natural radiation –, it is the immission monitoring that becomes ever more important during design-basis accidents because it enables identifying the radiological effects. In extreme cases, immission monitoring is practically the only measurement method to identify the radiological effects on the environment because the radioactive substances could also be discharged via other ways than those provided for discharging radioactive substances.

(8) The requirements specified in the present safety standard are intended to ensure that, in the case of those design-basis accidents where the results from emission monitoring are still of greater significance, this emission monitoring can be performed in a reliable way.

(9) The equipment required for fulfilling these tasks are subdivided as

a) stationary measuring or sampling equipment, and

b) mobile measurement equipment deployed for the nuclide specific measurements in the course of determining the activity of the cumulative samples specified under Section 3.

1 Scope

(1) This safety standard shall apply to the equipment for monitoring the discharge of gaseous radioactive substances and radioactive substances bound to aerosols with the vent stack exhaust air during and after design-basis accidents in nuclear power plants with light water reactors.

(2) The requirements specified in the present safety standard for the instrumentation take only those design-basis accidents into account where gaseous radioactive substances and radioactive substances bound to aerosols are discharged through the vent stack. In the case of design-basis accidents for which this monitoring of emitted radioactive substances cannot be assured, the monitoring must fall back on the measurements performed with the framework of environmental monitoring (immission monitoring).

(3) Measurement equipment for serious events that require plant-internal accident management measures are not within the scope of the present safety standard.

N o t e :

Plant-internal accident management measures may necessitate other requirements than those specified in the present safety standard.

2 Definitions

(1) Discharge rate

Discharge rate is the quotient of the amount of activity discharged and the time span in which this discharge occurred.

(2) Discharge of radioactive substances

Discharge of radioactive substances is the intentional release of liquid radioactive substances bound to aerosols or of gaseous radioactive substances from the power plant along paths provided for this purpose.

(3) Specified normal operation

Specified normal operation encompasses

a) Operating processes for which the plant, assuming the able function of all systems (fault free condition), is intended and suited (normal operation);
b) Operating processes which occur in the event of a component or system malfunction (fault condition) as far as safety related reasons do not oppose continued operation (abnormal operation);
c) Maintenance procedures (inspection, servicing, repair).

(4) Decision threshold

A decision threshold is a calculated value of a measurement parameter (e.g., activity, activity concentration, specific activity) for comparison with a measured value in order to decide whether this measurement parameter has contributed to the measurement or has had a zero effect.

Note:

(1) Decision thresholds are determined in accordance with DIN EN ISO 11929-1.

(2) Application examples are given in report KTA-GS 82.

(5) Release of radioactive substances

Release of radioactive substances is the escape or leakage of radioactive substances from the intended enclosures into the power plant or the environment.

(6) Cumulative beta activity

The cumulative beta activity is the activity determined by an integral measurement of the beta particles emitted by a radioactive substance and setting this value into relation to the reference nuclide used for calibrating the measurement equipment.

(7) Overall loss factor
(sampling airborne radioactive substances)

The overall loss factor is a correction factor to be applied when determining the discharge of airborne radioactive substances. It is, essentially, comprised of factors related to changes of the activity concentrations of airborne radioactive substances caused by

a) determination of the partial air stream with a sampling rake,
b) a non-isokinetic sampling,
c) the transport through the sampling pipe (pipe factor), and
d) the transport in the sampling and measurement equipment.

(8) Iodine fraction

An iodine fraction is that fraction of the iodine that, on account of its physical and chemical characteristics, can be selectively collected in special filter and absorption materials. According to the current state of science and technology these are the following fractions: elementary iodine, iodine bound to aerosols and organically bound iodine. Together, elementary iodine and organically bound iodine are referred to as gaseous iodine.

(9) Measurement equipment

Measurement equipment includes the entirety of all measuring and auxiliary devices required for determining a measurement parameter, for passing on and adjusting a measurement signal and for displaying the measured value as an image of the measurement parameter.

(10) Measurement medium

A measurement medium is that sample extracted from the monitored medium that flows through the measurement volume (i.e., that region for which the discrimination of the respective measurement equipment was determined during calibration) possibly after an engineering procedural treatment such as heating, filtration, dilution.

(11) Detection limit

The detection limit is a calculated value for a measurement parameter (e.g., activity, activity concentration, specific activity) meant to be compared to a predetermined reference value to help decide whether or not the measurement procedure is suitable for a particular measurement task.

Note:

(1) Detection limits are determined in accordance with DIN EN ISO 11929-1.

(2) Application examples are given in report KTA-GS 82.

(12) Design-basis accident

A design-basis accident is a chain of events upon the occurrence of which the plant operation or the work task cannot be continued for safety-related reasons and which, with respect to the plant operation, was considered in the plant design or for which, with respect to the work task, precautionary protective measures must be provided.

(13) Accident overview display equipment

Accident overview display equipment are those parts of the accident display equipment which display the essential measurement parameters describing the condition of the plant during design-basis accidents.

(14) Monitoring

Monitoring is a collective term for the various types of a controlled determination of physical parameters; monitoring includes comparing the results with previously specified values.

Note:

Monitoring is performed, e.g.,

a) by continuous measurements, or
b) by analyses of samples (e.g. in a laboratory), or
c) by a combination of selective measurement values, and

is always carried out in conjunction with a comparison of the results with previously specified values of the physical parameters (e.g., licensed limit values, operational values).

(15) Wide range display equipment

The wide range display equipment are those parts of the accident display equipment which display the measurement parameters specific to information about whether or not the plant parameters are approaching the design values of the activity barriers and which, in case these design values are exceeded, display the further development of those plant parameters.

3 Measurement Objects and Measurement Procedures

3.1 General Requirements

(1) During and after design-basis accidents the kind and activity of the discharged radioactive substances shall be determined in accordance with the requirements of the present safety standard. With respect to the measurement procedures and to the radiological significance of the discharged radioactive substances, it is necessary to distinguish between:

a) Radioactive noble gases,

b) Radioactive substances bound to aerosols and radioactive gaseous iodine (both, with the exception of Iodine-131),

c) Iodine-131 bound to aerosols and gaseous Iodine-131.

(2) The discharge of radioactive substances during and after design-basis accidents may also be monitored with the measurement equipment for monitoring the discharge of radioactive substances with the vent stack exhaust air during specified normal operation in accordance with KTA 1503.1. In this case, that equipment shall be additionally subject to the requirements under the present safety standard.

(3) Measurement equipment of the accident overview display equipment may be employed as part of the wide range display equipment, provided, they meet the additional requirements for the wide range display equipment.

(4) The discharge of radioactive substances shall normally be monitored within a partial air stream of the exhaust air. Measurements of the absorbed gamma ray dose rate may also be performed within or on the main air stream of the exhaust air.

