ČESKÝ METROLOGICKÝ INSTITUT

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Executive summary for the EC (not part of this legislation)

'*Measuring instruments used to monitor activity limits and volume activity of effluents from nuclear facilities, nuclear raw material mining or processing facilities, radioactive waste processing plants and from the processing or application of radioactive materials, and also used to determine environmental radiation exposure due to effluents – measuring instruments for the continuous monitoring of radioactive aerosols including transuranic aerosols in gaseous effluents from nuclear facilities*' may be placed on the market and put into use in the Czech Republic as specified measuring instruments pursuant to Act No 505/1990 on metrology, as amended. In accordance with this Act, specified measuring instruments are measuring instruments whose type is specified in the 'List of Specified Measuring Device Types' (Decree No 345/2002) and which are specified (by the manufacturer or importer) for measurements relevant to the protection of public interest in fields of *consumer protection, contractual relations, stipulation of sanctions, fees, tariffs and duties, health protection, environmental protection, occupational safety or protection of other public interests protected by separate legislation.* This is the same purpose of use by means of which specified products are defined – measuring instruments and scales with non-automatic operation pursuant to Directives 2014/31/EU and 2014/32/EU. The requirements of this regulation do not apply to measuring instruments which are not placed on the market in the Czech Republic for the above-mentioned purposes of use, defined by Act No 505/1990 on metrology.

The subject of this notified regulation is to lay down metrological and technical requirements for specified measuring instruments of the above-mentioned type. This regulation also stipulates tests for type-approval and verification of measuring instruments of the above-mentioned type.

(End of executive summary.)

PUBLIC NOTICE

As the authority with substantive and territorial jurisdiction in the matter of laying down metrological and technical requirements for legally controlled measuring instruments and stipulating the testing methods for type-approval and verification of legally controlled measuring instruments pursuant to § 14(1) of Act No 505/1990, on metrology, as amended (hereinafter the 'Metrology Act'), and in accordance with the provisions of § 172 et seq. of Act No 500/2004, the Code of Administrative Procedure (hereinafter the 'CAP'), the Czech Metrology Institute (hereinafter the 'CMI') commenced ex officio proceedings on 12 February 2016 pursuant to § 46 of the CAP, and, based on supporting documents, issues the following:

I.

D R A F T   G E N E R A L   M E A S U R E

number: 0111-OOP-C074-16

laying down the metrological and technical requirements for legally controlled measuring instruments, including testing methods for verification of the following legally controlled measuring instruments:

‘**measuring instruments used to monitor activity limits and concentration of effluents from nuclear facilities, nuclear raw material mining or processing facilities, radioactive waste processing plants and from the processing or application of radioactive materials, and also used to determine environmental radiation exposure due to effluents** – **measuring instruments for the continuous monitoring of radioactive aerosols including transuranic aerosols in gaseous effluents from nuclear facilities**’

1 Basic definitions

For the purposes of this general measure, terms and definitions pursuant to VIM and VIML[1] as well as the terms and definitions stated below shall apply.

1.1
gaseous effluent monitor

device intended for the continuous monitoring of radioactivity in gaseous effluents; individual parts of the device may be connected to two component devices, which may be connected or separated according to monitoring and operational requirements

1.2
aerosol monitor

device intended for continuous, delayed or subsequent measurement of aerosol activity in gaseous effluents released into the environment

1.3
aerosol

suspension of solid or liquid particles in air or gas

1.4
detection device

encompasses one or more radiation detectors and associated functional units

1.5
control and evaluation device

includes devices and functional units for measuring quantities associated with ionising radiation (activity, volume activity, etc.); the device has functional units for detecting clear warnings that the measured quantity exceeds the predetermined value

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[1] TNI 01 0115 International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM) and International Vocabulary of Terms in Legal Metrology (VIML) are part of the technical harmonisation compendium ‘Terminology in the Area of Metrology’, which is publicly accessible at www.unmz.cz

1.6
coefficient of variation

ratio V of standard deviation s and arithmetic mean of the $\bar{x}$ set of n measurements x_i, given by the relationship:

$$V = \frac{s}{\bar{x}} = \frac{1}{\bar{x}} \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2} \qquad (1)$$

1.7
detection limit L_D

measured value of the quantity obtained by the given measurement process, for which there is a probability of an inaccurate statement on the absence of an element in material β, where the probability of an inaccurate statement on its presence is α

In a sample with an actual content value of L_D, only 5 % of the measurement will be inaccurately declared as being indistinguishable from the background (type II error, β). Error β will equal precisely error α (type I error) of the background measurement, in which 5 % of the background measurement will exceed the detection limit. Implicit values for α and β equalling 0.05 are recommended.

Establishing the detection limit L_D :

$$L_D = 1.645 \sqrt{2u(B)} \qquad (3)$$

in which B ...... is the background value,

t .... is the time of the background measurement,

$u(B)$ .... is the standard background deviation

$$u(B) = \sqrt{\frac{B}{t}} \qquad (4)$$

1.8
coefficient of expansion

numeric coefficient (k) used as the multiple of combined standard uncertainty to obtain the expanded uncertainty

1.9
decision quantity

variable quantity used to decide whether the physical phenomenon in question is or is not present

1.10
decision level

fixed value of the decision quantity with which it is possible to decide that the given physical phenomenon is present if the result of the current measurement of the physical phenomenon is exceeded

1.11
effective measuring range of the meter

the range of values of the measured activity in which the properties of a part of the device or system meet the requirements of the specifications

1.12
dynamic range

signal ratio at the maximum measurable quantity value and the signal at the decision level

1.13
indication error

difference between the indicated value of the quantity **ν** and the conventionally correct value of this quantity $_{\nu c}$ at the measurement point

$$\Delta \nu = \nu - {}_{\nu c} \qquad (5)$$

1.14
relative fundamental error

the relative error of the indication e_i of the part of the device or system with respect to the given quantity at specified reference radiation and under specified reference conditions, expressed as:

$$e_i = \frac{\nu - \nu_c}{\nu_c} \qquad (6)$$

where: ν .... is the indicated value of the quantity,

ν_c .... conventional value of the quantity at the measurement point.

1.15
response time

is the time needed after a sudden change in the measured quantity in order for the change in the output signal to first reach the given relative value, usually 90 % of the final value

1.16
monitor sampling efficiency

is defined as the ratio of volume activity accessible to measurement on a capture medium and the volume activity in the air at the monitor input; it is the sum of the capture efficiency and air circuit monitor efficiency

1.17
capture efficiency

is defined as the ratio of the total activity accessible to measurement on the capture medium, such as a filter or charge of activated carbon, and the total activity in the air at the input of the capture medium

1.18
air circuit monitor efficiency

describes the loss of activity on the walls of the monitor between the input to the circuit and the capture medium; it is defined as the ratio of the total activity available for monitor sampling and the total activity in the air at the input to the monitor

1.19
reference response

under standard test conditions is given by the relation

$$R_{\mathrm{ref}} = \frac{A}{A_{\mathrm{C}}} \qquad (7)$$

where: A.......... is the volume activity value indicated by the test device or system,

A_c .... conventional volume activity value

1.20
sensitivity
is the ratio of the value obtained by the measurement to the conventional activity value

$$S = \frac{I - B}{A} \tag{8}$$

where: *I*.......... is the value indicated when measuring a radioactive sample;
B......... is the value indicated when measuring without a radioactive sample;
A......... is the conventional value of the activity of the sample measured

1.21
volume activity
activity per volume unit of air or gas

1.22
units
other than the statutory units, the following secondary units are used when appropriate:

- for time: year (y), day (d), hour (h), minute (min);
- for energy: electronvolt (eV);
- for volume activity: Becquerel per cubic metre (Bq/m^3)

1.23
classification of aerosol effluent monitors
The devices can be classified by measuring method, such as:

- total beta aerosol monitors;
- total alpha aerosol monitors;
- total alpha aerosol monitors and total beta aerosol monitors;
- monitors with alpha spectrometry.

