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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KTA SAFETY STANDARD

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2006-11 (BAnz-No. 245b of December 30,2006)
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Contents

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 Imission Monitoring in Nuclear Facilities also requires monitoring dispersion conditions in the atmosphere as the connecting link between emission monitoring and imission 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 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:

a) wind direction,

b) wind speed,

c) 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 categorie) or by a continuous stability parameter (e.g., the Obukhov length).

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

e) 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 chose 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 und 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 ± 3°. 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 the wind direction shall not deviate by more than ± 5° 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 °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 ± 10 %, or at the level of the average effective emission during specified normal operation,

b) 10 m to 15 m above the disturbance level, and

c) anywhere between the levels specified under item a) and b).

(2) In the case of vent stacks up to a height of 100 m, the wind direction need only be measured at the levels specified under para. 1 items a) and b).

(3) In case of the measurement level specified under para. 1 item a), the measurement sensor shall be mounted to the vent stack down from the opening by a distance that is least one-and-a-half times the outside stack diameter at this location.

(4) In case the diffusion category is determined on the basis of the standard deviation of the wind direction, then the standard deviation of the wind direction shall normally be measured at the measurement level specified under para. 1 item a).

5.2.3 Wind speed

5.2.3.1 Measurement deviations and characteristic values

(1) The transition value shall be smaller than or equal to 0.5 m/s.

Note:
The transition value is the minimum wind speed at which the anemometer indicates a measurement value larger than 0 m/s.

(2) In the range between 0.8 m/s and 5 m/s the measured wind speed shall not deviate by more than ± 0.5 m/s and in the range between 5 m/s and 30 m/s by no more than ± 10 % of the true wind speed. This test shall be performed with the temperature kept constant at the reference value to be specified by the manufacturer. The reference value of the temperature shall lie within the range between 15 °C and 25 °C.

(3) The delay distance shall be smaller than five meters.

Note:
The delay distance of a mechanical anemometer is the distance traveled by the air before the anemometer displays 63 % of a sudden increase in wind speed. The delay distance characterizes the dynamic behavior of a mechanical anemometer on account of its inertia and internal friction.

5.2.3.2 Parameters influencing the measurement sensors

When varying the ambient temperature at the measurement sensor within the nominal operating range between - 35 °C and + 45 °C, the measured wind speed may not deviate by more that ± 0.5 m/s at a wind speed of 1.5 m/s, and by no more than ± 1 m/s at a wind speed of 10 m/s. This test shall be performed with the influence parameter “wind direction” kept constant at the reference value to be specified by the manufacturer for this case.

5.2.3.3 Measurement levels

The wind speed shall be measured at the same measurement levels as the wind direction (cf. Section 5.2.2.3).

5.2.3.4 Mounting of the measurement sensors

The requirements specified under Section 5.2.1 apply to the mounting of the measurement sensors for wind speed and wind direction.

5.3 Wind and Turbulence Measurements with Ultrasonic Anemometers

Note:
Ultrasonic anemometers consist of sensor electronics for creating and evaluating ultrasonic signals, and of a sensor head with three differently aligned measurement sections, each one formed by two opposing ultrasonic transducers.

5.3.1 Measurement cycle

The internal measurement cycle for the measurements of wind speed and wind direction shall be no longer than 1 s, and no longer than 0.1 s for turbulence measurements.

5.3.2 Wind direction

5.3.2.1 Measurement deviations and characteristic values

The measured wind direction shall not deviate by more than ± 5° from the true wind direction when turning a full circle. 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 for this case. 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.

5.3.2.2 Parameters influencing the measurement sensors

(1) The measured wind direction may not deviate by more that ± 5° from the true wind direction whenever

a) the wind speed is varied within the nominal operating range between 0.8 m/s and 30 m/s, or

b) the ambient temperature at the measurement sensor is varied within the nominal operating range between - 35 °C and + 45 °C.

This test shall be performed, in case of item a), with the wind direction and temperature or, in case of item b), with the wind direction and wind speed kept constant at the individual reference values.

(2) The reference value of the wind direction shall be specified by the manufacturer of the measuring equipment. The reference values for the wind speed and ambient temperature shall be as specified under Section 5.3.2.1.

5.3.2.3 Measurement levels

The wind direction shall be measured at the levels specified under Section 5.2.2.3.

5.3.3 Wind speed

5.3.3.1 Measurement deviation and characteristic parameters

(1) The wind speed measurement shall not exceed 0.2 m/s (zero point) if the sensor head is located in a perfectly windless atmosphere.

(2) In the range between 0.8 m/s and 5 m/s the measured wind speed shall not deviate by more than ± 0.5 m/s and in the range between 5 m/s and 30 m/s by no more than ± 10 % of the true wind speed. This test shall be performed with the influence parameters wind speed and temperature kept constant at the reference values to be specified by the manufacturer. The reference value of the temperature shall lie within the range between 15 °C and 25 °C.

5.3.3.2 Parameters influencing the measurement sensors

(1) When the ambient temperature at the measurement sensor is varied within the nominal operating range between - 35 °C and + 45 °C, the measured wind speed may deviate by no more that ± 0.3 m/s at a wind speed of 1.5 m/s, and by no more than ± 0.5 m/s at a wind speed of 10 m/s. This test shall be performed with the influence parameter “wind direction” kept constant at the reference value to be specified by the manufacturer.

(2) When the device is rotated through a full circle in 3° increments, the measured wind speed may deviate by no more that ± 0.3 m/s at a wind speed of 1.5 m/s, and by no more than ± 0.5 m/s at a wind speed of 10 m/s. This test shall be performed with the influence parameter “temperature” kept constant at the reference value to be specified by the manufacturer for this case.

5.3.3.3 Measurement levels

The wind speed shall be measured at the same measurement levels as the wind direction (cf. Section 5.2.2.3).

5.3.4 Turbulence parameters

An ultrasonic anemometer may be used for the determination of turbulence parameters, e.g., the standard deviation of the wind direction, the turbulent sensitive heat flux, or the Obukhov length.