(5) The exhaust air volumetric flow shall be continuously measured and recorded.

(6) The volumetric flows of the individual partial air streams of the exhaust air shall be monitored; a drop of the volumetric flows of the partial streams to below a certain threshold value shall be signaled in that area of the control room dedicated to emission monitoring.

(7) In the case of fire and an associated smoke removal through the vent stack, the discharge of radioactive noble gases shall be determined with a continuously measuring ionization chamber for the measurement as specified under Section 3.2.1.1 para. (1), item b). In this case it is sufficient to monitor the radioactive substances bound to aerosols and the radioactive gaseous iodine by the accumulation on a single filter which is later evaluated in the laboratory.

(8) Suitable measurement equipment shall be provided for the determination of the activity of cumulative samples as specified under Section 3 that take into consideration the maximum expected activity of the samples. The requirements for this measurement equipment are specified under Sections 5 and 6.

Note:
An overview of the measurements to be performed is presented in **Table 3-1**.

(9) The laboratories contracted by the operating utility shall have suitable certifications of being qualified in accordance with the Verification of the Licencee's Monitoring Guideline.

3.2 Radioactive Noble Gases

3.2.1 Accident overview display equipment

3.2.1.1 Continuous measurements

(1) The discharge of radioactive noble gases with the exhaust air shall be continuously monitored by measuring the activity concentration and the volumetric flow. The activity concentration shall be determined by the following two measurements:

a) Measurement of the cumulative beta activity concentration of radioactive noble gases, and

b) Measurement of the absorbed gamma ray dose rate.

(2) The measurement specified under para. (1), item a), shall be able to detect a activity concentrations in the range from 1×10^6 Bq/m^3 to 1×10^{11} Bq/m^3 with respect to Xenon-133, and the measurements specified under para. (1), item b), activity concentrations in the range from 1×10^7 Bq/m^3 to 1×10^{11} Bq/m^3 with respect to one 300 keV gamma ray per decay.

Note:
Additional requirements are specified under Section 6.2.1.2.

(3) Measurements with the measurement objective specified under para. (1), item a), may also be performed by the measurement equipment specified under Section 3.2.1.2 para. (4), provided, the measurement range required under para (2) is covered by that equipment.

(4) To reduce contamination in the case of the measurements under para. (1), item a), a high-efficiency particulate filter of at least Filter Class E12 in accordance with DIN EN 1822-1 as well as a filter with a minimum retention rate of 90 % for elementary iodine shall be placed in line before the measurement equipment.

3.2.1.2 Nuclide specific measurements

(1) The nuclide composition of the radioactive noble gases discharged with the exhaust air shall be determined based on gamma-spectrometric measurements.

(2) In case of a non-continuous determination of the nuclide composition of radioactive noble gases, a representative sample shall be taken basically in hourly intervals from the beginning on of a design-basis accident and for as long as it must be expected that a discharge related to the design-basis accident could occur that exceeds one of the licensed limit values of specified normal operation; these samples shall be evaluated without delay. It is permissible to prolong the interval between the samplings and nuclide specific evaluation to more than one hour, provided, the measured value of the noble gas measurement point for the measurement specified under Section 3.2.1.1 para. (1), item a), indicates that no significant changes have occurred.

(3) In case of a non-continuous determination of the nuclide composition, the activity discharge of individual noble gas nuclides shall be based on the activity concentration determined with the equipment for the measurement specified under Section 3.2.1.1 para. (1), item a). In case this measurement equipment fails, the nuclide specific activity concentration shall either be calculated from the absorbed gamma ray dose rate determined with the equipment for the measurement specified under Section 3.2.1.1 para. (1), item b), or shall be determined directly from the evaluation of the samples specified under para. (2). The samplings and nuclide specific evaluation shall be performed basically in hourly intervals; however, longer intervals than one hour are permissible, provided, the measured value of the noble gas measurement point for the measurement specified under Section 3.2.1.1 para. (1), item b), indicates that no significant changes have occurred.

(4) In case equipment is available with which the nuclide specific activity concentration of the noble gases discharged with the exhaust air can be determined continuously, then, within their measurement range for determining the activity discharge of the individual noble gas nuclides, this equipment should be used, instead of the procedures under paras. (2) and (3).

3.2.2 Wide range display

3.2.2.1 Continuous measurement

(1) The discharge of radioactive noble gases with the exhaust air shall be continuously monitored by measuring the activity concentration and the volumetric flow. The activity concentration shall be determined by one of the following measurements:

a) Measurement of the cumulative beta activity concentration of radioactive noble gases, or

b) Measurement of the absorbed gamma ray dose rate.

(2) The measurement specified under para. (1), item a), shall be able to detect a activity concentrations in the range from 1×10^{10} Bq/m³ to 1×10^{13} Bq/m³ with respect to Xenon-133, and the measurements specified under para. (1), item b), activity concentrations in the range from 1×10^{10} Bq/m³ to 1×10^{13} Bq/m³ with respect to one 300 keV gamma ray per decay.

Note:
Additional requirements are specified under Section 6.2.1.2.

3.2.2.2 Nuclide specific measurements

(1) The nuclide composition of the radioactive noble gases discharged with the exhaust air shall be determined based on gamma-spectrometric measurements.

(2) In case of a non-continuous determination of the nuclide composition of radioactive noble gases, a representative sample shall be taken in basically hourly intervals (from the beginning on of a design-basis accident); these samples shall be evaluated without delay. It is permissible to prolong the interval between the samplings and nuclide specific evaluation to more than one hour, provided, the measured value of the noble gas measurement point for the measurement specified under Section 3.2.1.1 para. (1), item a), indicates that no significant changes have occurred.

(3) In case of a non-continuous determination of the nuclide composition, the activity discharge of individual noble gas nuclides shall be based on the activity concentration determined with the equipment for the measurement specified under Section 3.2.2.1 para. (1), item a), or from the activity concentration calculated from the absorbed gamma ray dose rate determined with the equipment for the measurement specified under Section 3.2.2.1 para. (1), item b), or the nuclide specific discharge of activity discharge shall be determined directly from the evaluation of the samples specified under para. (2). Sampling and the nuclide specific evaluation shall basically be performed in hourly intervals; however, longer intervals than one hour are permissible, provided, the measured value of the noble gas measurement point for the measurement specified under Section 3.2.2.1 para. (1), item b), indicates that no essential changes have occurred.

Note:
The requirements of Section 3.2 are summarized in **Table 3-2**.