They may also be classified by method of operation, such as:

- devices with static filter converter and simultaneous measurement;
- devices with mobile filter converter and simultaneous measurement;
- devices with mobile filter converter and delayed measurement;
- devices with mobile filter converter and simultaneous and delayed measurement;
- devices with static filter converter and simultaneous measurement combined with mobile filter converter and simultaneous and/or delayed measurement.

2 Metrological requirements

2.1 Defined operating conditions

An aerosol monitor must meet the metrological requirements in the range of work temperature and relative air humidity specified by the manufacturer.

2.1.1 Reference conditions and standard test conditions

The reference conditions and standard test conditions are listed in Table 1.

Table 1 — Reference conditions and standard test conditions

Influencing variables	Reference conditions	Standard test conditions
Ambient temperature	20 °C	18 °C to 22 °C
Relative air humidity	65 %	50 % to 75 %
Air pressure [1)]	101.3 kPa	86 kPa to 106 kPa
Supply voltage [2)]	Nominal supply voltage U_N	U_N ±1 %
Alternating supply voltage frequency [2)]	Nominal frequency	Nominal frequency ±0.5 %
Alternating supply voltage flow [2)]	Sinusoidal	Sinusoidal with a total harmonic distortion of less than 5 %
Background gamma radiation	Input air kerma 0.20 μGy/h	Input air kerma 0.25 μGy/h
Electrostatic fields	negligible	negligible
External electromagnetic field	negligible	less than the smallest value causing interference
External magnetic field	negligible	less than twice the Earth's magnetic field value
Sampling flow speed	Set to nominal flow rate (specified by manufacturer)	Set to nominal flow rate ±5 %
Control elements	Set for normal mode	Set for normal mode
Radionuclide contamination	negligible	negligible
Radon daughter products (222 and 220)	negligible	negligible
Chemical product contamination	negligible	negligible

1) If the detection method is particularly sensitive to changes in pressure, the conditions are limited to ±5 % of the reference pressure.

2) DC supply may be used, in which case the frequency is not specified.

2.2 Measuring range

The measurement range of the aerosol monitors is set by the manufacturer.

2.3 Instrument accuracy

The manufacturer must establish the ratio between the value on the measuring device and the activity of the reference source, when the device is operating at standard test conditions and is set according to the manufacturer’s instructions. The reference response uncertainty must be specified. The reference response may not differ from the values specified by the manufacturer by more than 20 %.

2.4 System linearity

At standard test conditions, the relative error of indication must be less than ±10 % for the entire effective measurement range. Uncertainty of radioactive sources is not included. If fixed sources are being used, then ν and $_{vc}$ relate to sensitivity when calculating relative error.

2.5 Change in detection efficiency as function of beta radiation energy (beta aerosol monitors)

The change in the device’s detection efficiency may not exceed the limits specified by the manufacturer. The manufacturer must specify the monitor’s behaviour for energy less than 150 keV upon request. A typical calibration curve indicating the change in detection efficiency with beta radiation energy must be provided with each device. The manufacturer must specify the beta radiation energies selected. The thickness and type of materials between the filter and the sensitive volume of the detector must be specified. The results must be expressed as the ratio of the instrument's indicated unitary surface emission input specification for the given beta radiation source used to the indicated unitary surface emission input specification for the reference beta radiation source.

2.6 Response to radioactive gases

The manufacturer must specify the response to the respective radioactive gases present in the sample of air or carrier gas.

2.7 Response to daughter products ^{222}Ra

Since the relationship between response to daughter products of radon and the decision level and both parameters usually depends on the given use in operation, the response to daughter products of radon and the decision level must be agreed upon by the manufacturer and the user.

2.8 Particle collection efficiency

The manufacturer must specify the collection efficiency of the sampling device for particles of a range of at least 0.1 μ, to 10 μof the aerodynamic equivalent of the average or, for other values, according to the agreement between the manufacturer and user. The efficiency values are specified for standard operating conditions, such as for air sampling flow rate

2.9 Response to ambient gamma radiation

Since the relationship between response to ambient gamma radiation and the decision level and both parameters usually depends on the given use in operation, the response to gamma radiation and the decision level must be agreed upon by the manufacturer and the user. The manufacturer must specify the decision level and the maximum indication level when a detector with elements for protection from ambient gamma radiation is irradiated in the position specified by the manufacturer with a sudden change in input air kerma from the reference background input air kerma to 10 μGy/h for radionuclide ^{137}Cs. The response to irradiation with gamma radiation at any orientation and any gamma radiation energy up to 1.3 MeV (radionuclide ^{60}Co) may not exceed two times the value of the decision level.

2.10 Overloading

Unless the manufacturer and user agree otherwise, the device must indicate a specification off the scale at its upper end or indicate overloading when irradiated with a source with an activity (or surface emission input) 10 times greater than that corresponding to the maximum measurement range, and then function normally after the overloading is eliminated.

2.11 Detection and evaluation device uptake time

When irradiated with a radiation source, the device must indicate a value which will not vary by more than ±10 % from the value obtained under standard conditions in a period of up to 30 minutes after being switched on.

2.12 Statistical fluctuation

In light of the statistical nature of radiation, the values read out may fluctuate around the mean value. The coefficient of variation of the activity value caused by the statistical fluctuations must be less than 10 % for values exceeding the first increment of 10 on the effective measurement range.

2.13 Stability of values on detection and evaluation device

The specification indicated with the given radiation source after 30 minutes of device operation may not change by more than 10 % for the next 100 hours.

2.14 Flow rate stability

The purpose of this test is to establish the nominal flow rate of sampling and the stability of sampling under standard test conditions with a loss of pressure caused only by the air circuit and input or sampling filter (clean filter). The manufacturer must specify the nominal flow rate for the filter type used. After the standard sampling device uptake time (30 minutes), the indicated sampling flow rate may not differ by more than ±10 % from the conventional flow rate value and the sampling flow rate may not change by more than 10 % for the next 100 hours.

2.15 Influence of pressure loss on the filter

Because the influence of the filter properties and the degree of blockage may vary from test to test, only the measurement of the total drop in pressure and flow rate are taken into consideration. The purpose of this test is to establish the increase in the drop in pressure at the filter causing a 10 % reduction from the nominal air-flow rate under standard conditions. An acceptable minimum drop in pressure which may cause a 10 % reduction from the nominal flow rate must be agreed upon by the manufacturer and user. For this drop in pressure, the flow rate indicated by the monitor may not differ by more than ±10 % from the conventional flow rate value.

2.16 Influence of supply voltage on flow rate

The flow rate may not change by more than 5 % if the supply voltage changes between +10 % and -12 % of the nominal supply voltage.

2.17 Influence of supply voltage frequency

The flow rate may not change by more than 10 % if the supply voltage frequency changes from 47 Hz to 51 Hz.