5.3.4.1 Measurement deviations and characteristic parameters

(1) Neither the quantity of the measured vertical wind component nor its standard deviation may exceed 0.25 m/s as the sensor head is rotated through a full circle in 3° increments while the true vertical wind component is 0 m/s (horizontal wind stream). This test shall be performed with the influence parameter “temperature“ kept constant at the reference value to be specified by the manufacturer for this case. This reference value shall lie within the range between 15 °C and 25 °C. The reference value of the horizontal wind speed is 5 m/s.

(2) Neither the quantity of the measured vertical wind component nor its standard deviation may exceed 0.1 m/s (zero point and noise level) if the sensor head is located in a perfectly windless atmosphere.

(3) The measured vertical wind component may deviate by no more than ± 0.25 m/s from the true value of the vertical wind component when inclining the sensor between - 20° and + 20° versus true vertical. This test shall be performed with the influence parameter “horizontal wind speed” kept constant at the reference value of 5 m/s. The influence parameters “wind direction” and “temperature” shall be kept constant at the reference value to be specified by the manufacturer. The reference value “temperature” shall lie within the range between 15 °C and 25 °C.

Note:
The horizontal and vertical wind components can be varied by inclining the sensor head in the wind tunnel.

5.3.4.2 Parameters influencing the measurement sensors

(1) The measured value of the vertical wind component may not deviate from the value determined at the individual reference value by more than ± 0.25 m/s for a true horizontal wind speed slower than 5 m/s, and by no more than ± 5 % of the true horizontal wind speed for a true horizontal wind speed faster than or equal to 5 m/s, whereby

a) the horizontal wind speed is varied within the nominal operating range between 0.8 m/s and 30 m/s, or

b) the ambient temperature at the measurement sensor is varied within the nominal operating range between - 35 °C and + 45 °C.

This test shall be performed with the wind direction and, in case of item a), the temperature and, in case of item b), the wind speed kept constant at the reference value specified in Section 5.3.4.1.

(2) The reference value for the temperature shall be specified by the manufacturer of the measuring equipment.

5.3.4.3 Measurement levels

Turbulence parameters required for determining the diffusion category shall be determined at the measurement levels specified under Section 5.2.2.3.

5.3.5 Monitoring

(1) The signal quality of momentary measurement values shall be monitored continuously during operation of the measuring equipment, e.g., by computer aided plausibility checks of the momentary values. Any implausible momentary values shall be excluded from the calculation of the mean measurement values.

Note:
Momentary values may be invalid due to, e.g.,

a) mechanical deformation of the sensor head,

b) electrical or electronic system failures,

c) icing, and

d) impact of hail stones or large rain drops on the ultrasonic transducers during extreme rain or hail showers.

(2) The share of valid momentary measurement values used in determining a 10-minute mean value (cf. Section 7.3.2) shall not be less than 70 %. Otherwise, this 10-minute mean value shall be marked as being invalid. Whenever the share of 10-minute mean values marked as invalid exceeds a monthly mean of 5 %, the ultrasonic anemometer shall be inspected and, if necessary, shall be repaired and newly calibrated.

5.4 Wind Measurements Using SODAR

Notes:
(1) When applying the SODAR (**So**nic **D**etection **A**nd **R**anging) principle, the physical values of the wind field specified under Section 3 items a) through c) are determined from the Doppler shift of the acoustic signals reflected in the ambient atmosphere.

(2) Further explanations of ground-based remote sensing of the wind vector and the vertical structure of the boundary layer via Doppler sodar are given in VDI 3786 Part 11.

5.4.1 Measurement deviations and characteristic values

(1) The antennas of the SODAR device shall be aligned accurately in horizontal and vertical direction such that any deviations in determining the horizontal wind direction and the horizontal component of the wind speed caused by angular misalignments will not exceed the values specified in Sections 5.2.2.1 para.1 and 5.2.3.1 para. 2. A SODAR device shall be provided with fittings that prevent any unintentional change of the angular setting; these fittings shall also enable reproducing and checking this angular setting.

(2) Any 10-minute mean value which, on account of the signal-to-noise ratio, may be subject to an uncertainty of more than ± 0.1 m/s with regard to the radial component of the wind speed, shall be suppressed. The quantitative relationship between the measurement uncertainty of the radial component of the wind speed and the signal-to-noise ratio shall be proven.

Note:
In the case of SODAR devices the measurement uncertainty is related to the ratio between the useful signal level caused by sonar reflection in the ambient atmosphere and the noise signal level caused by ambient noise and electronic noise. Those measurement values for which the signal-to-noise ratio falls below a certain value and which, therefore, would cause the measurement uncertainty to exceed a certain value, will not be displayed. Thus, for a given measurement uncertainty, the yield of measurement values depends not only on the device parameters, but also on, e.g., the reflection capability of the ambient atmosphere and the noise level in the vicinity.

The measurement uncertainties of the wind direction and of the horizontal component of the wind speed are geometrically related to the measurement uncertainty of the radial component; thus, it is sufficient to specify only one of these measurement uncertainties.

(3) At the intended location, the share of the 10-minute values suppressed as specified under para. 2 shall not exceed 5% at any one of the measurements heights specified under Section 5.2.2.3. Compliance with this requirement shall be demonstrated over a period of six months.

5.4.2 Influence parameters

(1) The requirements specified in Section 5.4.1 shall be fulfilled at all ambient temperatures within the range between - 35 °C and + 45 °C.

(2) The proof specified in Section 5.4.1 para. 2 shall be repeated whenever the conditions at the location of the SODAR device – be it the intensity of the ambient noise or its temporal distribution, or the occurrence of reflections on obstacles – have changed with regard to the conditions under which the proof specified in Section 5.4.1 para. 2 had been performed, e.g., due to long-term building activities or the commissioning of new plants near the location of the SODAR device.

5.4.3 Measurement levels

When SODAR devices are used, the wind direction and wind speed shall both be determined at least at the measurement levels specified in Section 5.2.2.3 para. 1 items a) through c). The diffusion category shall be determined at the measurement levels specified under Section 7.4.2 para. 2.

5.4.4 Location

Note:
Regarding possible noise pollution, the German Technical Guideline on Protection Against Noise (TALärm) of August 26, 1998 (GMBl. 1998, p. 503) applies.

