

Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 1502 (2022-11)

Monitoring Volumetric Activity of Radioactive Substances in the Inner Atmosphere of Nuclear Power Plants

(Überwachung der Aktivitätskonzentrationen radioaktiver Stoffe in der Raumlufte von Kernkraftwerken)

The previous versions of these safety standard were issued in 2005-11, 2013-11 and 2017-11

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

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Monitoring Volumetric Activity of Radioactive Substances in the Inner Atmosphere of Nuclear Power Plants

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PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 35-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in the Federal Gazette (Bundesanzeiger) on July 25, 2023. Copies of the German versions of the KTA safety standards may be mail-ordered through the Wolters Kluwer Deutschland GmbH (info@wolterskluwer.de). Downloads of the English translations are available at the KTA website (<http://www.kta-gs.de>).

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

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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 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) Radiation monitoring and the monitoring of the activity concentration of radioactive substances bound to aerosols serve to protect the persons inside and outside of the plant from ionizing radiation and to keep under control the specified normal activity flow of solid, liquid and gaseous radioactive substances inside the plant, as well as the discharge of radioactive substances from the plant.

(3) Monitoring the activity concentration of radioactive substances in the inner atmosphere during specified normal operation contributes to fulfilling Secs. 8 and 9 StrlSchG, specifically, by

- a) automatically initiating alarm signals when threshold limits are exceeded that are provided regarding increased activity concentration of radioactive substances in the inner atmosphere, and regarding the initiation of necessary measures,
- b) identifying the respective compartment groups where an increased activity concentration of radioactive substances can lead to an increase of the discharge of radioactive substances with the vent stack air,
- c) finding indications of leaking systems or components that contain radioactive substances (leakage monitoring of plant equipment and components) by detecting an increased activity concentration of radioactive substances bound to aerosols,
- d) detecting increased activity concentrations of radioactive substances bound to aerosols with special regard to the protection of persons.

The monitoring equipment concerned must meet the requirements of Sec. 90 StrlSchV.

(4) The equipment required for these tasks are structurally organized as being:

- a) Stationary measuring or sampling equipment, in particular, for monitoring the activity concentration of radioactive substances bound to aerosols in the exhaust-air collecting ducts, and
- b) Non-stationary measurement and sampling equipment for monitoring the activity concentration of radioactive substances bound to aerosols in the inner atmosphere of the compartments regarding, in particular, the radiation protection monitoring of work places.

(5) Whenever compartments or compartment groups are to be monitored with regard to a possible leakage from components or from pipe lines carrying radioactive media as well as to the possible release of radioactive substances into the inner atmosphere, this is done by taking air specimens from the exhaust-air collecting ducts or directly from the inner atmosphere. This task is performed, primarily, by stationary measuring equipment. With regard to the discharge of radioactive substances through the vent stack, a monitoring of the exhaust-air ducts simplifies identifying the sources. Monitoring the activity concentration of radioactive substances bound to aerosols in compartments and compartment groups provides an indication of the average activity concentration of radioactive substance in the inner atmosphere and, thus, helps the decision-making process regarding the accessibility of the compartments by personnel and regarding the

deployment of additional non-stationary measuring equipment. It also helps detecting any increase of the activity concentration of radioactive substances bound to aerosols in the inner atmosphere, thus enabling the initiation of necessary measures in case of escaping radioactive substances bound to aerosols as well as the automatic actuation of alarm signals whenever threshold limits are exceeded.

(6) The activity concentration of radioactive substances bound to aerosols in the inner atmosphere at the work places is monitored, primarily, by non-stationary measuring or sampling equipment. However, in individual cases this monitoring can be carried out by suitably located stationary measuring equipment, e.g., which is located at the work place, provided, it is ensured that this equipment delivers measurement results that are representative for the air at the work place. Non-stationary measuring and sampling equipment are also used for, e.g., leakage detection and the collection of data required for planning prior to the execution of a work task.

1 Scope

This safety standard applies to the specified normal operation of nuclear power plants with light water reactors during.

Notes:

(1) The stationary measuring or sampling equipment designed pursuant to this safety standard with special regard to specified normal operation, will also be able to provide information on design basis accidents, at least in their initial phases, regarding matters specified under Section Basic Principles, para. (3), items a) through d).

(2) If it becomes impossible during a design basis accident to perform onsite measurements with non-stationary measuring or sampling equipment, suitable specimens, when required, may be analyzed and evaluated in the laboratory.

2 Definitions

(1) Exhaust-air duct

An exhaust-air duct is a ventilation duct that guides the exhaust air out of a compartment.

(2) Exhaust-air collecting duct

An exhaust-air collecting duct is a ventilation duct that guides the exhaust air out of one or more compartment groups.

(3) Aerosol monitor

An aerosol monitor is a monitoring equipment for measuring the activity concentration of the cumulative beta activity or cumulative gamma activity caused by radioactive substances bound to aerosols.

(4) Discrimination of a measuring equipment

The discrimination of a measuring equipment is the ratio of the display value of a measured quantity to the actual value of this measured quantity.