2.18 External leak

This test is intended to determine the extent of an external leak, but not an internal leak around the filter holder or collection device. Air or gas leakage in the device upstream of the flowmeter must be less than 5 % of the nominal flow rate.

2.19 Ambient temperature

The indicated specification must remain within the limits specified in Table 2 for the temperature range specified by the manufacturer. It must be noted that, for this type of device, the detection and sampling device can work under other climatic conditions than the evaluation device. Part of or the entire detection device can work at a temperature higher than that specified in Table 2. In such case, the applicable test must be agreed upon by the manufacturer and user.

Table 2 – Ambient temperature

Ambient temperature	Deviation from value under standard conditions
+10 °C to +35 °C (median: +22 °C)	±10 %
−10 °C to +40 °C (median: +15 °C)	±20 %
–25 °C to +50 °C (median: +12 °C)	±50 %

2.20 Relative air humidity

The deviation caused by relative humidity up to 90 % at 35 °C must be less than 10 %.

3 Technical requirements

3.1 General requirements

The main requirement is the ability to measure a defined effluent level characterised by the volume activity and overall flow rate of the effluent.

3.2 Monitor types

3.2.1 General

The types of gaseous effluent monitoring under consideration are monitors of radioactive aerosols, monitors of rare gases and monitors with specific differentiation of radionuclides.

3.2.2 Aerosol monitors

This device usually includes some kind of means of collection on a sampling medium, such as a static filter or moving filter which is monitored by a suitable detection device. The selected detector must be suitable for the given type of radioactivity.

3.3 Effluent sampling

If the given type of measurement requires sampling, the effluent must be sampled at a representative point of the effluent pipe in order to measure the actual leakage downstream of the input points and capture of radioactive substances.

If, however, the required sensitivity is too low for reasonable measuring and if the activity comes from one or more well-defined sources, it is a good idea to measure the effluent locally before further dilution with non-radioactive effluent. In this case, effluent from all sources of radioactive contamination must be monitored either collectively or individually. If flow capture devices are downstream of the effluent sampling point, the activity indicated by the monitor is not the activity of the actual leak and the efficiency of the capture device must be determined in order to estimate the actual leaks.

In both cases, two methods are possible.

1. Measuring without withdrawing part of the flow relies on positioning the detector into the effluent flow or near the effluent flow. This has the advantage of simplicity and reduces problems associated with the representativeness of the sample. For a gas monitor, for instance, the detector may be positioned into the effluent flow; it must then be calibrated to the actual geometry for which it is used. Furthermore, it is necessary to prevent radioactive particles from gathering on or near the detector, because this may interfere with the measurement.
2. Measuring with a withdrawn part of the flow enables the detector to be positioned in an environment which is more suitable for measuring (as far as temperature, gamma background, etc. are concerned). For example, this enables particles and steam to be removed from the sample when gases are being measured. However, it is necessary to make sure the sample is representative.

NOTE The following characteristics should be taken into consideration:

- optimal number and positioning of the sampling nozzles;
- internal pipe diameter;
- type of material used with specific regard to corrosion caused by chemical influences and electrostatic phenomena;

- surface treatment of internal surfaces;
- radius of curvature and direction of change;
- length of pipe, inclination;
- connection of the pipe, to external pipe, to monitor;
- influence of harmful chemical products and water vapours.

Problems may occur if the measured effluent has a high temperature and/or high pressure. One solution is that the detector works under similar conditions. Another solution relies on preparing the sample at normal pressure and temperature (this is only possible when sampling part of the flow); the design of such an adjustment device is not the subject of this regulation, but the manufacturer and user must ensure that this device does not influence the representativeness of the sample.

3.4 Activity collection

If direct effluent flow measuring or withdrawal of a representative sample is not possible due to low volume activity of the effluent flow, then various methods of collecting activity may be considered prior to measurement. There are two approaches:

- measuring activity during collection;
- measuring after collection with a continuously repeating collection/measurement cycle.

The most common such procedure is the concentration of air particles, vapours or gases on a suitable sampling medium. The medium may be in the form of a belt or volume absorption granules in a suitably packaged system. After collection, the medium is exchanged and arranged so that one sample is measured and the next sample is collected.

3.5 Measurement and indication characteristics

3.5.1 Effective measuring range

The effective measurement range must be suitable for the given application.

3.5.2 Measurement characteristics

The manufacturer must indicate the device’s decision level, detection limit and effective measurement range. These characteristics should be specified for specific radionuclides in consideration of the level of background reference gamma radiation (0.2 μGy/h) and volume activity in the air (radon and its daughter products).

3.5.3 Display

It is desirable for the indicated value to be the actual volume activity of the effluent. This volume activity is usually given at Bq/m^3 of the equivalent of the reference radionuclide or mixture thereof.

3.6 Reliability

The uptake time for the entire device must be less than 30 minutes.

All devices must be designed to be reliable with a minimum of undetected malfunctions wherever possible.

The manufacturer must provide documentation on the expected average service life of critical components such as the air pump, detector, flow meter, etc.

The manufacturer must specify the periodicity at which maintenance must be repeated and fully describe all maintenance procedures. The requirements for this maintenance should be as small as possible.

Alarms should be available for failures to indicate that the system has a fault, such as a power cut or component malfunction.

3.7 Characteristics of sample flow rate fraction from the effluent flow

3.7.1 Pump

If a pump is an inseparable part of any device, then the following requirements must be met:

a) must be positioned downstream of the filter or activity measuring unit;
b) must be capable of uninterrupted operation between planned maintenance tasks. The frequency of maintenance tasks must be agreed upon by the manufacturer and user, but may not be more frequent than once every six months. The design must enable easy access to the pump and replacement of its parts;
c) must enable a constant flow rate to be maintained which is suitable for the given measurement method. If the method of measuring volume activity is sensitive to flow rate, the pump must be such that the flow rate is only slightly influenced by a change in the drop in pressure in the circuit.

3.7.2 Flow rate control

If the measurement method is sensitive to flow rate, a device to control the flow rate must be used which has a range of flow rate settings sufficient to allow for changes in the intrinsic characteristics of the air pump and all filters used.

3.7.3 Flow rate measurement

If the measurement method is sensitive to flow rate, a device to measure the flow rate must be used with an alarm warning of any excessive change in flow rate. The flow rate must be measured downstream of the collection medium and upstream of the pump. The sampling flow rate must be expressed in SI units. The pressure and temperature at which the flow rate meter is calibrated and at which the flow rate is expressed must be available. The necessary corrections must be made to the actual effluent conditions.

3.7.4 Pressure control

If the measurement method is sensitive to pressure within the measuring chamber, a device to measure the flow pressure must be used with an alarm warning of any excessive change in pressure in the measuring chamber.

3.8 Alarms

3.8.1 Types of alarm

Alarms and indication elements must be suitable for the device’s purpose and must be agreed upon by the manufacturer and the user.

High-level alarms and malfunction alarms must provide separate local visual value on the monitor and must also have two sets of output contacts (which may be collective for all malfunction alarms) for the purposes of external alarms. Audio alarms may also be provided.

All alarm functions must have a means of testing to check the functionality of the alarm. In case of an adjustable alarm, inspection must be possible within the range of settings with an indication of the current alarm operation point.

Alarm circuits must function either in a mode in which alarm conditions are maintained until specific zeroing via zeroing control or in an automatic zeroing mode in which the state of alarm disappears.