3.3 Radioactive Substances Bound to Aerosols and Radioactive Gaseous Iodine

3.3.1 Continuous measurements

3.3.1.1 General requirements

(1) The discharge of radioactive substances bound to aerosols and of radioactive gaseous iodine with the exhaust air shall be monitored by continuous measurements. To this end, the radioactive substances bound to aerosols and the radioactive gaseous iodine shall be continuously accumulated from a partial air stream on a high-efficiency particulate air filter of at least Filter Class E12 in accordance with DIN EN 1822-1 and on a filter for gaseous iodine. The measurements shall include:

a) the entire activity (with the exception of Iodine-131) accumulated on the filters or its temporal change, and

b) the entire activity of Iodine-131 accumulated on the filters or its temporal change.

(2) The continuous sampling and measurement required under para. (1) shall be considered as being continuous even if, during a cycle period of no more than 10 minutes, the sampling is interrupted and the filter loading determined automatically during this interruption period. However, the actual time for sampling shall be equal to at least 50 % of the cycle period.

(3) The volumetric flow of the partial air stream for sampling radioactive substances bound to aerosols and radioactive gaseous iodine shall be measured; any deviation of the volumetric flow of the partial air stream by more than 20 % of its nominal value shall cause an alarm.

3.3.1.2 Accident overview display equipment

(1) One measurement device (with the characteristics as specified under Section 3.3.1.1) shall be available that is able to determine overall activity concentrations in the exhaust air for radioactive substances bound to aerosols and for radioactive gaseous iodine in the range from 1×10^2 Bq/m³ to 1×10^6 Bq/m³, and for activity concentrations of Iodine-131 from 2×10^1 Bq/m^3 to 2×10^5 Bq/m³.

(2) The measurement equipment shall be designed such that, given a previously uncharged (fresh) accumulating filter, a short-term activity concentration with a time integral of 1×10^2 (Bq/m^3)h or 1×10^6 (Bq/m3)h, respectively, as specified under para. (1), will, within a maximum time of one hour, cause the lowest display value of the measurement range to be exceeded.

3.3.1.3 Wide range display equipment

(1) One measurement device (with the characteristics as specified under Section 3.3.1.1) shall be available that is able to determine overall activity concentrations in the exhaust air for radioactive substances bound to aerosols and gaseous radioactive iodine in the range from 1×10^5 Bq/m³ to 2×10^8 Bq/m³ and for activity concentrations of Iodine-131 in the range from 2×10^4 Bq/m^3 to 2×10^7 Bq/m^3.

(2) The measurement equipment shall be designed such that, given a previously uncharged (fresh) accumulating filter, a short-term activity concentration with a time integral of 1×10^5 (Bq/m^3)h or 2×10^4 (Bq/m^3)h, respectively, as specified under para. (1), will, within a maximum time of one hour, cause the lowest display value of the measurement range to be exceeded.

3.3.2 Nuclide specific measurements

(1) The nuclide composition of radioactive substances bound to aerosols and of radioactive gaseous iodine shall be determined from their continuous accumulation on a high-efficiency particulate air filter of at least Filter Class E12 in accordance with DIN EN 1822-1 and on a filter for gaseous iodine. This sampling equipment shall be designed to be doubly redundant within the measurement range of the accident overview display equipment.

(2) If the continuous measurement indicates that it could be possible that a discharge of radioactive substances bound to aerosols or of Iodine-131 exceeds one of the licensed limit values, the activity of the individual nuclides both on the high-efficiency particulate air filter and on the filter for gaseous iodine shall be determined without delay based on gamma-spectrometric measurements. However, only the filters from one sampling equipment are required to be evaluated in the laboratory.

(3) After measurements under para. (2), the activity shall be performed basically in hourly intervals. Longer intervals than one hour are permissible, provided, the measured values of the continuous measurement points specified under Section 3.3.1.2 or Section 3.3.1.3 indicate that no significant changes have occurred.

(4) The volumetric flow of the partial air stream for sampling shall be measured; any deviation of the volumetric flow of the partial air stream by more than 20 % of its nominal value shall cause an alarm.

(5) The analyses needed for determining the alpha emitters and the strontium isotopes discharged with the exhaust air may be carried out on cumulative samples after the end of the design-basis accident.

(6) When they are analyzed, the high-efficiency particulate air filters shall be partitioned and evidential pieces kept in storage for one year. In those cases where this requirement does not seem practicable, the high-efficiency particulate air filters of the redundant sampling points shall be stored as evidential pieces.

(7) The overall loss factor shall be taken into account when determining the nuclide-specific activity discharge of radioactive substances bound to aerosols including that of alpha emitters and strontium isotopes as specified under para. (5).

Note:
The requirements of Section 3.3 are summarized in **Table 3-3**.

4 Sampling

4.1 Radiation Protection and Sampling Points

(1) Sampling, transporting the samples and performing of the nuclide specific measurements shall be planned such that the effective dose rate of the associated exposure will not exceed the design reference value of 1 mSv per person and individual sampling.

(2) Those sampling points that must be accessed by personnel shall be chosen or shielded such that the local dose rates at these locations will not exceed the design reference value of 10 mSv/h, assuming a activity concentration of 1×10^{13} Bq/m^3 Xenon 133-equivalency of radioactive noble gases in the exhaust air.

Note:
The design reference values specified in this section are oriented on the objective of safety standard KTA 1301.1, and they take Accident Prevention Regulation BGV C 16 into account.

4.2 Sampling Equipment and Sampling Procedures

(1) The sampling procedure shall normally be chosen such that the samples taken are representative for the emission during a design-basis accident. The aim should be that the exhaust air is homogeneously mixed in the vicinity of the sampling point.

(2) The sampling pipe lines shall be designed, routed and from such materials that only the smallest amount possible of aerosols and gaseous radioactive iodine compounds are retained.

Note:
Details regarding the design are specified in DIN ISO 2889.

(3) The selection of sorption materials for the filters shall take aging effects into account. The specified temperature range shall be maintained.

(4) The separation efficiency and loading capacity of the filters, both for elementary iodine as well as for organically bound iodine, shall be taken into account when choosing the sorption material. The iodine sorption material shall have a low rate of adsorption for noble gases.

(5) The components for aerosol and iodine filters and their arrangement shall be designed taking the following points into consideration:

a) During operation, the volumetric flow of leakage air shall not be larger than 5 % of the volumetric flow of the partial air for sampling at a pressure difference of about 100 hPa.

b) Any damage to the filter in the region of the filter gasket shall be avoided, and a bypass flow around the filter shall be impossible.

c) It shall be ensured that the filters are easy to exchange.

d) All mechanical parts shall be resistant to corrosion.

e) It shall be possible to flush the arrangement, e.g., to remove noble gases.

(6) The sampling equipment shall be designed and installed such that no temperatures below the dew point can occur. The design requirements for the sampling medium (exhaust air) are specified in **Table 4-1**. It is permissible to use other values as design requirements, provided, these values are verified by design-basis accident analyses.

(7) In case of non-continuous sampling, the nuclide composition shall be considered as constant in the time interval between two consecutive samplings.

