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In the event of any differences in interpretation of this guide the Finnish version shall take precedence over this translation

RADIATION MONITORING SYSTEMS AND EQUIPMENT IN NUCLEAR POWER PLANTS

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1 GENERAL

The direct or indirect purpose of the information received from the measurements with the installed radiation measuring systems and the portable radiation measuring equipment of a nuclear power plant is to serve in the protection of the personnel and the population of the environment from hazards caused by ionizing radiation. These measurements are various radiation protection measurements inside the plant, radiation measurements of process streams and radiation measurements of releases. The radiation protection measurements inside the plant include measurements of external exposure, measurements of surface contamination on various work places, components, persons and protective equipment, and measurements of air contamination. The radiation measurements of process streams are used for following the movements of radioactive substances in liquid and gas systems inside the plant. The measurements of releases are used for controlling liquid and gaseous effluents of radioactive substances from the plant. Besides the above mentioned radiation measurements, which are performed either regularly or as necessary, samples of gas, liquid and contamination are taken inside the plant and measured in the laboratory of the nuclear power plant. The radiation exposure of the nuclear power plant personnel is controlled with radiation dose meters. In addition, radiation measurements are performed in connection with the treatment and storing of radioactive waste in the nuclear power plant.

2 SCOPE

This guide sets forth requirements for the properties, design, type tests, quality control of manufacture, pre-

operational testing and use of the installed radiation measuring systems and the portable radiation measuring equipment of nuclear power plants. The pertinent control activities of the regulatory authorities are also described. The guide does not deal with radiation measurements performed in a laboratory, in personal dosimetry or in the treatment of wastes. The guide presents requirements both for normal operation and for accident conditions.

As concerns the measurement of radioactive releases, the instructions presented in this quide for radiation measuring systems and equipment are supplemented with the requirements in Guide YVL 7.6 "Measuring Releases of Radioactive Materials from Nuclear Power Plants".

3 QUANTITIES AND UNITS

In this guide, dose (dose rate) means dose equivalent (dose equivalent rate) in a 30 cm sphere of density 1 g cm^{-3} of tissue equivalent material, when the sphere is exposed to unidirectional radiation and the dose equivalent (dose equivalent rate) is determined at a depth of 1000 mg cm^{-2} parallel to the radiation. This definition corresponds with the term "Depth Dose Equivalent (Depth Dose Equivalent Rate)" specified in ref. /9/.

The SI unit for dose equivalent is sievert (Sv). The previous (subsiding) unit is rem
1 rem = 0.01 Sv.
The radiation measuring equipment used for radiation protection purposes should indicate dose equivalent and/or dose equivalent rate. However, many of the measuring devices used nowadays for gamma radiation measure and indicate exposure rate. The following correlation can be used bet-

ween dose equivalent (dose equivalent rate) and exposure (exposure rate)

1 R $\triangleq$ 0.01 Sv
1 R/h $\triangleq$ 0.01 Sv/h.

4
DESIGN CRITERIA

This chapter contains guidance and regulations cconcerning the properties and design of radiation measuring systems and radiation measuring equipment.

4.1
General reguirements to be set for installed radiation measuring systems and equipment

Because of calibration, testing and maintenance, the accessibility of the measuring devices shall be given extra consideration.

Each measurement channel of a measuring system shall remain operable in the anticipated enviromental and operating conditions forming a design basis. These include at least

- temperature
- pressure
- humidity
- mechanical vibrations
- effect of radiation
- operating voltage (changes of).

It shall be especially ensured that the components that must be operable during a serious reactor accident can withstand the conditions prevailing in an accident. Requirements for the performance of type tests are given in

Guide YVL 5.5 "Supervision of Nuclear Power Plant Electric and Instrumentation Systems and Components".

The supply of electricity to the installed radiation measuring systems of a nuclear power plant shall be ensured either with a backed AC system or with a DC system. In choosing the source of electricity, attention shall be paid to the allowable interruption times.

The saturation of the radiation detector shall not diminish the reading in the display of the measurement channel. This requirement shall be met even when the dose rate is ten times higher than the maximum display. After the dose rate causing the saturation has reverted back to normal, the equipment shall be operable.

The measuring assembly shall functionally follow the measurement data given by the detector with such speed that the time lag cannot affect the safety of the plant personnel or the public or cause a deterioration of the plant condition. The location of the alarm limits and other controls of the equipment shall be such that inadvertent changes of the limits and controls are not possible. The alarms may not cease without operating actions.

The scale of the measuring device shall be able to indicate a dose rate that is ten times higher than the highest estimated dose rate. If it is necessary to use two or more measurement channels to cover a wide range of measurement, the measurement ranges of adjacent channels shall cover at least one decade of the measurement ranges of each other.

4.2
Installed measuring systems for external radiation

The main purpose of the installed measuring equipment for external radiation is to continuously measure the dose rate of gamma radiation in certain specified areas of the nuclear power plant and to inform of the measurement results and to warn the plant personnel if the preset value of the dose rate is exceeded in some measurement area.