3.8.2 High-level alarms

A high-level adjustable alarm covering the entire effective measurement range must be provided.

3.8.3 Malfunction alarms

The following must be provided:

- alarm indicating loss of detector signal;
- alarm indicating loss of sampling in the circuit;
- alarm indicating malfunctions in the electronic system circuits.

Wherever possible, alarms should indicate the source of the largest possible number of malfunctions and should have an automatic diagnostic system.

There should be a separate value for each malfunction.

3.9 Means of indication

Aside from the visual display of measured values, the device should have operating values for:

- power supply on;
- air pump on (if used);
- high-voltage power supply to detector on (if used);
- flow and/or level of coolant supply for detector (if used).

If air flows through the device, then a suitable flow measurement value must be provided.

An output enabling remote measurement and alarm value must be provided.

3.10 Means of checking operation

Means must be provided which enable the user to periodically check that the device is operating satisfactorily, including calibration and linearity of measurement verification. These means should usually be installed so as to enable checks to be carried out from the control and evaluation unit.

It must be possible to check the calibration of the device at two representative points in the measurement range.

This check must be conducted by means of one or, if necessary, several suitable radioactive sources. Linearity of measurement may be checked electrically.

3.11 Means of adjustment and maintenance

All electronic devices must have a sufficient number of easily accessible testing points to simplify adjustments and fault localisation. All special instruments for maintenance and the necessary maintenance instructions must be supplied.

The design of all devices must enable easy repair and maintenance.

Information on automatic diagnostic elements should be accessible on the display.

3.12 Detection device or sampling and detection device

This device contains one or more radiation detectors and potentially one or more of the following sub-devices and functional units:

- sampling and suction pipe;
- container or other apparatus for eliminating short-term disruptive gaseous radionuclides;
- means of removing samples for laboratory analysis and for calibration tests with radioactive gases;
- device to cool the detector;
- sampling chamber;

- device to catch air particles;
- device to move filter;
- device to protect from ambient gamma radiation;
- device to monitor and control air-flow rate;
- air pump;
- device to measure temperature, where appropriate.

The detection device or sampling and detection device must be designed so as to minimise internal contamination and simplify decontamination when necessary. The outer surfaces should be specially treated to enable decontamination.

If possible, the monitor should be designed so as to minimise the effects of mechanical impacts.

Under certain circumstances, the effluent flow may contain an explosive mixture of gases. In this case, the device must be designed so as to prevent the possibility of the effluent being ignited by the instrument.

The effluent may also contain harmful and corrosive chemical vapour and a special arrangement is needed to protect the measuring systems.

If the detector is cooled from a local supply tank, it should not be necessary to fill up the tank more often than every eight days.

3.13 Control and evaluation device

The control and evaluation device primarily contains the following parts:

- electrical control unit and power supply;
- electronic measuring device;
- measurement display unit;
- warning signal and alarm units.

The device may be connected to a radiation situation central display panel. In this case, it must be possible to install it in electronic frames of normal dimensions.

3.14 Ambient background shielding or compensation devices

These devices or procedures are used to reduce ambient background influence on the measurement. There are the following types:

- shielding devices;
- electronic devices;
- software methods.

These types may be integrated into the overall design of the system if necessary.

The shielding should provide the same radiation attenuation in all directions from the detector's sensitive surface area with consideration of the detection device's construction materials and the detector's angle responses. The thickness of the shielding must be determined with respect to the detector's detection efficiency.

If it is not possible to easily remove the device from the shielding, this shielding must be easily dismantled, and thus made up of constructional overlapping elements with a weight of 15 kg or less, unless agreed upon otherwise by the manufacturer and user.

If electronic methods with the use of additional detectors are used to reduce gamma background, these detectors must be selected and positioned so as to achieve the best possible compensation in consideration of the gamma energy range and direction of radiation.

3.15 Device noise level

The device's noise level primarily comes from the sampling and detection device and especially from the operation of the air pipe system and the arising vibrations.

The manufacturer must select components and design the device so that the noise level will be minimal and in compliance with the type of environment for which the device is intended.

3.16 Electromagnetic interference

The measuring instruments may not be influenced by electrical and electromagnetic interference from the surroundings and must meet the requirements of separate legislation2. The change in measuring instrument response may not exceed 1 % during the interference influence test. All necessary measures must be taken against the effects of electromagnetic interference and includes that which is received as well as emitted by the device.

Severity level 3 is used for resistance.

Severity class A is used for radiation emission.

3.17 Power supply

The device should be designed for operation from single-phase alternating current voltage in one of the following categories:

- Series I: 230 V a.c.;
- series II: 100 V a.c.;
- series III: 120 V and/or 240 V a.c.
- series IV: 24 V d.c.

The device may be designed for operation from a low-voltage backup source in case of a disturbance in power supply. In such cases, it is desirable for the device not to indicate a malfunction or trigger an alarm as a result of switching over the power supply; and indication of this switch-over should be provided.

Three-phase power supply may be used for air pump motors.

3.18 Protection against unauthorised tampering

The parts of the measuring instrument essential to its metrological characteristics must be designed to be secured in such a way as to provide proof of any unauthorised interference.

If the measuring instrument's response can be adjusted by correcting the long-term change in response, correcting the influence of temperature and pressure on response or applying a corrective factor, then the measuring instrument must be designed so as to prevent unintentional change of any adjustment factor by the operator.

Control switches and potentiometers must either be inside the measuring instrument and inaccessible from the outside without using tools, or be clearly marked and fitted with a scale so that they can be precisely adjusted according to the resolution of the measuring instrument and then locked in order for the settings not to be changed accidentally. Correction factors and calibration coefficients stored digitally may not be changed unless the operator enters the security code (or password) or changes the position of the blocked or inaccessible switch.

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[2] Government Regulation No 117/2016 on product conformity assessment regarding electromagnetic compatibility when supplied on the market

3.19 Safety

The measuring instrument must be safe in accordance with the basic principles of safety of ionising radiation installations and the requirements of relevant technical regulations under the conditions of normal use for the intended purposes.

4 Measuring instrument markings

4.1 Markings on the measuring instrument

The following information must be provided on each part of the measuring instrument, which may consist of two functionally separate parts:

a) Manufacturer identification;
b) Designation of the type of measuring instrument;
c) serial number of the detector(s), evaluation unit of the measuring instrument, pump, flow meter;
d) type-approval mark;
e) information on the safety of the ionising radiation measuring instrument.

All labels and inscriptions must be legible, durable, unambiguous and unalterable.

4.2 Placement of the official mark

The placement of official marks on the detection part and the evaluation unit is specified in the type-approval certificate.

Where possible, marks are to be placed on the front panel of the display unit so that they do not cover any of the data on the measuring instrument.

5 Type-approval of measuring instrument

5.1 General

The measuring instrument type-approval process includes the following tests:

a) External inspection;
b) instrument accuracy;
c) system linearity;
d) change in detection efficiency as function of beta radiation energy (beta aerosol monitors);
e) response to radioactive gases;
f) response to daughter products ^{222}Ra;
g) response to ambient gamma radiation;
h) overloading;
i) detection and evaluation device uptake time;
j) statistical fluctuation;
k) stability of values on detection and evaluation device;
l) flow rate stability;
m) influence of pressure loss on the filter;
n) influence of supply voltage on flow rate;
o) influence of supply voltage frequency;
p) external leak;
q) influence of ambient temperature;

r) influence of relative air humidity;
s) electromagnetic compatibility.