(8) The overall loss factor shall be determined during commissioning of the sampling equipment in accordance with safety standard KTA 1503.1 Sec. 4 para. (7), items a), b) or c).

(9) The overall loss factor shall be again determined if either one of the following conditions occur:

a) A significant change of the overall loss factor has been determined during specified normal operation for the sampling equipment in accordance with safety standard KTA 1503.1.

b) The sampling equipment was subjected to changes that could significantly influence the overall loss factor.

5 Design and Construction of the Monitoring Equipment

Note:
The requirements of Section 5 apply to both stationary and mobile measurement equipment unless indicated otherwise.

5.1 Design and Installation

5.1.1 General requirements

(1) All components of the monitoring equipment (e.g., sampling equipment, measuring sensors, measuring transducers) shall be designed such that, whenever their functioning is required, they resist even those ambient conditions and the measurement media conditions (e.g., local dose rate, temperature, humidity, pressure) occurring at their location of installation or deployment even during plant-internal design-basis accidents, and that they can be operated as specified in the present safety standard.

(2) The measurement and sampling equipment shall be operated, be installed or housed such that

a) the nominal operating ranges specified in the individual equipment specifications are maintained, and

b) tests and inspections, maintenance and repair can be easily performed.

5.1.2 Requirements for stationary monitoring equipment

(1) Upon variation of any one influencing physical parameter within its nominal operating ranges as listed in **Table 5-1**, the measured value shall not vary by more than ± 30 % of the one determined at the reference value of this influencing physical

parameter. In the course of this variation, all other influencing physical parameters – with the exception of the atmospheric pressure and the pressure of the measurement medium – shall, as far as possible, remain unchanged close to the reference values of the calibration. In this context, the pressure difference between measurement medium and ambient atmosphere shall normally not exceed 200 hPa.

(2) The reference values listed in **Table 5-1** shall be applied for the corresponding influencing physical parameters. Reference value for the filter loading shall be the uncharged (fresh) condition. The reference value for the background radiation shall be specified by the manufacturer of the monitoring equipment.

(3) In the case of mutually redundant measurement equipment including sampling equipment it shall be ensured that a failure due to fire is limited to one of the redundancies or that the remaining equipment can fulfill the necessary safety function.

(4) If it cannot be precluded that one of the components of the measurement equipment specified under Section 5.1.1 para. (1) will fail on account of the effects from design-basis accidents (e.g., fire), then it shall be ensured that the monitoring can be replaced without delay (e.g., by a non-continuous sampling). For this case, corresponding sampling points shall be provided (e.g., in the exhaust gas duct or in the base of the exhaust air stack).

(5) It shall be ensured that, during the time of smoke removal after a fire, the filters can be exchanged early on whenever necessary.

(6) With regard to the immunity of the measurement equipment to electromagnetic influences (e.g., electrostatic discharges, electromagnetic fields, interference voltages) the Act on the Electromagnetic Compatibility of Devices (EMVG) shall be observed.

(7) During required operation, the local dose rate shall be measured in the compartments where continuously operated measurement equipment are located.

(8) Detectors, measurement transducers and data storage shall be connected to a non-interruptible emergency power supply. Other components of the monitoring equipment (e.g., heat tracers of the sampling equipment, pumps for transporting the measurement medium) shall be connected to the emergency power supply;, however, a short-time power loss is permissible (e.g., during startup of the emergency Diesel units). It shall be ensured that these components will restart automatically after power is again available.

(9) Those redundant electrical power loads that are required for the operation of redundant systems shall be connected to redundant bus bars.

(10) In case measurement equipment are installed on or inside a bypass, the volumetric flow in the respective bypass shall be monitored.

(11) Possible pulse rate losses of the measurement equipment within the measurement range (e.g., due to delay times) shall be known as a function of the pulse rate and shall be taken into account. No decrease of the display with the increase of a measurement parameter (overloading) is permissible.

(12) If an operating medium (e.g. counter gas) is required, the supply of the operating medium shall be ensured and the supply shall be monitored with regard to a possible failure.

(13) If it is necessary to readjust devices during operation, built-in adjustment controls shall be provided. All adjustment controls on electronic devices of the monitoring equipment shall be arranged or secured in such a way that a readjustment by non-authorized personnel can, to a large extent, be precluded. A misadjustment by the equipment itself shall be impossible.

(14) Equipment failure and the exceeding of alarm thresholds shall be optically displayed and acoustically annunciated and recorded in the control room. Collective alarms are permissible, provided, the measurement location originating the alarm is displayed in the control room or in a control room annex. The acoustic alarms may be cancelled individually or collectively before remedying the cause of the alarm.

(15) The optical alarms in the control room indicating that a failure has occurred or that an alarm threshold value has been exceeded shall also indicate the alarm condition (e.g., registered, or acknowledged).

(16) Pumps serving more than one train of measurement equipment shall be provided as doubly redundant units.

(17) With regard to measuring radioactive substances bound to aerosols and radioactive gaseous iodine, precautionary measures shall be taken by which any portions of the measurement signal caused by other radiation sources are reduced to such an extent that the associated feigned activity concentration of the substance to be measured remains sufficiently small. **Table 5-2** lists the interference sources and the respective maximum permissible feigned activity concentrations to be considered in the design of the measurement equipment.

(18) The effect of an increased dose rate on the measurement equipment shall not exceed the maximum permissible feigned activity concentration as listed in **Table 5-2**. The interference source's dose rate shall be assumed to be 10 µSv/h from Cesium-137 for the accident overview display equipment and 1 mSv/h from Cesium-137 for the wide range display equipment.

(19) If the actual effect of the interference source at the time of measurement is not known, it shall be conservatively assumed that the measurement signal is caused entirely by the substance to be measured. This overestimation may later be corrected when the actual effect of the interference source is known for the time of measurement and the associated feigned signal can be calculated.

(20) The influence of radioactive noble gases in the measurement volume on the measurement of radioactive substances bound to aerosols and of gaseous radioactive iodine as well as of Iodine-131 shall be specified in the equipment specification.

5.2 Statistical Certainty and Detection Limit

(1) The value of the factor $k_{1-\alpha}$ in accordance with DIN EN ISO 11929-1 shall be set equal to 1.645.

(2) The value of the factor $k_{1-\beta}$ in accordance with DIN EN ISO 11929-1 shall be set equal to 1.645.

(3) The detection limit shall not be higher than the lower limit of the measurement ranges specified under Section 3. In the case of accumulating, continuously measuring equipment, this requirement needs to be met only for the uncharged (fresh) filter.

Note:

The herein specified requirements for the detection limit apply to the plant-independent verification of the equipment characteristics.