4.2.1
Placement and location detectors

Installed measuring instruments for external radiation shall be located in those accessible sections of the controlled area where changes in the operational status or condition of the plant or some other events can cause an essential increase in the local dose rate. Attention shall be paid to those normally accessible sections which can contain dose rates that are considerably higher than the dose rates in the other sections, for instance due to the gathering of activated corrosion products or due to operating transients.

At light-water reactor plants, there shall be measuring instruments at least in the following locations:

- reactor containment (in a PWR plant near the personnel hatch)
- refuelling machine and room
- rooms for the solidification system of wastes
- rooms for handling and storing medium-activity wastes
- rooms for storing spent fuel.

The measuring instruments should be placed in such a way

that their displays represent the dose rates in the occupied area as well as possible and thus help the personnel in keeping radiation doses low. The rooms that are the most likely to be occupied shall be given priority in the placement of detectors.

In determining the location of the measuring equipment, it shall be especially noted that there will be no such material layers between the radiation sources and the detectors that would dampen radiation and impair the representative quality of the measurement.

4.2.2
Energy dependence and measurement range of the equipment

The response of installed gamma radiation meters, used for the measurement of external radiation, should be independent of the energy of gamma radiation so that the deviation from the real dose rate is no more than $\pm$ 30 % while the energy of the radiation is between 100 keV and 2.5 MeV. If the main source of radiation is ^{16}N, the response to the gamma radiation emitted by ^{16}N shall be indicated. If besides gamma radiation, also radiation of some other kind (beta radiation, neutrons) can appear in the place of measurement, its response and effect on the measurement shall be worked out and taken into account, and the need for a separate measurement shall be considered.

The range of installed measuring devices for external radiation shall be determined using the following data:

- the lowest assumed dose rate in the place of measurement and the importance of measuring it
- the anticipated dose rate during normal operation
- the highest anticipated dose rates in operation
- the estimated dose rates during accidents, in

case the information given by the measuring device is utilized in accident conditions.

It shall be possible to measure the dose rate in the reactor containment both in normal operation and in all postulated accident conditions, including an accident where 100 % of the noble gases, 25 % of the halogens and 1 % of other radioactive substances contained in the fuel are released into the containment. In a light-water reactor plant with a maximum thermal power from 1000 to 5000 MW, the measurement range shall extend at least to dose rate 10^5 Sv/h (exposure rate 10^7 R/h). The range of the measurements that are located elsewhere but are essential during a severe accident shall extend to 10^2 Sv/h (10^4 R/h).

4.2.3
Displays and alarms

Each measurement channel shall generally have a local display of dose rate and an audible and visible alarm, which are activated on pre-set dose rate values. It shall be possible to adjust the alarm limit over the whole measurement area and its value at each particular time shall be recorded. The cessation of the local audible alarm shall in no way affect the visible alarm display.

In addition, the measurement channels shall generally have a display of dose rate and the indication of an alarm caused by a high dose rate in an appropriate control place. Alarms that are common to several channels can also be used if the channel causing the alarm can be quickly determined from the equipment nearby. The displays and alarms of measurement channels that are located in the reactor containment and intended for observing an accident shall also be placed in the main control room.

The measurement channels that are placed in rooms with a high dose rate shall be provided with remote equipment (display of dose rate, audible and visible alarms) which show the radiation level before the room is entered. The measurig device located near the personnel hatch in the containment of a PWR plant shall have the above-mentioned remote equipment placed outside the contaiment near the entrance.

The loss of a signal in a detector or in the equipment following the detector shall cause an alarm conveying failure. The failure alarm shall have a local visible indication and an indication in the remote display.

4.2.4
Capability to withstand radiation

The measuring equipment that are inside the reactor containment and are intended for observing an accident shall be so dimensioned that they retain their operability while the external radiation dose is 10^6 Sv (exposure 10^8 R), when the energy of gamma radiation is between 0.6 and 1.3 MeV. The measuring equipment to be used outside the containment during an accident shall be so dimensioned that they retain their operability despite the effects of external radiation in their places of operation during the accident. In the absence of more accurate analyses, the value 5×10^3 Sv can be used as the maxium dose (exposure 5×10^5 R) while the energy of gamma radiation is within the above-mentioned boundaries.

4.3
Systems for monitoring air contamination

The purpose of the measuring system for air contamination is to measure the general level of radioactive air conta-

mination inside the plant, to provide data on the possible radiation exposure of the workers, and to give a warning to the plant personnel if the pre-set alarm limit is exceeded. The quantity and quality of the necessary air contamination measurements and measuring equipment depends on the probability, amount and quality of air contamination in the various places at the plant.

In the design of the measuring system for air contamination, attention shall also be paid to the information received from other radiation measurements (surface contamination measurements, measurements of external radiation, whole-body measurements, and measurements of radioactive gaseous effluents) because they often give an indication of the appearane of air contamination.

Measurements of air contamination shall be performed in such accessible sections of the controlled area where it is possible that the air of the working enviroment contains significant concentrations of radioactive substances. In designing the quantity, quality and location of the measuring equipment to be placed in such areas, an effort shall be made to keep the time-lag between the appearance and detection of the concentration short.