5.2 External inspection

The external inspection assesses

a) the completeness of the prescribed technical documentation, including the operating instructions;
b) the conformity of the metrological and technical characteristics specified by the manufacturer in the documentation with the requirements under this regulation as referred to in Chapters 2 and 3;
c) the completeness and status of the functional units of the measuring instrument according to the prescribed technical documentation;
d) the software version of the measuring instrument with the version specified by the manufacturer.

5.3 Functional tests

5.3.1 Instrument accuracy

The device operates under standard test conditions and is set according to the manufacturer’s instructions without reference radiation being present. The background value is recorded. Then the device is irradiated with a suitable reference source with sufficient activity to provide a value approximately in the middle of the scale or several increments of 10 above the lowest scale or increment of 10. The specification indicated is recorded and the value R_{ref} is quantified.

The measured value must not exceed the permitted change limits specified in Article 2.3.

5.3.2 System linearity

The test is conducted with a set of sources of the same radionuclide and geometric characteristics. However, standard preparation of the test sources used in the required tests must be such that the absolute conventional uncertainty of the activity value ($_{\varepsilon sa}$) of each source is better than 10 % (k = 2) and the relative uncertainty of conventional activity value ($_{\varepsilon sr}$) between the sources of the given test set is better than 5 % (k = 2).

The tests may be carried out two ways:

a) with gaseous or solid radioactive sources;
b) with an electrical signal supply.

The tests are conducted at a single point on each scale for devices with a linear scale and on each increment of 10 on the effective measurement range for devices with a numerical or logarithmic display approximately at 25 % of the most sensitive range or increment of 10, at 50 % of the maximum moderate range or increments of ten and 75 % of the maximum value. At least three of these tests must be carried out with the help of a radioactive source, while two are on threshold values. If electrical signals are used, they must be used at all ranges or increments of 10 (in addition to radionuclide sources).

The measured value must not exceed the permitted change limits specified in Article 2.4.

5.3.3 Change in detection efficiency as function of beta radiation energy (beta aerosol monitors)

The tests are conducted with at least three sources of beta radiation, the maximum energies of which are divided as follows:

- for one source ≥ 0.4 MeV;
- for one source between 0.4 MeV and 1 MeV;

- for one source ≤ 1 MeV.

The sources of beta radiation used may be selected from the list on Table 3.

Table 3 — List of radionuclide suitable for tests with change of beta energy

Radionuclide	**Half-life**	**Maximum beta radiation energy** (MeV)
^{63}Ni	96 y	0.0659
^{14}C	5 730 y	0.1565
^{203}Hg	46.6 d	0.2122
^{147}Pm	2.6234 y	0.2247
^{45}Ca	163 d	0.2569
^{60}Co	5.271 y	0.3179
^{137}Cs	30.0 y	0.51155 (94.6 %)
		1.1732 (5.4 %)
^{185}W	75.1 d	0.4324
^{204}Tl	3.779 y	0.7634 (97.4 %)
^{36}Cl	3.01×10^5 y	0.70955 (98.1 %)
^{198}Au	2.696 d	0.28241 (1.30 %)
		0.9607 (98.7 %)
^{89}Sr	50.5 d	1.4913
^{32}P	14.29 d	1.7104
^{90}Sr+^{90}Y	29.12 y	0.545
		2.2839

All sources used must have sufficient activity to reach the indicated specification with a standard deviation of less than 1 %.

Tests of change in detection efficiency with alpha radiation energy are not required, since the detection efficiency usually does not depend on energy.

If mixed alpha-beta activities are used to measure beta or alpha activities in the effluent, then the measurement may be influenced by a second non-specific radiation. The limit of detection efficiency for non-specific radiation must be less than 2 % for sources of beta radiation in the alpha channel and 25 % for sources of alpha radiation measured in the beta channel.

Detection efficiency (ε) must be expressed by the frequency of impulses in relation to the surface emission input of the respective source and is as follows:

$$\varepsilon = \frac{\text{četnost impulsů}}{\text{příkon plošné emise}} \quad (9)$$

četnost impulsů	frequency of impulses
příkon plošné emise	surface emission input

The given device’s detection efficiency must be determined for the second radiation with the help of a source of the second radiation (an alpha radiation source for a beta monitor, a beta radiation source for an alpha monitor). The sources of radiation need not necessarily be sources with reference energies, but they should be sources which probably cause interference: such as ^{241}Am for alpha radiation and ^{90}Sr + ^{90}Y for beta radiation.

The efficiency stated in the same units as ε_{ref} must be:

$\varepsilon \geq 0.02\ \varepsilon_{ref}$ for beta radiation in the alpha channel

$\varepsilon \geq 0.25$ $_{\varepsilon ref}$ for alpha radiation in the beta channel

The measured value must not exceed the permitted change limits specified in Article 2.5.

5.3.4 Response to radioactive gases

The manufacturer must specify the response to the respective radioactive gases present in the sample of air or carrier gas.

Two methods may be used.

1. A known volume activity of rare gas (such as ^{133}Xe or ^{85}Kr) is supplied to the monitor for the amount of time necessary to reach an equilibrium. A reading corresponding to the equilibrium value is recorded. The result is expressed as the ratio of the indicated value to the volume activity of the test gas.
2. The supply air pipe is connected to the output air pipe and the total volume of air in the pipe is measured (e.g. the supply air pipe is connected to a known volume under pressure and the change in pressure at equilibrium is recorded). A small volume (1 % of the volume of the air pipe) of gas such as ^{133}Xe or ^{85}Kr of a known activity is fed into the system. The aerosol monitor is then operated normally. A response corresponding to equilibrium is recorded and the highest value is reached. The result is expressed as the ratio of the indicated value to the volume activity of the gas being tested.

The measured value must not exceed the permitted change limits specified in Article 2.6.

5.3.5 Response to daughter products ^{222}Ra

Since the relationship between response to daughter products of radon and the decision level and both parameters usually depends on the given use in operation, the response to daughter products of radon and the decision level must be agreed upon by the manufacturer and the user.

The manufacturer must specify the decision level and the maximum indication level when a detector with elements for radon compensation is exposed to the effect of natural radioactive aerosols with a sudden change in volume activity from reference background without the presence of radon and its daughter products to a_{vRa}= 1 kBq.m^{-3} from ^{222}Ra. The manufacturer must specify the method used to reduce the influence of daughter products of radon on the monitor's response and a test must be conducted to establish the effectiveness of this method. Natural and artificial radioactive aerosols can be distinguished using special algorithms by processing the primary frequency of impulses measured by the detector at the filter or by another technique intended to separate the signal of the artificial aerosols from the natural ones and thus suppress their influence on the measurement result as much as possible. The quantity characterising this process is called the radon compensation coefficient k_{Ra} and is defined as:

$$k_{Ra} = \frac{L_{D,0}}{L_{D,Ra}} \tag{10}$$

in which $L_{D,0}$ is the detector's detection limit determined without the presence of radon and its daughter products and $L_{D,Ra}$ is the detector's detection limit at a_{vRa} = 1 kBq.m^{-3}

The device must work under standard test conditions without the presence of a radioactive source and the indicated background specification is determined. Depending on its design, the detector is then exposed to the influence of ^{222}Ra, air of a known volume activity is fed through the detector, or the detector is placed in an area with a known volume activity of ^{222}Ra. The method of influencing the ^{222}Ra detector must be in accordance with the manufacturer's specifications. After the onset of irradiation, the values are recorded at intervals of one minute and recording is continued until the device gives a stable value. Once a stable state has been reached, at least 10 readouts are carried out. The detection limit is determined based on the final readouts and the radon compensation coefficient. This must be in accordance with the manufacturer's specifications.