5.3 Displaying and Recording the Measured Values of Stationary Measurement Equipment

(1) The continuously measured values of the volumetric flow of exhaust air, of the activity concentration and absorbed gamma ray dose rate of radioactive noble gases, of the accumulated activity on the two filters or their temporal change and

of the accumulated activity of Iodine-131 on the two filters or their temporal change as well as the values of the discharge rates if they are determined by the measuring equipment shall all be displayed and automatically recorded.

(2) The measured value should be displayed on the measurement equipment; it shall be displayed and automatically recorded in the control room. The measured values of the accident overview display equipment and of the wide range display equipment for the continuous measurements specified under Section 3.2.1.1 para. (1), items a) and b), and under Section 3.2.2.1 para. (1), items a) or b), shall be displayed and recorded in the emergency control center or at a location that remains accessible even during design-basis accidents.

(3) In case of an analog display, the measurement equipment shall normally have only one display range for each measurement parameter. If more than one display range is necessary, it is required

a) that, in the case of multiple linear display ranges, the sequential measurement ranges shall overlap each other by at least 10 % and the full-scale values do not differ by more than the factor of 10; and
b) in the case of multiple logarithmic display ranges, the sequential measurement ranges shall overlap each other by at least one decade.

(4) If more than one measurement equipment is deployed to cover the entire measurement range, then their individual measurement ranges shall overlap each other by at least one decade.

(5) The recorded data shall remain directly visible and well legible for a time span of at least 3 hours.

5.4 Testability

The monitoring equipment shall be designed and constructed such that a verification of the perfect functioning order of individual devices is possible within the framework of the initial tests specified under Section 6.2.1 and of the inservice inspections specified under Section 6.2.2, and for tests of the mobile measurement equipment specified under Section 6.3. It shall be possible to perform functional tests even during full power operation of the nuclear power plant.

6 Maintenance of the Monitoring Equipment

Note:
The requirements of Section 6 apply to both stationary and mobile measurement equipment unless indicated otherwise.

6.1 Servicing and Repair

6.1.1 Execution

Servicing and repair of the monitoring equipment shall be performed in accordance with the individual operating and repair instructions and by qualified personnel.

6.1.2 Documentation

(1) All servicing and repair tasks performed shall be documented.

(2) In the case of stationary monitoring equipment, this documentation shall contain the following information:

a) Unambiguous identification of the monitoring equipment involved,
b) Type of the servicing or repair task performed,
c) Type and number of exchanged parts,
d) Reasons for exchanging the parts,
e) Regarding the newly installed parts:
date and detailed identification of the test certificates and of the verifications required under the present safety standard,
f) Information regarding the outage times,
g) Date of the servicing or repair task,
h) Name and signatures of the qualified persons.

6.2 Tests and Inspections of Stationary Monitoring Equipment

The monitoring equipment shall be subjected to the following tests and inspections:

a) Prior to their deployment in a nuclear power plant:
   aa) Certification of suitability, and
   ab) Calibration,
b) Prior to their first deployment in a particular nuclear power plant:
   ba) Check of suitability,
   bb) Factory test,
   bc) Calibration check with solid calibration sources, and
   bd) Commissioning tests and inspections,
c) During deployment in the nuclear power plant:
   ca) Regular inservice inspections, and
   cb) Tests and inspections after servicing and repair tasks.

6.2.1 Initial tests and inspections

6.2.1.1 Verification of suitability

(1) Prior to their initial deployment in a nuclear power plant, it shall be verified that the monitoring equipment can fulfill their tasks and meet the specified requirements.

Note:
Requirements regarding verifying the suitability of stationary measurement equipment for monitoring activity are dealt with in safety standard KTA 1505.

(2) The verification of suitability comprises a (plant independent) verification of the equipment characteristics and a plant-dependent suitability check.

(3) The plant-dependent suitability check shall be performed by the proper authority or an authorized expert appointed by the proper authority.

6.2.1.2 Calibration and check of the calibration

(1) Prior to their first deployment, suitable calibration factors shall have been established for the monitoring equipment. It is permissible to determine the calibration factors on type-identical measurement equipment.

(2) The measurement equipment for measuring the cumulative beta activity of the radioactive noble gases shall be calibrated using Xenon-133 and Krypton-85; the measurement equipment used for measuring the absorbed gamma ray dose rate of the radioactive noble gases shall be calibrated with a Cesium-137 or Cobalt-60 solid calibration source.

(3) The energy dependence of the discrimination of the measurement equipment for determining the beta radiation of radioactive noble gases shall be determined using at least three representative beta emitters with a maximum beta energy within the range from 150 keV to 2500 keV. The energy dependence of the discrimination of the measurement equipment for determining the gamma radiation of radioactive noble gases shall be known for gamma radiation in the energy range from 60 keV to 2500 keV.

(4) The measurement equipment for measuring the gamma radiation of radioactive substances bound to aerosols or of gaseous radioactive iodine shall be calibrated with Iodine-131 and with Cesium-137.

(5) The energy dependence of the discrimination of the measurement equipment specified under para. (4) shall be known for a gamma radiation in the energy range from 200 keV to 2500 keV.

(6) The measurement equipment for monitoring Iodine-131 shall be calibrated with Iodine-131.

(7) During the initial calibration, a set of solid calibration sources shall be specified that are suited to check the display values in the measurement range of the accident overview display equipment. For this purpose, the following solid calibration sources shall be provided:

a) For monitoring noble gases:
Cobalt-60, Technetium-99 or Cesium-137 for the measurement equipment for beta emitters as well as Cesium-137 for the measurement equipment for gamma radiation;

b) For monitoring radioactive substances bound to aerosols and gaseous radioactive iodine:
Cesium-137 and Barium-133, respectively;

(8) Directly after initial calibration of the monitoring equipment, a solid calibration source shall be applied in a defined and reproducible geometry to determine a display value which will later make it possible to check the calibration and to connect further type-identical equipment.

6.2.1.3 Factory Test

(1) A factory test shall be performed to verify that the monitoring equipment was properly manufactured and is in perfect functioning order. In case the monitoring equipment is comprised of components from different manufacturers, the proper manufacturing and perfect functioning order of these components shall be verified by factory tests performed at the respective manufacturing plant.

(2) The factory test shall be performed as a production test and shall comprise:

a) Visual inspection,

b) Test of the output value as a function of the specified fluctuation of the operating voltage,

c) Test of the response characteristic with a pulse or current generator and at least one test value for each decade of the measurement range,

d) Test of the overload resistance (using electronic means or a solid radiation source),

e) Function test (using a solid radiation source),

f) Test of the volumetric flow monitoring or of the integral volumetric flow measurement,

g) Leak-tightness test.

(3) The factory test shall be performed by plant experts and, in justified cases, in the presence of an authorized expert appointed by the proper authority.