(5) Specified normal operation

Specified normal operation includes:

- a) Operating processes for which the plant, assuming the functional condition of all systems (unperturbed condition), is intended and suited (normal condition);
- b) Operating conditions which occur in the event of malfunctions in parts of the plant or in systems (perturbed condition), in so far as safety-related reasons do not stand against continuing the operation (abnormal operation);
- c) Maintenance procedures (inspections, repairs, etc.)

(6) Cumulative beta activity

The cumulative beta activity is the ratio of the integrally determined activity of the beta radiation from a radioactive substance to the activity of a reference nuclide used for calibrating the measuring equipment.

(7) Cumulative gamma activity

The cumulative gamma activity is the ratio of the integrally determined activity of the gamma radiation from a radioactive substance to the activity of a reference nuclide used for calibrating the measuring equipment.

(8) Calibration of the measuring equipment for radiation monitoring

The calibration of the measuring equipment for radiation monitoring is the determination of the relationship between the value defined by specific norms (e.g., activity of the calibration source) and the displayed value (e.g., count rate) of the measurement parameter.

(9) Measuring equipment

Measuring equipment comprises the entirety of all measuring devices and auxiliary equipment that are required for measuring a measurement parameter, for transferring and adapting a measurement signal and for passing on a measured value as image of the measurement parameter.

(10) Measurement medium

A measurement medium is a sample taken from the medium to be monitored that passes through the measurement volume (i.e., the spatial region for which the discrimination was determined during calibration of the respective measuring equipment), possibly, after having been subjected to a specific physical treatment, e.g., heating, filtration, thinning.

(11) Detection limit

The detection limit is a calculated value of a measurement parameter (e.g., activity, activity concentration, specific activity) that is normally compared to a predetermined reference value in order to decide whether or not the measuring procedure is suited for a particular measurement task.

Notes:

- (1) Detection limits are determined in accordance with DIN EN ISO 11929-1.
- (2) Application examples are given in report KTA-GS 82.

(12) Monitoring the inner atmosphere

Monitoring the inner atmosphere means monitoring the radioactive substances contained in the inner atmosphere.

(13) Sampling equipment

Sampling equipment comprises the technical devices for the removal and storage of radioactive substances from gaseous or liquid media for a later analysis in the laboratory.

(14) Aerosols

Aerosols are solid or liquid particles suspended in air or in a gaseous medium.

(15) Monitoring

Monitoring is a collective term for all types of controlled data acquisition of physical parameters and includes the process of comparing these data with specified values.

Note:

Monitoring is carried out, e.g., in the form of

- a) continuous measurements or
- b) analysis of test specimens (e.g., in the laboratory) or
- c) concatenation of measured values

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

3 Compartments and Compartment Groups Relevant to Monitoring**3.1 General Requirements**

The activity concentration of radioactive substances bound to aerosols in the inner atmosphere shall be monitored in those compartments and compartment groups where radioactive substances can be released. This shall be carried out as follows:

- a) Monitoring by using stationary, continuously measuring equipment for the specimens collected from representative locations in the inner atmosphere, from the exhaust-air duct of the compartment, or from the exhaust-air collecting ducts of the compartment groups. Additionally, stationary sampling equipment may be deployed, e.g., in individual exhaust-air ducts.

Note:

- (1) The requirements regarding the measuring equipment dedicated to monitoring the activity concentration of radioactive substances bound to aerosols in the inner atmosphere depend on the release of radioactive substances (radioactive noble gases, radioactive substances bound to aerosols, radioactive iodine) possibly released into the inner atmosphere, and on the design of the air conditioning facilities (e.g., recirculated air filtration, air exchange rate).
 - (2) Already in the design phase of the nuclear power plants, various compartments, usually, are considered as groups with regard to air conduction. This in mind, Section 3.2 specifies examples for the compartment groups that shall be monitored using stationary measuring equipment.
 - (3) By monitoring the activity concentration of radioactive substances bound to aerosols in the air of the exhaust-air collecting duct of a compartment group, an early detection of an increase in air contamination of the associated compartment group is made possible.
- b) Monitoring by using non-stationary measuring or sampling equipment, namely
 - ba) at the work place with special regard to personal protection if the possibility for an incorporation relevant to radiological protection exists, and
 - bb) if it becomes necessary to localize a leakage.
 - c) Monitoring by non-continuous sampling at special sampling nozzles that are to be provided as specified under Section 4.1.1.2.

3.2 Monitoring by Using Stationary Measuring Equipment**3.2.1 Nuclear power plant with pressurized water reactor (PWR)****3.2.1.1 Compartment groups**

The typical compartment groups of a PWR are shown schematically in **Figure 3-1**. These are:

- a) Compartment Group 1, inside the containment
Compartment Group 1 inside the containment is comprised of the compartments directly enclosing the primary coolant circuit.
- b) Compartment Group 2, inside the containment
Compartment Group 2 inside the containment is comprised of the compartments which house activity-retaining components that do not belong to Compartment Groups 1 or 3.