The detector is then irradiated in several different volume activities as agreed upon by the manufacturer and user. If the evaluation device can be programmed with a compensation factor for ^{222}Ra, then the factor must not be changed during this test. The readout on the evaluation device may not exceed two times the value specified by the manufacturer for a_{vRa} = 1 kBq.m^{-3} for all volume activities of ^{222}Ra.

The measured value must not exceed the permitted change limits specified in Article 2.7.

5.3.6 Response to ambient gamma radiation

Since the relationship between response to ambient gamma radiation and the decision level and both parameters usually depends on the given use in operation, the response to gamma radiation and the decision level must be agreed upon by the manufacturer and the user. The manufacturer must specify the decision level and the maximum indication level when a detector with elements for protection from ambient gamma radiation is irradiated in the position specified by the manufacturer with a sudden change in input air kerma from the reference background input air kerma to 10 μGy/h for ^{137}Cs. The response to irradiation with gamma radiation at any orientation and any gamma radiation energy up to 1.3 MeV (^{60}Co) may not exceed two times the value of the decision level.

The device must work under standard test conditions without the presence of a radioactive source and the indicated background specification is determined. The source of ^{137}Cs is then positioned in relation to the detector so that the distance between the source and the detector is at least 2 metres and the conventional air kerma input value at the detector's location (as if the detector were not present) is 10 μGy/h ± 10 %. The reference orientation of the detector must be in accordance with the manufacturer's specifications. After the onset of irradiation, the values are recorded at intervals of one minute and recording is continued until the device gives stable values. Once a stable state has been reached, at least 10 readouts are carried out. The decision level is calculated based on the final readings. This decision level must be in accordance with the manufacturer's specifications. The maximum readout on the evaluation device may not exceed the value specified by the manufacturer. The detector is then irradiated in several source-detector geometries as agreed upon by the manufacturer and user. If the evaluation device can be programmed with a compensation factor for gamma radiation, then the factor must not be changed during this test. The readout on the evaluation device in all directions may not exceed two times the value specified by the manufacturer for the reference direction.

The above-mentioned test is repeated for the source-detector reference direction with the use of alternative sources of gamma radiation as agreed upon by manufacturer and user, including a source of ^{60}Co. If the evaluation device can be programmed with a compensation factor for gamma radiation, then the factor must not be changed during this test. The readout on the evaluation device may not exceed two times the value specified by the manufacturer for ^{137}Cs.

The measured value must not exceed the permitted change limits specified in Article 2.9.

5.3.7 Overload test

Unless the manufacturer and user agree otherwise, the device must indicate a value off the scale at its upper end or indicate overloading when irradiated with a source with an activity (or surface emission input) 10 times greater than that corresponding to the maximum measurement range, and then function normally after the overloading is eliminated.

a) The detection device is exposed to a source of radiation of an activity which provides a value of approximately 50 % of the first increment of 10 on the measurement range and the value readout is recorded.
b) The detection device is exposed to a source of radiation with an activity 10 times greater than that which corresponds to the maximum measurable value. The radiation is maintained for at least 10 minutes and it is verified that the instrument continuously shows a value off the scale at its uppermost end.

c) The source of radiation is removed and, after a period of time agreed upon by the manufacturer and user (usually less than 1 hour), the detection device is irradiated under the same conditions as in a). The values read out may not differ from the original value by more than 10 %.

5.3.8 Detection and evaluation device uptake time

When irradiated with a radiation source, the device must indicate a value which will not vary by more than ±10 % from the value obtained under normal conditions in a period of up to 30 minutes after being switched on.

The device must be disconnected from the mains for at least 1 hour prior to this test. A radiation source is used which provides an value at approximately one third to one half of the maximum range. The detection and evaluation device are turned on. The values indicated are recorded every 5 minutes for 1 hour. Ten hours after being turned on, a sufficient number of readouts is carried out in accordance with Chapter 25 and the mean value is used as a ‘final value’ of the indications. A graph is drawn of the activity value indicated at the time and the half-life is adjusted if necessary. The difference between the ‘final value’ and the value read out on the curve for 30 minutes must lie within the specified limits.

NOTE If the level of activity is very low, less than 10 times the decision level, it may happen that the device does not specify the indicated value required during the uptake time. This is caused by statistical deviations at the low frequencies of impulses measured.

5.3.9 Statistical fluctuation

In light of the statistical nature of radiation, the values read out may fluctuate around the mean value. The coefficient of variation of the activity value caused by the statistical fluctuations must be less than 10 % for values exceeding the first increment of 10 on the effective measurement range.

A radioactive source is used which provides an indicated value between 10 and 20 times the decision level. At least 10 readouts are conducted at suitable intervals of time in order to obtain independent values. The mean value and coefficient of variation of all readouts made are calculated. The coefficient of variation must be within the required limits.

The measured value must not exceed the permitted change limits specified in Article 2.12.

5.3.10 Stability of values on detection and evaluation device

The specification indicated with the given radiation source after 30 minutes of device operation may not change by more than 10 % for the next 100 hours.

A radioactive source is used which provides an indicated value between 10 and 20 times the decision level. A sufficient number of readouts are carried out after 30 minutes, additional readouts are conducted after 10 hours and 100 hours without making any adjustments to the device and without changing any conditions. The mean values of the readouts must lie within the specified limits for all times.

If necessary, the readouts must be corrected to half-life.

The measured value must not exceed the permitted change limits specified in Article 2.13.

5.3.11 Flow rate stability

The purpose of this test is to establish the nominal flow rate of sampling and the stability of sampling under standard test conditions with a loss of pressure caused only by the air circuit and input or sampling filter (clean filter). The manufacturer must specify the nominal flow rate for the filter type used. After the standard sampling device uptake time (30 minutes), the indicated sampling flow rate may not differ by more than ±10 % from the conventional flow rate value and the sampling flow rate may not change by more than 10 % for the next 100 hours.

This test is conducted in dust-free air in order to prevent any kind of change to the collection device’s drop in pressure during the test. For that reason, a HEPA filter with a very low drop in pressure is placed upstream of the air circuit. For this test, a flow meter calibrated under measurement conditions and having an uncertainty better than 3 % (k = 2) is installed at the input to the air circuit. The device is turned on and the flow rate is measured after 30 minutes, 5 hours, 20 hours and 100 hours of operation. The readouts must be in accordance with the requirements.

The measured value must not exceed the permitted change limits specified in Article 2.14.

5.3.12 Influence of pressure loss on the filter

Because the influence of the filter properties and the degree of blockage may vary from test to test, only the measurement of the total drop in pressure and flow rate are taken into consideration. The purpose of this test is to establish the increase in the drop in pressure at the filter causing a 10 % reduction from the nominal air-flow rate under normal conditions. An acceptable minimum drop in pressure which may cause a 10 % reduction from the nominal flow rate must be agreed upon by the manufacturer and user. For this drop in pressure, the flow rate indicated by the monitor may not differ by more than ±10 % from the conventional flow rate value.