(1) The requirements regarding the location specified under Section 4.1 shall be fulfilled accordingly for the location of the SODAR antenna system.

(2) It shall be demonstrated by on-site test measurements that reflections do not influence the measurement values at the required measurement levels.

Note:
Generally, interferences from reflections can be avoided if

a) reflecting obstacles in a sector of at least 180° have an angular elevation smaller than 10° relative to the line-of-horizon, and
b) reflecting obstacles in the remaining sector have an angular elevation smaller than 30° relative to the line-of-horizon, and
c) reflecting obstacles in close proximity (at a distance of less than 15 m) are not higher than 1 m above the upper edges of the SODAR antenna.

5.5 Determining the Temperature Gradient for Calculating the Diffusion Category

(1) The vertical temperature gradient shall be measured using measurement sensors positioned in aerated thermal radiation protection pipes.

Note:
In this context, resistance thermometers are generally used. The vertical gradient is the temperature change with increasing height.

(2) The vertical temperature gradient shall be determined either by measuring the temperature at two measurement levels and subsequently calculating the difference, or by a direct measurement of the temperature difference. The gradient is the result of dividing the temperature difference by the difference of the measurement heights. The result shall be specified in K/100 m.

5.5.1 Measurement deviations and characteristic parameters

(1) In the nominal operating range between - 2 K/100 m and + 2 K/100 m the measured temperature gradient shall not deviate from the true value by more than ± 0.1 K/100 m. Within the nominal operating range, the highest and the lowest value of the deviation shall differ by no more than ± 0.05 K/100 m.

(2) An extended measurement range for the temperature difference shall be chosen such that, under consideration of the difference in measurement levels, temperature difference can be measured that would result in temperature gradients between - 4 K/100 m and + 8 K/100 m. In this extended measurement range outside of the range specified under para. 1, the measured temperature gradient shall not deviate from the true value by more than ± 0.3 K/100 m.

(3) If one of the two measurement sensors is subjected to a thermal radiation of 1100 W/m², then the temperature gradient calculated from the temperature difference after the display has stabilized shall deviate by no more than ± 0.1 K/100 m from the value obtained prior to switching on the heat source. This test shall be performed with constant ambient temperature at both measurement sensors; the ambient atmosphere shall be windless.

5.5.2 Influence parameters regarding the measurement sensors

(1) The nominal operating range of the temperature shall be between - 35 °C and + 45 °C. When varying the temperature within this nominal operating range, the measured temperature difference shall deviate by no more than 0.1 K/100 m from the value measured at the reference value of the temperature. This test shall be performed with all other influence parameters kept constant at their individual reference values.

(2) The reference value of the temperature (mean measurement value of the two measurement sensors) shall be specified by the manufacturer. It shall lie in the range between 15 °C and 25 °C. Reference value for the wind speed is the windless ambient atmosphere.

5.5.3 Measurement levels

The distance between the upper and the lower measurement level shall be at least 60 m and shall be no greater than 120 m. The lower measuring point shall be located at least 10 m above the disturbance level.

5.5.4 Mounting of the measurement sensors

(1) When mounting the measuring sensors for determining the temperature gradient, care shall be taken that the measurement is not detrimentally affected by heat sources or heat sinks.

(2) The temperature sensors shall be installed such that they are at least 10 m above any horizontal surfaces, i.e., when they are installed on the roof top of a building.

(3) The ventilator drawing in the air shall normally do this with as uniform a flow as possible. The ventilation speed shall normally be at least 2,5 m/s.

(4) If the temperature sensors for determining the temperature gradient are mounted on the vent stack, the upper measuring point shall be mounted to the vent stack down from the opening by a distance equal to at least one-and-a-half times the outside stack diameter at this location.

5.6 Measurement of Net Thermal Radiation

Notes:
(1) In this context, the net thermal radiation is understood as being the difference between the radiation within a range of wavelengths between 0.3 µm and 60 µm radiating down from the upper hemisphere minus that radiating up from the ground.

(2) Further explanations of meteorological radiation measurements are given in VDI 3786 Part 5.

5.6.1 Measurement deviations and characteristic parameters

(1) Within the range between - 200 W/m² and + 200 W/m², the measurement deviation of the net thermal radiation shall not deviate by more than ± 10 W/m² and, within the range from ± 200 W/m² to + 800 W/m², by no more than ± 5 % of the true net thermal radiation. In this context, the thermal radiation from the upper hemisphere shall be assumed to be no larger than 1000 W/m^2.

(2) The requirement specified under para. 1 applies if the ambient temperature is adjusted at a fixed reference value. The reference value shall be specified by the manufacturer of the measuring equipment. It shall lie between 15 °C and 25 °C.

5.6.2 Influence parameters regarding the measurement sensors

A variation of the ambient temperature within the nominal operating range between - 35 °C and + 45 °C may not affect the display by more than ± 40 W/m² with respect to the value measured at the reference value. This test shall be performed with the thermal radiation from above being constant and larger than 450 W/m² and the thermal radiation from below being constant and smaller than 200 W/m².

5.6.3 Mounting the measurement sensor

(1) The measurement sensor shall be mounted at a height of at least 1.5 m above a dense grass sod and shall be horizontally aligned.

(2) The measurement sensor shall be mounted such that the incident thermal radiation from, both, the upper hemisphere and the lower hemisphere can reach it with at little hindrance as possible. The location shall normally by chosen such that there are no long enduring shadow effects, e.g., from buildings or vegetation. The angular elevation of extended obstacles in the range swept over by the sun should not exceed 5° with regard to the line-of-horizon.

(3) The measuring sensor shall be mounted such that it is ensured that the measurement is not detrimentally affected by any heat sources or heat sinks.

5.7 Measurement of Precipitation

5.7.1 Measurement deviations and characteristic parameters

(1) The measurement range for the precipitation measurement shall extend from 0 mm to 10 mm over a 10 minute collecting time (measurement interval).

Note:
(1) Further explanations of precipitation measurements are given in VDI 3786 Part 7.

(2) Within the measurement range from 0 mm to 2 mm within a 10-minute interval, the measurement value shall not deviate by more than ± 2 mm from the true precipitation. Within the measurement range from 2 mm to 10 mm in a 10-minute interval, the measurement value shall not deviate by more than 10 % of the true precipitation.

