

Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 1508 (2022-11)

Instrumentation for Determining the Dispersion of Radioactive Substances in the Atmosphere

(Instrumentierung zur Ermittlung der Ausbreitung radioaktiver Stoffe in der Atmosphäre)

The previous versions of this safety standards were issued in 1988-09, 2006-11 and 2017-11

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

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Instrumentation for Determining the Dispersion
of Radioactive Substances in the Atmosphere

KTA 1508

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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, 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) Objective of the instrumentation for determining the dispersion of radioactive substances in the atmosphere is to acquire the data required for a correct situation analysis regarding a potential exposure in the environment after a design basis accident or after an even more serious event. This situation analysis becomes the basis for determining the need for, and type of, protection measures to be taken in the environment. This objective derives from Secs. 106 to 108 and 152 StrlSchV.

Furthermore, the data acquired with the meteorological instrumentation during specified normal operation can also be used to determine the potential exposure in the environment. This task results from § 101 para. 4 StrlSchV.

(3) Safety standard KTA 3502 "Design Basis Accident Instrumentation" requires the performance of meteorological measurements in order to estimate the radiological effects on the environment after a design basis accident. In so far as any instrumentation specified in this safety standard KTA 1508 serves this purpose, this instrumentation becomes part of the design basis accident instrumentation as per KTA 3502.

(4) The Guideline on the Emission and Immission Monitoring in Nuclear Facilities also requires monitoring dispersion conditions in the atmosphere as the connecting link between emission monitoring and immission monitoring of airborne radioactive substances.

1 Scope

This safety standard applies to the instrumentation required for determining the data needed to calculate or estimate the dispersion of radioactive substances from nuclear power plants in the atmosphere.

2 Definition

(1) Reference value

Reference values are values defined within the nominal operating range of the influence parameter and within the measurement range. When varying either the influence parameter or the measurement parameter itself, all other parameters shall be kept as constant as possible at the individual reference value. Only a single parameter at a time shall be varied within the nominal operating range. In this context, specified tolerance ranges shall not be exceeded.

(2) Suitability check

The suitability check is a test prior to the deployment of the measuring equipment in the power plant. It shall be determined, whether the measuring equipment meets the manufacturer specifications for the intended application and is suited for the individual deployment in the power plant.

(3) Influence parameter

Influence parameter is a parameter the change of which can change the display of the measurement value. The range in which the display of the measurement value may vary only within specified limits from the true value is called nominal operating range. During variation of the influence parameter, all other quantities (including the measurement parameter) shall be kept constant at their individual reference values.

(4) Measurement equipment

The term measurement equipment comprises the entirety of all measuring devices and auxiliary devices required for registering a measurand, for transferring and adapting the measurand and for displaying a measured value as image of the measurand.

(5) Nominal operating range

Nominal operating range is the range in which the displayed measurement value of a measuring equipment may vary only within the limits that are specified for the displayed value at the reference value.

(6) Disturbance level

The disturbance level of a meteorological measuring equipment is defined as the average height of the buildings and vegetation within a one-kilometer radius around the measuring equipment weighted by their individual surface areas.

3 Measurement parameters

The following measurement parameters shall be determined with one of the measuring equipment specified in Section 5:

- wind direction,
- wind speed,
- measurement parameters from which the necessary dispersion parameters for the dispersion analysis can be derived, e.g., standard deviation of wind direction, vertical temperature gradient.

Note:

The dispersion parameters introduced into the dispersion analysis are connected to the atmospheric turbulence. The turbulence condition is described either by classified form (e.g. diffusion category) or by a continuous stability parameter (e.g., the Obukhov length).

- measurement parameters for determining the super-elevation of the vent stack (ambient temperature, temperature and volumetric current inside the vent stack), and
- precipitation rate.

4 Measuring Device Supports

The following requirements apply to measuring equipment for determining the measurement parameters specified under Section 3, items a) through c), where the measurement sensors are mounted on measuring device supports (lattice pylon, pipe pylon, or vent stack).

4.1 Location of the Measuring Device Support

The measuring device support shall basically be located such that none of the surrounding buildings or vegetation are more than 10° above the line-of-horizon from any of the measurement sensors mounted to the measuring device support. If, however, the elevation of buildings or vegetation is in excess of 10° above the line-of-horizon, then the location should be chosen such that the sum of the wind frequencies where the location is leeward of such structures will not exceed an average long-term time percentage of 10 %.

Note:

The line-of-horizon is the orographically given separating line between the surface of the earth and the atmosphere.

4.2 Bracket Arms on the Measuring Device Support

(1) The measurement sensors shall be mounted on bracket arms in order to minimize the influence of the measuring device support on the flow and temperature distribution at the measurement location.

(2) The bracket arms with the mounted measurement sensors shall be designed such that maintenance of the measurement sensors is possible, e.g., by employing hinged or retractable bracket arms.