For this test, the monitor must be equipped with a clean collection medium. The flow meter is inserted before the monitor and adjustable limiter (such as a valve) between the flow meter and monitor input. A calibrated pressure sensor (or differential pressure gauge, etc. in the case of a tube) is positioned after the collection medium at the point determined by the manufacturer in order to measure the drop in pressure in the monitor caused by the air flow. The nominal flow rate is measured at the nominal drop in pressure at the collection medium, then the adjustable limiter shall be set to achieve a mean flow rate value of 10 % below the nominal flow rate under standard test conditions. The conventional value of the sampling flow rate is measured under these conditions.

The measured drop in pressure and flow rate must meet the requirements under these conditions.

The measured value must not exceed the permitted change limits specified in Article 2.15.

5.3.13 Influence of supply voltage on flow rate

The supply voltage changes between +10 % and −12 % of the nominal supply voltage.

This test is conducted in dust-free air in order to prevent any kind of change to the collection device's drop in pressure during the test. For that reason, a HEPA filter with a very low drop in pressure is placed upstream of the air circuit. For this test, a flow meter calibrated under measurement conditions and having an uncertainty better than 3 % (k = 2) is installed at the input to the air circuit. The device is switched on and the flow rate is measured at stable voltage, and a record is made of the flow rate. After that, the supply voltage is changed in a defined range of 88 % UN to 110 % UN and the flow rate is measured at the same time.

The measured value must not exceed the permitted change limits specified in Article 2.16.

5.3.14 Influence of supply voltage frequency

The supply voltage frequency changes from 47 Hz to 51 Hz.

During this test, the sampling and detection device is connected to the nominal voltage supply and frequency, which changes from 47 Hz to 51 Hz (alternative values are 57 Hz to 61 Hz). The test is conducted in dust-free air in order to prevent any kind of change to the collection device's drop in pressure during the test. For that reason, a HEPA filter with a very low drop in pressure is placed upstream of the air circuit. For this test, a flow meter calibrated under measurement conditions and having an uncertainty better than 3 % (k = 2) is installed at the input to the air circuit. The flow rate is recorded at the nominal frequency and at specified limit frequencies.

The measured value must not exceed the permitted change limits specified in Article 2.17.

5.3.15 External leak

This test is intended to determine the extent of an external leak, but not an internal leak around the filter holder or collection device.

The size of the leak is measured with two volume gauges or flow rate meters, which must mutually be calibrated more precisely than 1 %. The filter holder is fitted with a clean filter or other capture device. One meter is placed upstream of the device and the second in the direction of flow downstream of the filter or other capture device and immediately before the flow rate meter installed in the device. A series of 10 of the following measurements is carried out at suitable intervals of time (even after heavy fouling). The mean values of flow rates measured upstream and downstream may not differ by more than 5 % during the normal sampling period. A correction of the air pressure differences is carried out if necessary.

The measured value must not exceed the permitted change limits specified in Article 2.18.

5.3.16 Ambient temperature

It must be noted that, for this type of device, the detection and sampling device can work under other climatic conditions than the evaluation device. Part of or the entire detection device can work at a higher temperature.

The detection device is irradiated with a suitable test source so that the nominal value is known under standard test conditions. This test is usually conducted in an environmental chamber. Usually, it is not necessary to regulate the air humidity in the chamber if the device is not particularly sensitive to changes in humidity. The temperature is maintained at both of its limit values of the agreed temperature range for a period of at least 24 hours. The indicated specification is measured over the last 30 minutes of this interval and must be in within the applicable limits. In addition, the indicated specification is measured at the mean of the temperature range specified in Table 2. If the readout at this mean temperature is not within limits of ±10 % with respect to the monitor’s readout at the reference temperature, the manufacturer must specify the difference at this point.

The measured value must not exceed the permitted change limits specified in Article 2.19.

5.3.17 Relative air humidity

It must be noted that, for this type of device, the detection and sampling device can work under other climatic conditions than the evaluation device. Part of or the entire detection device can work at a higher relative humidity value.

The detection device is irradiated with a suitable test source so that the nominal value is known under standard test conditions. The test can be carried out at a temperature of +35 °C and a relative air humidity of 90 %; the permissible deviation of ±10 % from the specification is in addition to the permissible deviation caused by the temperature itself.

The measured value must not exceed the permitted change limits specified in Article 2.20.

5.4 Electromagnetic compatibility (EMC) test

EMC tests are conducted with an aerosol monitor connected according to the manufacturer’s specification. These tests must demonstrate that the aerosol monitor is in conformity with the requirements of the applicable separate legislation[2].

5.4.1 Immunity to electrostatic discharge

Immunity to electrostatic discharge is tested with the instrument switched on, with a contact discharge of 6 kV and an air discharge of 8 kV. The discharges are applied to the conductive surfaces and junction plates.

After this test, the measured deviation may not exceed the limits specified in Article 2.3 during a subsequent test of the instrument’s accuracy.

5.4.2 Immunity to high-frequency electromagnetic fields

Immunity to a radiated high-frequency field shall be tested with the instrument switched on, in the frequency range of 80 MHz to 3 000 MHz at a field intensity of 10 V/m. Amplitude modulation 80 % AM/1 kHz sine.

After this test, the measured deviation may not exceed the limits specified in Article 2.3 during a subsequent test of the instrument’s accuracy.

5.4.3 Immunity to rapid transient phenomena

Immunity to repeated rapid electrical transient phenomena/burst impulses shall be tested with the instrument switched on. A test voltage of ±0.5 kV, ±1 kV and ±2 kV is applied with a coupling circuit to the power, earth and signal inputs/outputs.

After this test, the measured deviation may not exceed the limits specified in Article 2.3 during a subsequent test of the instrument’s accuracy.

5.4.4 Resistance to surges

Resistance to surges is tested by applying a test voltage of ±0.5 kV, ±1 kV and ±2 kV between the power conductors.

After this test, the measured deviation may not exceed the limits specified in Article 2.3 during a subsequent test of the instrument’s accuracy.

5.4.5 Immunity to disturbances from high power lines induced by high-frequency fields

Immunity to disturbances from high power lines induced by high-frequency fields is tested with the instrument switched on in a frequency band of 150 kHz to 80 MHz. Amplitude modulation 80 % AM/1 kHz, voltage level 10 V.

After this test, the measured deviation may not exceed the limits specified in Article 2.3 during a subsequent test of the instrument’s accuracy.

5.4.6 Immunity to disturbances induced by damped oscillatory waves

Immunity to disturbances induced by damped oscillatory waves is tested with the instrument switched on by applying a damped oscillatory wave to the power, signal and control inputs/outputs of the monitor. The test level is defined as the voltage of the first peak (maximum or minimum) at the test shape of the wave and is asymmetrical 2 kV, symmetrical 1 kV for a slow damped oscillatory wave 100 kHz and 1 MHz, for rapid damped oscillatory wave 3 MHz, 10 MHz or 30 MHz and is 2 kV asymmetrical.

After this test, the measured deviation may not exceed the limits specified in Article 2.3 during a subsequent test of the instrument’s accuracy.

5.4.7 Immunity to voltage dips, short interruptions and voltage variations

Immunity to voltage dips, short interruptions and voltage variations is tested with the instrument switched on by applying a voltage dip to level 0 % U_t for a period of 10 ms.

After this test, the measured deviation may not exceed the limits specified in Article 2.3 during a subsequent test of the instrument’s accuracy.