6.2.1.4 Commissioning Tests

(1) The post-installation commissioning tests shall verify the proper design and proper functioning order of the monitoring equipment. The following items shall be tested:

a) Design of the monitoring equipment,

b) Installation of the monitoring equipment,

c) Display (with at least one test value for each decade of the measurement range),

d) Calibration check (using solid calibration sources),

e) Connection to the emergency power system,

f) Volumetric flow monitoring,

g) Measurement value processing,

h) Supply of operating media,

i) Equipment failure alarms,

k) Threshold limit settings and alarm signals, and

l) Automatic restart after interruption of the power supply.

(2) The commissioning tests shall be carried out by the plant operator and, to an extent specified by the proper authority, by or in the presence of an authorized expert appointed by the proper authority.

6.2.2 Inservice inspections

6.2.2.1 General requirements

(1) The testing schedule, the test instructions and test certificates shall be in accordance with safety standard KTA 1202.

(2) It shall be possible to perform the inservice inspections without manual changes of the circuitry (e.g., soldering).

6.2.2.2 Regularly inservice inspections

(1) Regular inservice inspections shall be performed to verify the perfect functioning order of the monitoring equipment.

(2) In this context, the test procedures and the test frequencies shall be as specified in **Table 6-1**.

(3) The verification of the calibration listed under Running Number 1 b) of **Table 6-1** shall be carried out in the defined geometry and with the solid calibration source specified during initial calibration of the measurement equipment (cf. Section 6.2.1.2 (8)). The required value of the display shall be achieved with an accuracy that must be specified in the testing manual.

(4) The regular inservice inspections shall be performed by the plant operator or by the proper authority or an authorized expert appointed by the proper authority.

6.2.2.3 Post-repair testing

After completion of a repair task, the perfect functioning order shall be verified by a commissioning test as specified under Section 6.2.1.4 to an extent corresponding to the repair task.

6.2.3 Removal of defects

The time limits and, possibly, alternative measures for the removal of defects shall be specified in the operating manual. The defects including the measures taken for their removal shall be documented.

6.3 Tests of the Mobile Measurement Equipment.

(1) It shall be verified that the measurement equipment fulfill their task and meet the requirements specified in the present safety standard.

(2) The measurement equipment shall be calibrated for their individual measurement task.

(3) Commissioning tests shall be performed to verify the proper design and perfect functioning order of the measurement equipment. In this context the following shall be tested:

a) Design of the measurement equipment,

b) Arrangement of the measurement equipment,

c) Functionality and performed calibration check, and

d) Supply of operating media.

(4) The commissioning test shall be carried out by the plant operator and, to an extent specified by the proper authority, by the proper authority or an authorized expert appointed by the proper authority or in their presence.

(5) Regular inservice inspections shall be performed.

(6) The testing schedule, the test instructions and test certificates shall be as specified in safety standard KTA 1202.

(7) Regular inservice inspections shall be performed to verify that the measurement equipment is in perfect functioning order. The tests and test intervals shall be as listed under Running Numbers 2 and 7 of **Table 6-1**.

(8) After completion of a repair task, the perfect functioning order shall be verified by a commissioning test to an extent corresponding to the repair task.

7 Documentation of Measurement Results

7.1 Flow Chart

(1) The sampling and monitoring equipment provided for measuring the discharge of gaseous radioactive substances and of radioactive substances bound to aerosols shall be clearly presented in a flow chart. Different symbols shall be used to identify the type of sampling and monitoring.

(2) In a description correlated to the flow chart (e.g., in the form of a table), the required measurement task and the measurement procedure shall be specified for each sampling and monitoring equipment. In case of sampling equipment, the task, type, location and frequency as well as the measurements to be performed shall be listed. In case of monitoring equipment, the measurement tasks and technical measurement requirements, in particular, the measurement procedure, the arrangement of the measurement equipment including radiation shielding, the calibration, the measurement ranges, detection limits and measurement uncertainties shall be listed. Likewise, the measurement tasks and technical measurement requirements of the measurement laboratory shall be described.

7.2 Extent of Documentation

The documentation regarding the discharged radioactive substances shall be structured such that

a) the chronological development of the activity discharged through the vent stack

   aa) prior to the occurrence of,

   ab) during and

   ac) after

   the design-basis accident can be traced back based on continuous measurements and sample evaluations, and such that

b) the sampling

   ba) prior to the occurrence of,

   bb) during and

   bc) after

   the design-basis accident including the point in time, duration and sampling type (continuous, non-continuous) and other boundary conditions occurring during sampling can be traced back, and such that

c) the volumetric flow of the vent stack exhaust air

   ca) prior to the occurrence of,

   cb) during and

   cc) after

   the design-basis accident is described together with the automatically recorded physical parameters.

Radionuclide Group	***Accident overview display equipment***	***Wide Range Display Equipment***
Radioactive noble gases	a) Continuous measurement of the activity concentration (cumulative beta activity) b) Continuous measurement of the absorbed gamma ray dose rate c) Determination of the activity of the individual radionuclides (by gamma ray spectrometry)	d) Continuous measurement of the activity concentration (cumulative beta ray activity) or e) Continuous measurement of the absorbed gamma ray dose rate f) Determination of the activity of the individual radionuclides (by gamma ray spectrometry)
Radioactive substances bound to aerosols and radioactive gaseous iodine	a) Continuous measurement of the overall activity accumulated on the filters, or the activity's change with time b) Continuous measurement of the overall Iodine-131 activity on the filters or the activity's change with time c) Determination of the activity of the individual nuclides (by gamma ray spectrometry) on the charged filters	d) Continuous measurement of the overall activity accumulated on the filters, or the activity's change with time e) Continuous measurement of the overall Iodine-131 activity on the filters or the activity's change with time f) Determination of the activity of the individual nuclides (by gamma spectrometry) on the charged filters

Table 3-1: Correlation of the continuous measurements and the nuclide specific measurements to the accident overview display and wide range display equipment