(3) The proof of meeting these requirements shall be performed with the influence parameters wind speed and temperature kept as constant as possible at their individual reference values. Reference value for the wind speed is the windless ambient atmosphere. The reference value for the temperature shall be specified by the manufacturer and shall lie between 15 °C and 25 °C.

(4) The measurement device shall be operational within a temperature range from - 10 °C to + 45 °C.

5.7.2 Mounting the measurement sensor

(1) The catching surface shall be mounted approximately 1 m above ground and shall be aligned horizontally to within less than 3°.

(2) The measurement device shall be mounted such that measurements will not be impaired by obstacles, e.g., building structures or vegetation, even under high wind speed conditions,

Note:
This is, generally, the case if the angular elevation of extended obstacles does not exceed 45° relative to the line-of-horizon.

5.8 Measurement of Ambient Temperature

5.8.1 Measurement deviations and characteristic parameters

It shall be possible to measure ambient temperatures accurately to within ± 2 K in the range between - 35 °C and + 45 °C.

5.8.2 Measurement level

The ambient temperature shall normally be measured at a measurement level of at least 2 m above ground.

5.8.3 Mounting the measurement sensor

The measurement sensor shall be protected from direct sun radiation, e.g., by radiation shielding pipes, by mounting in a measuring hut.

5.9 Vent Air Measurements

5.9.1 Temperature of the vent air

It shall be possible to measure the temperature of the vent air accurately to within ± 2 K in the range between 10 °C and 100 °C.

5.9.2 Volumetric flow of the vent air

As specified in safety standard KTA 1503.1, the volumetric flow of the vent air shall be displayed accurately to within ± 5 % of the nominal volumetric flow.

6 Tests, Maintenance and Repairs

6.1 Tests

6.1.1 Test schedule and test instructions

The tests to be performed shall be compiled in a test schedule. Test instructions shall be drawn up for the individual tests.

6.1.2 Test certificates

All tests performed shall be certified by test certificates. The test certificates shall be stored. They shall contain at least the following information:

a) test object,

b) test documents,

c) test results,

d) date of test, and

e) name and signature of tester.

6.1.3 Initial tests

6.1.3.1 General requirements

(1) The components of the measuring equipment shall be subjected to the following tests:

a) certification of suitability,

b) factory test, and

c) commissioning test.

(2) The measuring equipment, including all of the measuring sensors, shall be calibrated and shall be adjusted such that the display will correspond to the value of the measurement parameter within its permissible deviation.

Note:
The measures and tests required in this context, are performed, depending on the type of equipment, in the course of fabrication, of the factory tests, of onsite assembly, or of the commissioning tests.

6.1.3.2 Certification of suitability

(1) Prior to the erection of the measuring device support and to the installation of the measuring equipment, a suitability check shall be carried out to certify that the equipment can fulfill its functions on the basis of the characteristics specified by the manufacturer. In this context, it shall, specifically, be tested whether the specifications comply with the requirements specified under Sections 4 and 5.

(2) The suitability check shall be carried out by the proper authority or an authorized expert appointed by the proper authority.

(3) Prior to the initial use of a certain type of device, the manufacturer of the measuring equipment shall prove to the proper authority or an authorized expert appointed by the proper authority that the type of measuring equipment actually possesses the properties postulated at the time of the test specified under para. 1, and in particular, that all requirements specified under Section 5 are fulfilled. Permissible certification procedures are:

a) satisfactory service life under comparable operating conditions,

b) individual test certificates,

c) acceptance of suitability certifications from other nuclear licensing procedures, and

d) trial operation.

6.1.3.3 Requirements regarding certification procedures

6.1.3.3.1 Satisfactory service life

Satisfactory service life shall be proven on the basis of the characteristics and ambient conditions specified for the operation of the individual measuring equipment by evaluating records of the time periods of prior operation of the measuring equipment under comparable operating conditions. The time period covered by these records shall be at least on year.

6.1.3.3.2 Individual test certificates

If individual test certificates regarding specific characteristics of the measuring equipment are available, they shall be recognized, provided:

a) It shall be possible to identify the type and design status of the tested measuring equipment at the time of the test.

b) A plant-independent tester or a plant expert of the manufacturer shall have performed the test.

c) The test shall be comprehensible with regard to the applied test schedule, the test parameters, the applied measurement means and methods, as well as to the documentation of the test results.

6.1.3.3.3 Acceptance of suitability certifications from other nuclear licensing procedures

If the suitability of a measuring equipment or of parts thereof have already been certified in a nuclear licensing procedure as meeting the requirements of this safety standard, then this certification shall be recognized.

6.1.3.3.4 Trial operation

In the case of measuring equipment for which the suitability cannot be proven by one of the procedures specified under Section 6.1.3.2 para. 3 items a) through c), the individual characteristics may be proven by a trial operation. The individual characteristics shall be evaluated on the basis of the operating records made over the time period to be specified.

6.1.3.4 Factory test

(1) A factory test shall be performed to certify the proper fabrication and perfect functioning of the measuring equipment.

(2) If the measuring equipment is comprised of components from different manufacturers, the proper fabrication and perfect functioning of these components shall be proven at the individual manufacturer. Nevertheless, the entire measuring equipment shall still be tested as specified under para. 1.

(3) The factory test shall be performed as a production test and shall comprise at least the following:

a) visual examination, and

b) functional test of the measurement sensors and of the electronic modules.

(4) The factory test shall be performed by plant experts of the manufacturers.

6.1.3.5 Commissioning tests

(1) After its installation, the proper manufacture and perfect functioning of the measuring equipment shall be proven in a commissioning test. The following shall be tested:

a) construction of the measuring equipment,

b) installation of the measuring equipment,

c) functioning and allocation to the displays, the recordings and alarms of the individual measurement sensors,

d) measurement value processing,

e) energy supply, and

f) available measurement sensor heaters and ventilation equipment as well as their failure alarms.

(2) The commissioning tests shall be performed by the plant licensee in participation with an authorized expert appointed by the proper authority.