5.4.8 Measuring disruptive terminal voltage

The monitor tested must comply with the interference limits specified in Tables 4 and 5. The test is conducted with the device switched on by measuring the disruptive terminal voltage at the power, signal and control inputs/outputs of the monitor. If the value of the measuring receiver fluctuates near a limit, then the value must be observed for at least 15 seconds at each measurement frequency. The highest value is measured, with the exception of random brief extreme values, which are ignored.

The limits for disruptive terminal voltage at the mains terminals are specified in Table 4.

Table 4 — Limits for conducted disturbances at mains terminals

Frequency range (MHz)	**dB limits** (μV)	
	Quasi-peak	Average
0.15 to 0.50	79	66
0.50 to 30	73	60
NOTE For frequencies at the boundary of a band, the lower limit shall apply.		

The limits for disruptive terminal voltage at the signal inputs/outputs are specified in Table 5.

Table 5 — Limits for disturbances from power lines on signal inputs/outputs

Frequency range (MHz)	**dB voltage limits** (μV)		**dB current limits** (μA)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 to 0.50	97 to 87	84 to 74	53 to 43	40 to 30
0.50 to 30	87	74	43	30
NOTE For frequencies at the boundary of a band, the lower limit shall apply.				

5.4.9 Measuring the disruptive electromagnetic field (radiated high-frequency interference)

The monitor tested must comply with the interference limits specified in Table 6. The test is conducted with the device switched on by measuring the radiated electromagnetic field at a distance of 10 metres. If the value of the measuring receiver fluctuates near a limit, then the value must be observed for at least 15 seconds at each measurement frequency. The highest value is measured, with the exception of random brief extreme values, which are ignored.

Table 6 — Limits of conducted radiation interference at a measurement range of 10 m

Frequency range MHz	**Quasi-peak limits** dB (μV/m)
30 to 230	40
230 to 1 000	47
NOTE For frequencies at the boundary of a band, the lower limit shall apply.	

6 Initial verification

6.1 General

During initial verification, the following tests are performed:

a) Visual inspection;
b) instrument accuracy;

c) system linearity;
d) change in detection efficiency as function of beta radiation energy (beta aerosol monitors);
e) response to ambient gamma radiation;
f) overloading;
g) statistical fluctuation;
h) stability of values on detection and evaluation device;
i) flow rate stability;
j) influence of ambient temperature.

6.2 Visual inspection

The inspection is conducted pursuant to Article 5.2.

6.3 Functional tests

6.3.1 Instrument accuracy test

The test is conducted pursuant to Article 5.3.1.

6.3.2 Instrument linearity test

The test is conducted pursuant to Article 5.3.2.

6.3.3 Test of change in detection efficiency as function of beta radiation energy

The test is conducted pursuant to Article 5.3.3.

6.3.4 Response to ambient gamma radiation

The test is conducted pursuant to Article 5.3.5.

6.3.5 Overload test

The test is conducted pursuant to Article 5.3.7.

6.3.6 Statistical fluctuation test

The test is conducted pursuant to Article 5.3.9.

6.3.7 Long-term stability test

The test is conducted pursuant to Article 5.3.10.

6.3.8 Long-term flow rate stability test

The test is conducted pursuant to Article 5.3.11.

6.3.9 Test of ambient temperature influence

The test is conducted pursuant to Article 5.3.16.

7 Subsequent verification

7.1 General

During initial verification, the following tests are performed:

a) Visual inspection;
b) instrument accuracy;

c) system linearity;
d) overloading;
e) stability of values on detection and evaluation device;
f) flow rate stability.

7.2 Visual inspection

The inspection is conducted pursuant to Article 5.2.

7.3 Functionality tests

7.3.1 Instrument accuracy test

The test is conducted pursuant to Article 5.3.1.

7.3.2 Instrument linearity test

The test is conducted pursuant to Article 5.3.2.

7.3.3 Overload test

The test is conducted pursuant to Article 5.3.7.

7.3.4 Long-term stability test

The test is conducted pursuant to Article 5.3.10.

7.3.5 Long-term flow rate stability test

The test is conducted pursuant to Article 5.3.11.

8 Measuring instrument verification

When examining measuring instruments pursuant to § 11a of the Metrology Act at the request of a person who may be affected by an incorrect measurement, please proceed pursuant to Chapter 7. The maximum permissible error used is double the maximum permissible errors pursuant to Chapter 7.

9 Notified standards

For the purposes of specifying the metrological and technical requirements for measuring instruments and specifying the testing methods for their type-approval and verification arising from this general measure, the CMI shall provide notification of the Czech technical standards, other technical standards or technical documents of international or foreign organisations, or other technical documents containing more detailed technical requirements (hereinafter referred to as ‘notified standards’). The CMI shall publish a list of these notified standards attached to the relevant measures, together with the general measure, in a manner accessible to the public (on www.cmi.cz).

Compliance with notified standards or parts thereof is considered, to the extent and under the conditions stipulated by a general measure, to be compliance with the requirements stipulated by this measure to which these standards or parts thereof apply.

Compliance with notified standards is one way of demonstrating compliance with the requirements. These requirements may also be met by using another technical solution guaranteeing an equivalent or higher level of protection of legitimate interests.

II.

G R O U N D S

The CMI issues, pursuant to § 14(1)(j) of the Metrology Act, for the implementation of § 6(2), § 9(1) and (9) as well as § 11a(3) of the Metrology Act, this measure of a general nature, stipulating metrological and technical requirements for specified measuring devices and test methods for type-approval for verification of the following specified measuring devices – 'measuring instruments used to monitor activity limits and concentration of effluents from nuclear facilities, nuclear raw material mining or processing facilities, radioactive waste processing plants and from the processing or application of radioactive materials, and also used to determine environmental radiation exposure due to effluents – measuring instruments for the continuous monitoring of radioactive aerosols including transuranic aerosols in gaseous effluents from nuclear facilities.'

Decree No 345/2002 laying down measurement instruments for mandatory validation and measurement instruments subject to type-approval, as amended, classifies the measuring instruments under item 8.1 in the Annex to the Second List of Specified Measurement Instruments of the specified type as measurement instruments subject to type-approval and mandatory validation.

This legislation (general measure) will be notified in accordance with Directive (EU) 2015/1535 of the European Parliament and of the Council of 9 September 2015 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services.

III.

I N S T R U C T I O N S

In accordance with § 172(l) APC, in conjunction with § 39(l) APC, the CMI has stipulated a time limit for comments of 30 days as of the date of posting the draft on the official notice board. Comments submitted after this time limit will not be considered.

The persons concerned are hereby invited to comment on this general draft measure. With regard to the provisions of § 172(4) APC, comments are to be submitted in writing.

Pursuant to the provisions of § 174(1) APC, in conjunction with the provisions of § 37(1) APC, it must be clearly stated who is submitting the comments, which general measure the comments concern, how the draft contradicts legislation or how the general measure is inaccurate. The comments must also contain the signature of the person making the comments.

The supporting documents for this draft general measure may be consulted at the Czech Metrology Institute, Legal Metrology Department, Okružní 31, 638 00 Brno, after making arrangements by telephone.

This draft general measure shall be posted for 15 days.

....

RNDr. Pavel Klenovský

Director-General

Person responsible for accuracy: Mgr. Tomáš Hendrych

Posted on:

Signature of the authorised person confirming posting:..

Removed on:

Signature of the authorised person confirming removal: ....