(3) In the case of lattice or pipe pylons, the uppermost measurement level shall normally be located on a vertical bracket arm at the tip of the pylon.

(4) With regard to the measurement sensors of wind direction, wind speed, or turbulence parameters, each measurement level shall basically be provided with at least one bracket arm in the case of lattice pylons and at least three bracket arms in the case of pipe pylons or vent stacks; an exception is the arrangement specified under para. 3. However, the number of bracket arms on pipe pylons and vent stacks may be reduced, provided, it can be demonstrated that with the remaining bracket arms a correction for any systematic deviations of the measurement sensors is possible.

(5) At each measurement level except for the arrangement specified under para. 3, one of the bracket arms for the measurement sensors of wind direction, wind speed, or turbulence parameters shall normally be oriented to be perpendicular to the most frequent wind direction. In the case of two bracket arms at one measurement level, the second bracket arm shall be oriented at a 90° angle to the first one and, in case of three bracket arms, the second and third shall be offset by 120° each.

(6) The bracket arms for the measurement sensors of wind direction, wind speed, or turbulence parameters shall basically be designed such that the distance between measurement sensor and outer boundary of the measuring device support is at least twice the diameter of the support at the individual measurement level. However, this distance may be reduced to the value of a single diameter, provided, a continuous correction analysis is performed and it is shown that this analysis keeps the deviations at level that is no larger than the one achieved for the arrangement according to the first sentence.

Note:

With regard to the turbulence parameters, these requirements can usually not be met in the case of a large vent stack.

(7) The measuring equipment for determining wind direction, wind speed, or turbulence parameters shall be arranged on the bracket arm such that the influence of the measurement disturbance due to the bracket arm is not essentially larger than the disturbance from the measuring device support equipment, e.g., by a vertically offset of the measuring equipment with respect to the bracket arm.

(8) The measurement sensors for determining the wind direction shall be installed, e.g., with a fixed mechanical stop, such that the north alignment is not lost when the measuring equipment is replaced.

(9) At every measurement level one bracket arm shall be available for the measurement sensors for determining the temperature gradient. The bracket arms possibly available at this measurement level for wind measuring equipment may be used for this purpose. The bracket arms for the temperature sensors at the various measurement levels shall all be aligned to point in the same direction.

(10) In case the temperature sensors for determining the temperature gradient are installed on the vent stack or on a pipe pylon, either two bracket arms offset by 180° or three offset by 120° shall be available at each measurement level.

(11) In case the temperature sensors to determine the temperature gradient are installed on the vent stack or on a pipe pylon, these shall basically be installed such that the distance between measurement sensor and outer boundary of the measuring device support equipment is at least twice the diameter of the support at the individual measurement level. A maximum distance of a single diameter is sufficient, provided, the selection circuit is adapted to choose the windward temperature sensor for determining the temperature. A maximum distance of a single diameter is always sufficient in case of a lattice pylon.

5 Measuring Equipment

The required features of the measuring equipment to determine the characteristics of an actual wind field may be demonstrated in a stationary wind field (wind tunnel).

5.1 General Requirements

5.1.1 Environmental influences

(1) In choosing the electronic devices for the measuring equipment outside of the measurement sensor, the conditions to be expected at the mounting location, e.g., power voltage, ambient temperature, sun exposure and humidity, shall be taken into account. This requires that the manufacturers specify the permissible ranges for the cited parameters within which the electronic devices will meet the requirements regarding specified measurement deviations.

(2) Devices of the measuring equipment that might be subjected to the influence of dust and water at their mounting location shall be protected, with the degree of protection being as specified in accordance with DIN EN 60529.

(3) Measurement sensors which, in the case of icing or snow deposit, would not be able to fulfill the requirements of this safety standard shall be provided with a thermostatically controlled heater to ensure their functionality.

(4) The requirements specified under Sections 5.2.2.1, 5.2.2.2 para. 1, 5.2.3.1, 5.2.3.2, 5.3.2.1, 5.3.2.2 para. 1, 5.3.3.1, 5.3.3.2, 5.3.4.1 and 5.3.4.2 shall be met even after a short term loading at a wind speed of 50 m/s and after a 24 hour storage of the measurement sensor under conditions of a relative humidity between 90 % and 100 % and a temperature between 15 °C and 25 °C.

5.1.2 Failure surveillance

Active components of the measuring equipment, e.g., heaters, ventilation equipment, SODAR (**S**onic **D**etecting **A**nd **R**anging) loudspeakers, shall be monitored with regard to a possible failure. (In the case of failure,) a failure alarm as specified under Section 7.1.1 shall be issued.