6.1.4 Inservice inspections

6.1.4.1 General requirements

(1) The measuring equipment shall be subjected to recurrent inservice inspections and to tests and examinations following equipment replacement or repair, as well as after special meteorological events.

(2) The tests and examinations shall be performed in accordance with the test instructions that are to be prepared in accordance with Sec. 3.4 KTA 1202.

6.1.4.2 Recurrent inservice inspections

(1) The perfect functioning of the measuring equipment shall be demonstrated by performing recurrent inservice inspections. The tests and examinations to be performed in this context, as well as the corresponding test frequencies are listed in **Table 6-1**.

(2) The inservice inspection specified in **Table 6-1** shall be performed by expert personnel assigned by the plant licensee.

6.1.4.3 Tests and examinations following equipment replacement or repair

After completion of the replacement or repair, the plant licensee shall perform the tests specified under Section 6.1.3.5 para. 1 to certify a perfect functioning of the measurement chain concerned.

6.1.4.4 Tests and examination after special meteorological events

(1) Following special meteorological events, e.g., hail storms, lightning strikes, peak wind speeds exceeding 40 m/s, the measurement value recordings shall be checked for possible indications of a malfunction of the measuring equipment.

(2) In case a malfunction is indicated, detailed tests and examinations shall be performed.

6.2 Removal of Defects

(1) Any defects found in test and examinations or identified on account of plausibility checks as specified in Sections 7.2.4 or 7.3.4 shall be removed within the period of time specified in the operating instructions.

(2) In case of a failure or malfunction of the measuring equipment for measuring the wind direction or wind speed at the measurement level specified in Section 5.2.2.3 para. 1 item a), the repair procedure shall be started without delay immediately after occurrence of the failure or malfunction. The repair time of 100 h shall basically not be exceeded. In exceptional cases, substitute measures shall be provided in coordination with the proper authority.

6.3 Maintenance and Repair Tasks

6.3.1 Performing the tasks

(1) Maintenance and repair tasks on measuring equipment shall performed in accordance with the individual operating and maintenance instructions.

(2) The maintenance tasks specified in **Table 6-1** shall be performed at least with the frequency listed in this table.

6.3.2 Records on maintenance and repair tasks

Records shall be prepared on all maintenance and repair tasks performed. These records shall contain the following information:

a) unambiguous designation of the measuring equipment,

b) type of the maintenance or repair performed,

c) type and number of replaced component parts,

d) reasons for the replacement of component parts,

e) date of issue and detailed description of the test certificates required as specified in this safety standard for newly installed or repaired component parts,

f) information on the outage times,

g) date of the maintenance or repair, and

h) name and signature of the person responsible for the maintenance or repair.

7 Measurement Values

7.1 General

7.1.1 Alarms

Any response of failure monitors, e.g., for ventilators or heaters, shall be signaled to the control room as an alarm. In this context, collective alarms are permissible, provided, a display is provided at an easily accessible location indicating which measurement sensor or monitoring equipment initiated the alarm signal.

7.1.2 Selection circuit, correction analysis

In case multiple measurement sensors are needed to determine a measurement value, a display of the measurement values from all measurement sensors is not required, provided, an automatic selection circuit is provided, or a correction analysis performed, with which the representative measurement value is determined and subsequently displayed and recorded.

7.2 Measurement Value Monitoring and Display with Line or Dot Matrix Printers

7.2.1 Data output in the control room area

(1) The measurement signals of the measuring equipment for the following measurement parameters shall continuously be conducted to, and displayed in, the main control room:

a) wind direction at the measurement levels specified under Section 5.2.2.3 or Section 5.4.3,

b) wind speed at the measurement levels specified under Section 5.2.3.3 or Section 5.4.3,

c) diffusion category, or the measurement values required for its calculation,

d) precipitation,

e) ambient temperature,

f) volumetric flow of the exhaust air,

g) temperature of the exhaust air.

(2) In case more than one measurement sensor is required to determine a measurement value, then the output shall comprise the measurement values from each one of these measurement sensors.

7.2.2 Data output in the emergency control room area

(1) If accident management measures shall normally be performed from the emergency control room or from an equally

equipped facility, the output of the following measurement values shall be conducted to this locality in addition to being conducted to the control room:

a) wind direction at the top of the vent stack,

b) wind speed at the top of the vent stack, and

c) diffusion category, or the measurement values required for its calculation.

(2) In case more than one measurement sensor is required to determine a measurement parameter, then the output shall comprise the measurement values from each one of these measurement sensors.

7.2.3 Measurement value display and recording

(1) The display of the measurement values specified in this safety standard shall be spatially arranged together with the displays related to emission monitoring.

(2) Any single display device displaying measurement values specified in this safety standard may not display other values except for those related to emission monitoring.

(3) The measurement values shall be displayed and recorded in a clear and unambiguous form.

(4) The unambiguous and easily discernable correlation is required between the measurement value, its unit, the identification of the measurement parameter, as well as the date and time.

(5) Measurement values shall remain well legible over a period of the last three hours.

7.2.4 Plausibility check

(1) The visual examinations of the data output as specified in **Table 6-1** Item No. 12 shall be extended to checking the measurement value display with regard to possible indications of a malfunction of measuring equipment. The criteria used in this context may be, e.g., varying displays of otherwise redundant measurement sensors or displays that show a constant value over a long time period.

(2) If the plausibility check identifies faulty measurement values, the corresponding Sections of the recording strip shall be marked accordingly.

7.3 Computer-aided Measurement-Value Acquisition and Display

Note:
The application of computer based functions may be restricted to single measurement values or to parts of the measurement channel of a single measurement value.

7.3.1 Data acquisition

(1) Data acquisition of a measurement signal by a computer requires that the momentary measurement values are transferred in a cyclical sequence. The following cyclical transfer-call intervals shall not be exceeded:

wind direction:	60 s,
wind speed:	60 s,
wind direction with regard to determining the standard deviation:	5 s,
temperature gradient:	60 s,
net thermal radiation:	60 s,
ambient temperature:	10 min,
precipitation:	10 min,
volumetric flow of the exhaust air:	10 min,
temperature of the exhaust air	10 min.