	Accident overview display equipment	*Wide Range Display Equipment*
Measure-ment para-meter	a) Activity concentration (cumulative beta activity) b) Absorbed gamma ray dose rate c) Fractional contribution of individual nuclides to overall activity	d) Activity concentration (cumulative beta activity) or e) Absorbed gamma ray dose rate f) Fractional contribution of individual nuclides to overall activity
Measure-ment range	re a): 1×10^{6} Bq/m³ to 1×10^{11} Bq/m³ re b): 1×10^{7} Bq/m³ to 1×10^{11} Bq/m³ re c): If a continuous nuclide specific measurement is available, this should be used within its meas-urement range [1]	re d): or re e): 1×10^{10} Bq/m³ to 1×10^{13} Bq/m³ re f): No requirements specified [2]
Redundancy	re a): and re b): Individual measurement equipment provided for a) and b) are redundant to each other re c): Not required	re d): or re e): Not required re f): Not required
Exhaust air	re a): Volumetric flow shall be measured and recorded re b): Volumetric flow shall be measured and recorded	re d): Volumetric flow shall be measured and recorded re e): Volumetric flow shall be measured and recorded
Partial air stream	re a): Partial air stream shall be monitored re b): Monitoring of partial air stream not required, provided the measurement is performed within or on the exhaust air stream re c): Partial air stream shall be monitored	re d): Partial air stream shall be monitored re e): Monitoring of partial stream not required, pro-vided the measurement is performed within or on the exhaust air stream re f): Partial air stream shall be monitored
Sampling	re a): Continuous flow of partial air stream of the ex-haust air through the measurement chamber [3] re b): Sampling not required, provided, the measure-ment is performed dire4ctly within or on the ex-haust air stream re c): In the case of non-continuous sampling: One gas samples should be extracted in hourly intervals for as long as it must be expected that the discharge of radioactive noble gases ex-ceeds the licensed limit value and significant changes are seen in the measured value of the measurement equipment specified under item a).	re d): Continuous flow of partial air stream of the ex-haust air through the measurement chamber [3] re e): Sampling not required, provided, the measure-ment is performed directly within or on the ex-haust air stream re f): Gas samples should be extracted from the ex-haust air stream in hourly intervals for as long as significant changes are seen in the meas-ured values of the measurement equipment specified under item d) or item e).
Type of Measure-ments	re a): Continuous measurement of the cumulative beta activity in the measurement chamber re b): Continuous measurement of the absorbed gamma ray dose rate within or on an air stream re c): In case of non-continuous sampling: Gamma spectrometric evaluation of the gas sample without delay after the sampling	re d): Continuous measurement of the cumulative beta activity in the measurement chamber re e): Continuous measurement of the absorbed gamma ray dose rate within or on an air stream re f): Gamma spectrometric evaluation of the gas sample without delay after the sampling

[1] In case of a non-continuous evaluation of the radionuclide composition, the activity discharge of the individual noble gas radionuclides shall be based on the concentration of cumulative beta activity determined with the measurement equipment specified under item a). In case of failure of this equipment, the absorbed gamma ray dose rate determined with the measurement equipment specified under item b) shall be used as the basis.

[2] In case of a non-continuous evaluation of the radionuclide composition, the activity discharge of the individual noble gas radionuclides shall be based on the concentration of cumulative beta activity determined with the measurement equipment under item d) or on the absorbed gamma ray dose rate determined with the measurement equipment specified under item e).

[3] To reduce contamination, a high-efficiency particulate air filter of at least Filter Class E12 in accordance with DIN EN 1822-1 as well as a filter with a minimum retention rate of 90 % for elementary iodine shall be placed in line before the measurement chamber.

Table 3-2: Measurements with respect to radioactive noble gases

	Accident Surveillance and Wide Range Display Equipment	
	Continuous Measurements *(Measurements specified in **Table 3-1,** items a), b), d) and e))*	***Nuclide Specific Measurements*** *(Measurements specified in **Table 3-1,** items c) and f))*
Mea-sure-ment para-meter	Activity collected on the filters or its temporal change	Activity of the individual nuclides collected on the filters
Mea-sure-ment range	It shall be possible to determine the following activity concentrations: Accident overview display measurement as specified under item a): from 1×10^2 Bq/m^3 to 1×10^6 Bq/m³ measurement as specified under item b): from 2×10^1 Bq/m^3 to 2×10^5 Bq/m³ Wide range display measurement as specified under item d): from 1×10^5 Bq/m^3 to 2×10^8 Bq/m³ measurement as specified under item e): from 2×10^4 Bq/m^3 to 2×10^7 Bq/m³	no requirements specified
Re-dun-dancy	not required	The sampling equipment shall be (doubly) redundant within the measurement range of the accident overview display equipment
Ex-haust air	Measurement and recording of the volumetric flow	Measurement and recording of the volumetric flow
Partial air stream	Volumetric flow shall be kept constant and shall be of monitored	Volumetric flow shall be kept constant and shall be monitored
Samp-ling	Continuous accumulation on a high-efficiency particulate air filter of at least Filter Class E12 in accordance with DIN EN 1822-1 and on a filter for gaseous iodine	If it cannot be precluded that a discharge of radioactive substances bound to aerosols or of Iodine-131 will exceed a license value, one sampling equipment (or two sampling equipment in the measurement range of the accident overview display) with one high-efficiency particulate air filter of at least Filter Class E12 in accordance with DIN EN 1822-1 and with one filter for gaseous iodine shall normally be continuously charged over individual sampling periods of one hour for as long as significant changes occur in the measurement values of the corresponding continuous measurements.
Mea-sure-ment proce-dure	Continuous measurement of the overall activity on the filters and the overall activity of all fractions of Iodine-131 on the filters.	Gamma spectrometric evaluation of the filters of all sampling equipment (or, within the measurement range of the accident overview display equipment, of one collecting device) as far as possible immediately after the end of the sampling period. [1]

[1] It is permissible to forestall the evaluation of the high-efficiency particulate air filter with respect to alpha emitters and strontium isotopes based on cumulative samples until after the end of the design-basis accident.

Table 3-3: Measurements with respect to radioactive substances bound to aerosols and with respect to radioactive gaseous iodine

Design Value	***PWR***	***BWR***
Temperature	50 °C	80 °C
Relative humidity	85 %	100 % 1)
Pressure	850 hPa to 1250 hPa	850 hPa to 1250 hPa
1) additional fog droplet content of the exhaust air: 10 g/m³		

Table 4-1: Design conditions at the sampling location (exhaust air)

Influence Parameters	Nominal Operating Range	Reference Value
Operating voltage		Manufacturer specification
alternating current voltage supply	85 to 110% of the nominal value of the operating voltage	
direct current voltage supply	specified voltage range of the direct current grid	
Ambient temperature	15 °C to 40 °C	20 °C
Ambient air pressure	900 hPa to 1100 hPa	1013 hPa
Relative humidity of ambient air	10 % to 95 %, non-dewing	60 %
Temperature of the measurement medium	reference value ±10 °C	1)
Pressure of the measurement medium	850 hPa to 1250 hPa	1013 hPa
Relative humidity of the measurement medium	10 % to 85 %	50 %
1) Shall be specified by the manufacturer depending on the sampling and treatment concept such that the temperature is always higher than the dew point.		