5.1.3 Redundancy and diversity

(1) No redundancy or diversity is required in the design of the measuring equipment

Note:

In case one measuring equipment fails, the information from the remaining measuring equipment during the time period specified in Section 6.2 para. 2 for its repair can be deemed as being sufficient. Furthermore, suitable neighboring weather stations or meteorological services can be asked to supply necessary information, e.g., point-in-time predictions.

(2) If only a single SODAR device is deployed for the wind measurements, suitable measures shall be provided for the case of its failure with which the wind direction and wind speed can be determined at a height of at least 10 m above the disturbance level, e.g., by erecting a small mast that meets the requirements specified under Section 4.

5.1.4 Lightning protection device

In case lightning protection devices are provided at the measurement sensors, these shall normally be installed such that they create only a minor flow disturbance at the location of the wind sensors.

5.1.5 Electrical and magnetic disturbances

(1) All measuring equipment shall be designed to be resistant against the influence of electrical and magnetic fields, e.g., high frequency fields, power cables.

(2) With regard to the disturbance resistance of the measuring equipment against electromagnetic interferences, e.g., electrostatic discharges, electromagnetic fields, induced voltages, the German Act on the Electromagnetic Compatibility of Devices (*Gesetz über die elektromagnetische Verträglichkeit von Geräten – EMVG*) shall be taken into account.

5.1.6 Testability

(1) The devices of the measuring equipment shall be accessible for the purpose of testing.

(2) It shall be possible to perform recurrent inservice inspections without any manipulation of the circuitry.

(3) Provisions shall be made to enable signal decoupling on the transmission path between measurement sensor and display.

5.1.7 Power supply

(1) It shall be ensured that switching procedures in the power supply will not disrupt the measurements and data processing in a way that any of the already determined 10-minute-values would be lost.

(2) The measuring equipment shall normally be connected to an emergency power supply.

5.1.8 Adjusting devices

The adjusting devices on the measuring equipment shall be secured against inadvertent adjustments and self-loosening.

5.1.9 North alignment

The deviation of the north alignment of measuring equipment for determining the wind direction shall be no larger than $\pm 3^\circ$. Any inadvertent change of the north alignment or of the vertical alignment shall be prevented by a suitable design of the mounting or of the equipment support.

5.2 Wind Measurements with Mechanical Sensors

Note:

Mechanical sensors are, e.g.,

- a) wind vane / cup anemometer,
- b) propeller anemometer,
- c) vector-indicating wind vane.

5.2.1 Mounting of the measurement sensors

The measurement sensors shall be arranged such that the measurement sensors for wind direction and wind speed have only a minor influence on each other; this can be achieved, e.g., in the case of separate sensors, by vertically offsetting the equipment relative to each other such that the lower edge of the upper equipment is about 0.3 m above the upper edge of the lower equipment.

5.2.2 Wind direction

5.2.2.1 Measurement deviation and characteristic values

(1) The measured wind direction shall not deviate by more than $\pm 5^\circ$ from the true wind direction when turning a full circle. In this context, the error related to the north alignment shall not be taken into account. This test shall be performed with the parameters influencing wind speed and temperature kept constant at the reference values to be specified by the manufacturer. The wind speed reference value shall be in the range between 0.8 m/s and 5 m/s and the temperature reference value in the range between 15°C and 25°C .

(2) The damping factor (in accordance with VDI 3786 Part 2) shall be in the range between 0.3 and 0.7 for an initial deflection of 10° from the actual wind direction.

Note:

The damping factor characterizes the vibration behavior of the wind vane.

(3) For an initial deflection of 90° to the actual wind direction, the transition value shall not exceed 0.2 m/s. In this context, all influence parameters and the measurement parameter itself shall be adjusted at a constant value in the vicinity of their individual reference values.

Note:

The transition value is the minimum wind speed at which the wind direction measurement starts to change from the initial deflection toward the true wind direction.

(4) If the measuring equipment is used to determine the standard deviation of the horizontal wind direction, a rotation of the wind vane as small as 3° shall be recognizable on the display. In this context, all influence parameters shall be adjusted at a constant value in the vicinity of their individual reference values.

5.2.2.2 Influence parameters for the measurement sensors

(1) The measured wind direction shall not deviate from the true wind direction by more than 5° whenever

- a) the wind speed is varied within the nominal operating range between 0.8 m/s and 30 m/s, or
- b) the temperature at the measurement sensors is varied within the nominal operating range between -35°C and $+45^\circ\text{C}$

and the wind direction and the temperature in the case of item a), or the wind direction and wind speed in the case of item b), are kept constant at their individual reference values.

(2) The reference value for the wind direction shall be the one specified by the manufacturer of the measuring equipment. The reference values for wind speed and temperature are the ones specified under Section 5.2.2.1 para. 1.

5.2.2.3 Measurement levels

(1) In case the vent stack is higher than 100 m, the wind direction shall be measured at least at the following three levels:

- a) stack height $\pm 10\%$, or at the level of the average effective emission during specified normal operation.