(2) In case of those 10-minute mean values calculated from the momentary measurement values that are transferred to another computer for further processing, it is permissible to issue the transfer call for these momentary measurement values directly in 10-minute intervals. The computers involved shall be synchronized such that the transferred measurement values are correlated to the correct time interval over which they will be averaged.

(3) Those momentary measurement values or 10-minute mean values that must be discarded on account of alarms as specified in Section 7.1.1 or on account of a plausibility check as specified in Section 7.3.3 shall basically be marked accordingly. It is permissible, instead, to display the corresponding disturbance signal.

(4) With regard to testing measures, it shall be possible evaluate or display the momentary measurement values of each measuring equipment. In this context, it is permissible to display and evaluate the measurement values with the corresponding data acquisition computer, with the electronics of the measuring equipment, with a separate electronic subunit for testing, or in the control room.

7.3.2 10-minute mean values

(1) On the basis of the momentary measurement values acquired as specified in Section 7.3.1, mean values shall be calculated over time intervals of ten minutes each. In this context, any momentary measurement values that are invalid as specified in Section 7.3.1 or implausible as specified in Section 7.3.3 shall be discarded.

(2) The wind direction and wind speed shall be represented by vectorial mean values that shall be constructed in accordance with Sec. 6.2.1 VDI 3786 Part 2.

(3) In the case that the diffusion category shall be calculated from the standard deviation of the wind direction, this standard deviation shall be determined from the momentary measurement values of the wind speed acquired in a single 10-minute interval.

(4) If more than one momentary measurement value of the precipitation falls into a single 10-minute interval, the precipitation for this 10-minute interval shall be set equal to the sum of these measurement values.

Note:
The method of using momentary measurement values to calculate the precipitation over a certain time interval is dependent on the type of equipment used.

(5) In the case of any other measurement parameter, the momentary measurement values occurring more than once in a single 10-minute interval shall be averaged arithmetically. For the Obukhov length the arithmetic mean shall be carried out by its reciprocal value.

(6) In case any 10-minute mean values are discarded on account of alarms specified in Section 7.1.1 or on account of a plausibility check specified in Section 7.3.3, this shall basically be indicated accordingly in the status of the measurement value. It is permissible, instead, to display the corresponding disturbance signal.

(7) If the ratio of faulty momentary measurement values in a 10-minute interval exceeds 30 %, the 10-minute mean value shall be marked as being inadequate.

7.3.3 Plausibility check

(1) Plausibility checks shall be performed continuously and automatically.

(2) The momentary measurement values of, basically, all measurement parameters shall be checked at least with respect to whether they are within the measurement range. The momentary measurement values for the temperature gradient are excepted from this requirement.

Note:
The plausibility of measurement values can be checked, e.g., by checking the difference between concurrent measurement values from different measurement sensors, or by checking the difference between sequential measurement values.

(3) The automatic plausibility checks do not replace the visual examination specified in **Table 6-1** Item No. 12.

7.3.4 Data storage

(1) The 10-minute mean values of all measurement values specified in Section 7.3.1 shall remain directly accessible for at least 30 days.

(2) After 30 days, the data stored as specified in para. 1 may be transferred to a data storage medium that is not anymore directly accessible.

7.3.5 Output in the main control room area

(1) The requirement for a continuous output of measurement values in the main control room area may be dispensed with, provided, the data is stored as specified in Section 7.3.4 and the 10-minute mean values specified in Section 7.3.1 can be displayed in the main control room area on demand. In this context, a computer instruction shall cause a mutual display of the measurement values of the following parameters:

a) date and time of day,

b) wind direction at the top of the vent stack,

c) wind speed at the top of the vent stack,

d) diffusion category, or the measurement values required for its calculation,

e) precipitation,

f) ambient temperature,

g) volumetric flow of the exhaust air, and

h) temperature of the exhaust air.

(2) Once every day the measurement values from a continuous time period of at least three hours shall be displayed on the computer and in tabular form in order to enable performing the visual examination specified in **Table 6-1** Item No. 12.

(3) It shall be possible, on demand, to provide a printed output.

7.3.6 Output in the emergency control room area

The requirement for a continuous output of measurement values in the emergency control room area, or in an equally equipped facility, may be dispensed with, provided, the 10-minute mean values of these measurement values at the top of the vent stack (cf. Section 7.2.2 para. 1 items a) through c)) are stored as specified in Section 7.3.4 and can be displayed in the emergency control room on demand. In this context, a computer instruction shall cause the mutual display of the specified measurement values:

7.4 Evaluations

7.4.1 Determining a representative measurement value for a measurement level

When multiple measurement sensors are provided in order to reduce interference effects, then representative values shall be determined either by a selection circuit or by a correction analysis. The representative values shall normally be selected on the basis of the 10-minute values.

7.4.2 Determining the diffusion category

(1) With the objective of describing the turbulence condition, the diffusion category shall be determined.

Note:
The diffusion category can be determined from the measurement parameters to be measured as specified in Section 3.

(2) The determination of the diffusion category from the standard deviation of the vertical or of the horizontal wind direction shall normally be based on **Table 7-1**. The determination of the diffusion category from the vertical temperature gradient in connection with the wind speed shall normally be based on **Table 7-2**. The determination of the diffusion category of the basis of SODAR shall normally be based on **Table 7-3**. In this context, the determination of σ_w at the height of 100 m may b replaced by averaging over the measurement levels between 70 m and 130 m. The determination of the diffusion category from the net thermal radiation in connection with the wind speed as specified in **Table 7-4** shall normally be only carried out for use in long-term statistics or if the regularly scheduled determination methods have failed.

(3) Other determination methods shall be tested by the proper authority or an authorized expert appointed by the proper authority.

(4) If the measurement regarding the standard deviation of the wind direction is performed at another measurement level z than the measurement level of 100 m on which **Table 7-1** is based, new category boundaries shall be determined. This shall normally be based on the following equation

$$\sigma\,(z) = \sigma\,(100\ \text{m}) \cdot (z/100\ \text{m})^{-0,2} \qquad (7\text{-}1)$$

7.4.3 Statistics

(1) For a description of the meteorological conditions at the plant site, a four-dimensional statistics shall be prepared and kept available that includes the parameters wind direction at the top of the vent stack, wind speed at the top of the vent stack, diffusion category and precipitation; the statistics shall extend over the calendar year and over the summer half-year (1st of May to the 31st of October).