Table 5-1: Nominal operating ranges and reference values of the influence parameters

Measurement objective	***Interference Source to be Assumed***			
	Accident overview display		***Wide Range Display***	
	Activity inside the reactor containment from the design-basis accident “Leakage of the reactor coolant pipe line”	Noble gas activity concentration in the sampling stream from the design-basis accident “Leakage of the reactor coolant pipe line”	The activity in the reactor containment shall be assumed at 100 times the values on which the accident overview display equipment is based.	The noble gas activity concentration in the sampling stream shall be assumed at 100 times the values on which the accident overview display equipment is based.
Radioactive substances bound to aerosols and radioactive gaseous iodine	10^3 Bq/m^3	10^3 Bq/m^3	10^5 Bq/m^3	10^5 Bq/m^3
Iodine-131	10^2 Bq/m^3	10^2 Bq/m^3	10^4 Bq/m^3	10^4 Bq/m^3
Noble gas (cumulative beta activity)	10^6 Bq/m^3 1)	—	10^{10} Bq/m^3 1)	—
Noble gas (absorbed gamma ray dose rate)	10^7 Bq/m^3 1)	—	10^{10} Bq/m^3 1)	—
1) These values specify the associated lower limits of the required measurement ranges. For the assumed interference sources the feigned activity concentrations are lower.				

Table 5-2: Maximum values of the feigned activity concentration

1	2	3	4	5
Running No.	***Test Object***	***Testing Procedure***	***Test Frequency***	
			by the plant operator	***by the proper authority or an authorized expert appointed by the proper authority***
1	Monitoring equipment	a) Visual inspection	during inspection rounds	annually
		b) Calibration check with a solid radiation source	quarter annually	annually
		c) In case of counter tubes: check of the plateau	—	annually
2	Inspection and maintenance records	Visual check	—	annually
3	Electronic modules	Insertion of suitable signals at inputs provided or simulation of signals directly into the measurement transducer input with at least one value in each decade of the measurement range [1)] for the integral test of the measurement transducer. For testing the measurement transducer output as well as devices such as displays, recorders, monitoring computers, at least one value shall be simulated for each decade of the measurement range; in the case of computer based measurement equipment, these values may be created by the software. Comparison of all displays and recordings.	annually	annually
4	Alarm signals	a) Operational availability: visual inspection	during inspection rounds	annually
		b) Failure alarm signal: by interrupting the voltage supply or interrupting the signal connection between measurement transducer and detector or by inserting a value below the failure threshold	quarter annually	annually
		c) Hazard alarm: by radiation source or electrically	quarter annually	annually
		d) Volumetric flow monitoring: by varying the volumetric flow to values outside of the alarm thresholds		
5	Flow monitoring and supply of operating media			
	without automatic function control	Visual inspection	during inspection rounds	annually
	with automatic function control	Comparison of the required value with the actual value	quarter annually	annually
6	Sampling equipment	Visual inspection, check of the switching of ventilators or blower	annually	annually
7	Mobile measurement equipment	a) Visual inspection	quarter annually	annually
		b) Calibration check	quarter annually	annually

[1)] The test procedure of simulating of detector signals at the measurement transducer inputs for the integral test of measurement transducers and measurement circuits – with at least one value in each decade of the measurement range – is not required in the case of computer-based measurement equipment, provided, the software program is certified. In this case it is sufficient to insert one signal in the uppermost decade of the measurement range, provided, the pre-processing electronics do not perform any switching procedures throughout the entire measurement range. This too is not required if the verification of the calibration is carried out with one measurement value in the uppermost decade of the measurement range.

Table 6-1: Regularly recurring 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 version that was valid when the latter regulations were established or issued.)

AtG		Act on the Peaceful Utilization of Atomic Energy and the Protection against its Haz-ards (Atomic Energy Act) Atomic Energy Act in the version promulgated on July 15, 1985 (BGBl. I, p. 1565), most recently changed by article 1 of the act dated December 4, 2022 (BGBl. I, p. 2153)
StrlSchG		Act on the Protection against the Harmful Effect of Ionising Radiation (Radiation Protection Act - StrlSchG) Radiation Protection Act of June 27, 2017 (BGBl. I, p. 1966), most recently changed by the promulgation of January 3, 2022 (BGBl. I, p. 15)
EMVG		Act on the electromagnetic compatibility of operating components (EMVG) of September 26, 1998 (BGBl. I, No. 64, p. 2882), most recently changed by Article 51 of the act of June 23, 2021 (BGBl. I p. 1858)
StrlSchV		Ordinance on the Protection against the Harmful Effects of Ionising Radiation (Radiation Protection Ordinance - StrlSchV) Radiation Protection Ordinance of November 29, 2018 (BGBl. I, p. 2034, 2036), most recently changed by article 1 of the ordinance dated October, 2021 (BGBl. I p. 4645)
SiAnf	(2015-03)	Safety Requirements for Nuclear Power Plants (SiAnf) of November 22, 2012, amended version of March 3, 2015 (BAnz AT 30.03.2015 B2), most recently changed as promulgated by BMUV on February 25, 2022 (BAnz AT 15.03.2022 B3)
Interpret of SiAnf	(2015-03)	Interpretations of the safety requirements for nuclear power plants of November 22, 2012, of November 29, 2013 (BAnz AT 10.12.2013 B4), changed on March 3, 2015 (Banz AT of March 30, 2015 B3)
Self-Surveillance Control Guideline	(1996-02)	Control of the self-surveillance regarding radioactive emissions from nuclear power plants of February 5, 1996 (GMBl. 1996, No. 9/10, p. 247)
KTA 1202	(2017-11)	Requirements for the testing manual
KTA 1301.1	(2022-11)	Radiation protection considerations for plant personnel in the design and operation of nuclear power plants – Part 1: Design
KTA 1503.1	(2022-11)	Monitoring the Discharge of Radioactive Gases and Airborne Radioactive Particulates Part 1: Monitoring the Discharge of Radioactive Matter with the Stack Exhaust Air During Specified Normal Operation
KTA 1503.3	(2022-11)	Monitoring the Discharge of Radioactive Gases and Airborne Radioactive Particulates Part 3: Monitoring the Non-Stack Discharge of Radioactive Matter
KTA 1505	(2022-11)	Suitability verification of the stationary measurement equipment for radiation monitoring
DIN EN 1822-1	(2019-01)	High efficiency air filters (EPA, HEPA and ULPA) - Part 1: Classification, performance testing, marking; German version EN 1822-1:2019
DIN ISO 2889	(2012-07)	Sampling airborne radioactive materials from the stacks and ducts of nuclear facilities (ISO 2889:2010)
DIN EN ISO 11929-1	(2021-11)	Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation - Fundamentals and application - Part 1: Elementary applications (ISO 11929-1:2019); German version EN ISO 11929-1:2021
DGVU Regulation 32		Nuclear power plants (so far BGV C16, 1987-01) Accident prevention regulation most recent version of January 1, 1997
KTA-GS 82	(2016-11)	Determination of the characteristic limits (decision threshold, detection limit and limits of the confidence interval) for nuclear radiation measurements according to DIN ISO 11929 - Application examples for the KTA safety standard series 1500, Revision 1