(2) The statistics specified under para. 1 shall be prepared on the basis of 1-hour mean values. These shall be calculated analogously to the 10-minute values as specified in Section 7.3.2.

(3) The statistics specified under para. 1 shall be based on the following classifications:

a) wind direction

   12 classes each with a width of 30° and the class boundaries at 345°, 15° etc.

b) wind speed

   10 classes; these are three classes with a width of 1 m/s each, starting at 0 m/s, followed by three classes with a width of 2 m/s, three classes with a width of 3 m/s and one class extending beyond 18 m/s.

c) diffusion categories

   6 classes designated as A to F or V to I.

N o t e :

(1) The diffusion categories A to F according to Pasquill corresponds with those after Klug/Manier V to I as follows: A(V), B(IV), C(III.2), D(III.1), E(II) and F(I).

(2) The determination of dispersion categories according to Klug/Manier is contained in VDI 3782 part 6.

d) precipitation (per hour)

4 classes: zero precipitation, precipitation up to 0.5 mm, precipitation between 0.5 mm and 3 mm, and precipitation more than 3 mm.

8 Documentation

8.1 Technical Documents

(1) The documentation of technical documents shall comprise:

a) system description,

b) manufacturer documents, and

c) documents regarding maintenance and repair.

(2) The system description shall normally contain a clearly arranged diagram showing the arrangement and interconnections of the measuring equipment. Correlated to this diagram, the measurement principles and the measurement value processing shall normally be specified for each measuring equipment. In particular, the criteria of the plausibility checks used in the system shall be specified as well as the selection table on which the determination of diffusion categories is based.

(3) Extent and content of the manufacturer documents shall, at least, be such that they meet the requirements in accordance with DIN EN 61187. In particular, they shall comprise the following documents.

a) equipment description,

b) documents regarding installation and erection,

c) operating instructions, and

d) maintenance and testing instructions of the manufacturer.

(4) The documentation on maintenance and repair shall comprise the documents specified in Sections 6.1.1, 6.1.2, 6.1.4.1 para. 2, 6.3.1 para. 1 and 6.3.2.

(5) The technical documents shall be compiled in the form of a life-time documentation for each measuring equipment that shall be kept up-to-date at all times.

8.2 Measurement Data

The measurement data recorded as specified in Sections 7.2.1 and 7.2.2 or stored as specified in Section 7.3.4 para. 2 shall, together with their temporal correlation, be stored over a period of at least five years.

Item No.	Test Object	Testing Method, Maintenance Task [1]	Test Frequency [2] by Licensee
1	Mechanical measurement sensors for wind direction and wind speed	Plausibility checks or visual inspection of the measurement sensor	every 14 days
		Replacement by calibrated reserve measurement sensors, and testing as specified in Section 6.1.4.3	annually
2	SODAR devices	Visual examination	every 14 days
		Checks with simulated echoes and plausibility check of the measurement values	annually
3	Ultrasonic anemometer	Plausibility check or visual examination of the measurement sensor	every 14 days
4	Measurement sensors of the net thermal radiation measurement	Visual examination and, if necessary, cleaning or replacement of the plastic hoods	weekly
		Replacement by calibrated reserve measurement sensors, and testing as specified in Section 6.1.4.3	annually
5	Measurement sensors of the temperature gradient measurement	Plausibility check or visual examination of the measurement sensor	every 14 days
		Replacement of the ventilation equipment, and testing as specified in Section 6.1.4.3	annually
		Comparison with precision thermometers	annually
6	Measurement sensors of the ambient temperature measurement	Plausibility check or visual examination of the measurement sensor	quarter annually
		Comparison with a calibrated thermometer	annually
7	Measurement sensors of the exhaust air thermometer	Comparison with a calibrated thermometer	annually
8	Volumetric flow of exhaust air	[3]	[3]
9	Precipitation measurement devices	Visual examination and, if necessary, cleaning	weekly
		Check of the calibration	annually
10	Electronic subassemblies	Simulation of measurement sensor signals by simulators or test equipment, comparison of all displays, recordings and further processing of measurement data	annually
11	Failure alarms, monitoring equipment	In the course of the inspection of the electronic subassemblies (Item No. 10)	annually
12	Measurement data display	Visual examination of the measurement data specified in Section 7.2.1 and, if applicable, Section 7.3.6	daily

1) Any replaced measurement sensors may be used again, provided, they are tested and no defects are detected.

2) Once every year under participation of the proper authority or an authorized expert appointed by the proper authority.

3) Tests and examinations in accordance with safety standard KTA 1503.1

Table 6-1: Recurrent inservice inspections and maintenance tasks

Standard Deviation in Degrees	Boundaries of Diffusion Categories				
	A/B	B/C	C/D	D/E	E/F
σ_ϑ	16.9	12.0	8.8	5.0	3.0
σ_φ	14.5	10.5	7.0	3.3	1.8
Sample reading: Given the condition of $10.5° \geq \sigma_\varphi > 7.0°$, the category C applies.					

Table 7-1: Determination of the diffusion category on the basis of the standard deviation σ_ϑ of the horizontal wind direction or of the standard deviation σ_φ of the vertical wind direction, each measured at a measurement level of 100 m.

(The values were determined with a vector-indicating wind vane.)

$\bar{u}_{10}$ in $\frac{m}{s}$	Boundaries of Diffusion Categories				
	A/B	B/C	C/D	D/E	E/F
	$\frac{dT}{dz}$ in $\frac{K}{100m}$				
0 through 0.9	- 1.13	- 1.03	- 0.91	- 0.37	+ 0.78
1.0 through 1.9	- 1.18	- 1.05	- 0.91	- 0.22	+ 1.12
2.0 through 2.9	- 1.39	- 1.18	- 0.97	- 0.16	+ 1.25
3.0 through 3.9	- 1.61	- 1.33	- 1.00	- 0.10	+ 1.32
4.0 through 4.9	- 1.82	- 1.48	- 1.04	- 0.04	+ 1.39
5.0 through 5.9	–	- 1.62	- 1.08	+ 0.02	+ 1.46
6.0 through 6.9	–	- 1.77	- 1.16	+ 0.08	–
7.0 through 7.9	–	–	- 1.25	–	–
8.0 through 9.9	–	–	- 1.40	–	–
equal or greater 10.0	diffusion category D applies to all values				
Sample reading: Given the condition of 2.0 m/s $\leq \bar{u}_{10}$ < 3.0 m/s and $-1.18 \frac{K}{100m} < \frac{dT}{dz} \leq -0{,}97 \frac{K}{100m}$, the diffusion category C would apply. The measured values of $\bar{u}_{10}$ shall be rounded to tenths of m/s before applying this table.					

Table 7-2 : Determination of the diffusion category on the basis of dT/dz, the temperature gradient, and of $\bar{u}_{10}$, the wind speed at a measurement level of 10 m above disturbance level

(The temperature difference is measured between 30 m and 100 m).

$\bar{u}_{100}$ in $\frac{m}{s}$	Boundaries of Diffusion Categories				
	A/B	B/C	C/D	D/E	E/F
	σw in $\frac{m}{s}$				
0 through 0.9	0.51	0.42	0.32	0.20	0.14
1.0 through 1.9	0.55	0.43	0.33	0.20	0.14
2.0 through 2.9	0.63	0.47	0.35	0.21	0.15
3.0 through 3.9	0.72	0.53	0.38	0.22	0.15
4.0 through 4.9	0.83	0.58	0.42	0.22	0.15
5.0 through 5.9	0.94	0.66	0.45	0.23	0.16
6.0 through 6.9	1.07	0.73	0.49	0.25	0.16
7.0 through 7.9	1.20	0.81	0.54	0.26	0.17
8.0 through 8.9	1.33	0.89	0.58	0.27	0.18
9.0 through 9.9	1.46	0.98	0.63	0.29	0.18
10.0 through 10.9	1.59	1.06	0.68	0.31	0.19
11.0 through 11.9	1.74	1.15	0.73	0.32	0.20
12.0 through 12.9	1.88	1.24	0.79	0.34	0.21
13.0 through 13.9	2.03	1.33	0.84	0.36	0.21
14.0 through 14.9	2.15	1.42	0.89	0.38	0.22
15.0 through 15.9	2.29	1.50	0.94	0.40	0.23
16.0 through 16.9	2.44	1.59	1.00	0.42	0.24
17.0 through 17.9	2.58	1.68	1.06	0.44	0.25
18.0 through 18.9	2.73	1.77	1.11	0.46	0.26
19.0 through 19.9	2.87	1.87	1.17	0.48	0.27

Sample reading:

Given the condition of 2.0 m/s $\leq \bar{u}_{100} <$ 3.0 m/s and 0.35 m/s $< \sigma w \leq$ 0.47 m/s, the diffusion category C would apply.

The measured values of $\bar{u}_{100}$ shall be rounded to tenths of m/s before applying this table.

Table 7-3 : Determination of the diffusion category on the basis of σw, the vertical component of the wind speed, and of $\bar{u}_{100}$, the average wind speed, each measured at a measurement level of 100 m

(The values were determined using a SODAR device).

$\bar{u}_{10}$ in $\frac{m}{s}$	Boundaries of Diffusion Categories				
	A/B	B/C	C/D	D/E	E/F
	Net thermal radiation in $\frac{W}{m^2}$				
0 through 0.9	214	125	60	- 2	- 9
1.0 through 1.9	214	126	60	- 4	- 13
2.0 through 2.9	301	162	60	- 6	- 21
3.0 through 3.9	400	232	63	- 12	- 34
4.0 through 4.9	495	305	67	- 28	- 55
5.0 through 5.9	—	376	84	- 55	—
6.0 through 6.9	—	450	108	—	—
7.0 through 7.9	—	—	150	—	—
8.0 through 9.9	—	—	240	—	—
equal or greater 10.0	diffusion category D applies to all values				

Sample reading:

Given the condition of 2.0 m/s $\leq \bar{u}_{10}$ < 3.0 m/s and of 162 W/m^2 $\geq$ net thermal radiation > 60 W/m^2, the diffusion category C would apply.

The measured values of $\bar{u}_{10}$ shall be rounded to tenths of m/s before applying this table.

Table 7-4: Determination of the diffusion category on the basis of the net thermal radiation and of $\bar{u}_{10}$, the wind speed at a measurement level of 10 m above disturbance level

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)
KTA 1202	(2017-11)	Requirements for the testing manual
KTA 1503.1	(2022-11)	Monitoring and assessing of the discharge of gaseous and dispersed particle-bound radioactive substances; Part 1: Monitoring and assessing of the stack discharge of radioactive substances during specified normal operation
DIN EN 60529	(2014-09)	Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989 + A1:1999 + A2:2013); German version EN 60529:1991 + A1:2000 + A2:2013
DIN EN 60529 Corrigendum 1; VDE 0470-1 Corrigendum 1:2017-02		Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989 + A1:1999 + A2:2013); German version EN 60529:1991 + A1:2000 + A2:2013, Corrigendum to DIN EN 60529 (VDE 0470-1):2014-09, (IEC 60529 Edition 2.2 Corrigendum 2:2015); German version EN 60529:1991/AC:2016-12
DIN EN 60529 Corrigendum 2; VDE 0470-1 Corrigendum 2:2019-06		Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989/A2:2013/COR1:2019); German version EN 60529:1991/A2:2013/AC:2019-02
DIN EN 61187	(1995-06)	Electrical and electronic measuring equipment - Documentation
VDI 3786 Part 2	(2018-05)	Environmental meteorology - Meteorological measurements concerning questions of air pollution; Wind
VDI 3786 Part 5	(2022-04)	Environmental meteorology - Meteorological measurements – Radiation
VDI 3786 Part 7	(2010-12)	Environmental meteorology - Meteorological measurements - Precipitation
VDI 3786 Part 11	(2015-07)	Environmental meteorology - Ground-based remote sensing of the wind vector and the vertical structure of the boundary layer - Doppler sodar