When a worker's breathing air is controlled in connection with a working operation that can cause significant air contamination, an effort shall be made to perform the measurement in such a way that sampling is representative, taking into account the fact that local differences in concentration can be considerable.

An effort shall be made to place the measuring equipment for air contamination in large areas in such a way that significant air contamination cannot be left undetected. The location of possible air contamination sources and

the ventilation of the area shall be taken into account. When necessary, the suitability of the placement shall also be ensured experimentally (for instance by using smoke).

The measuring device shall not be placed so that it can be unnecessarily contaminated. Also places where the concentration of radioactive substances in the air is unusually high without being representative shall be avoided.

It shall be possible to continuously measure the concentration of radioactive noble gases in the air inside reactor containments that are accessible during normal operation. The measurement of radioactive iodines and radioactive substances in particle form shall be arranged in all reactor containments and it can also be based on sampling. In designing and constructing sampling lines, attention shall be paid to the fact that the sample is representative and that it can be taken also in accident conditions. The measurement ranges for the concentrations of iodines and substances in particle form shall extend at least to the value 4×10^{14} Bq/m^3 (10^4 Ci/m^3).

4.4
Installed systems and equipment for monitoring radioactivity in releases

Measurements of radioactive releases are needed to ascertain that nuclear power plants are operating within allowable release amounts. They are also used as a calculation basis for radiation doses received by the population in the enviroment. Requirements for the measurement of releases are also given in Guide YVL 7.6 "Measuring Releases of Radioactive Materials from Nuclear Power Plants". This guide sets forth requirements applying to the measurement equipment in particular.

4.4.1
General design requirements

In the design of measuring equipment for radioactive releases, attention shall be paid, among other things, to the possibly necessary decontamination of the equipment. Surfaces that are in contact with the release flow shall be manufactured and treated so that there is not much gathering of radioactive substances.

4.4.2
Measuring radioactivity in gaseous effluents

The measuring equipment for the continuous monitoring of radioactivity in gaseous effluents, as specified in Guide YVL 7.6, shall be provided with at least two parallel measurement channels. The equipment shall be provided with both a pre-set upper limit alarm and an alarm indicating component failure. The alarms shall have a display in the control room. The measurement shall be registered, for instance, by means of a plotter. The upper limit of the measurement range shall be such that the equipment will function during all postulated accident conditions, including an accident where 100 % of the noble gases, 25 % of the halogens and 1 % of other radioactive substances contained in the fuel are released into the containment, the integrity of the containment is lost, and part of the radioactive substances are released through the stack into the enviroment. It shall be ensured that the measurement of releases is not disturbed by external radiation during an accident.

The pumps that are possibly included in the measuring equipment shall be placed downstream from any filter or measuring unit.

4.4.3
Measuring radioactivity in liquid effluents

The equipment for the continuous measurement of total activity, as specified in Guide YVL 7.6, shall be provided with both a pre-set upper limit alarm and an alarm indicating component failure. Both alarm signals shall cause an automatic closing of the release channel. The alarms shall have a display in the control room.

If it is possible that detectors, joints or connecting cables can get into contact with water, they must be watertight.

4.5
Installed systems and equipment for monitoring radioactivity in process streams

The information given by the radiation measurements of liquid and gas flows on the amount of radioactive substances in the flows is needed for observing the condition of the plant and for detecting and controlling fuel damages and radioactive leakages.

4.5.1
General requirements for system design

Each measurement channel shall have an activity display and an alarm for the flow that is measured, and, when necessary, the measurement results shall be recorded in the control room. In addition, it should be possible to provide the measuring equipment with local display for installation, maintenance and testing activities.

The measuring equipment, regarded as important to safety, which send a signal used for starting the mitigation of the consequences of malfunctions or failures, shall carry out their function also in case of a single failure. If the signal of a detector is used for starting the operation of protective systems, the measuring equipment shall meet the requirements that are set for the protective systems. The measuring equipment also include the possibly existing by-pass flow pumps and other devices that make possible the continuous activity measurement.

The measuring equipment shall be provided with component failure alarms (lower limit alarm) and alarms that are actuated when the pre-set activity level is exceeded (upper limit alarm). In case background radiation does not exceed the needed lower limit value, a suitable radioactibe source shall be placed to increase background radiation. The control room shall contain the lower limit and upper limit alarms for each process measurement channel.

In the design of measuring equipment, attention shall be paid to the possibly necessary decontamination of the equipment. Surfaces that are in contact with process streams shall be manufactured and treated so that the gathering of radioactive substances is as little as possible.

4.5.2
Placement and location of detectors

The amount of radioactive substances shall be measured in such liquid or gas flows that can include radioactive leakages essential to the condition of the plant and/or to the releases from the plant. Continuous measurement shall be applied at least to the activity of primary coolant in a PWR and to the activity of steam in a PWR and in a BWR. Primary loops can also be measured through sys-

tems that are connected with the loops if delays and mixing do not make this kind of measurement impossible. These systems include the clean-up system of primary coolant and the radioactive gas treatment system. Radiation measurements should also be located in such steam and water circuits that can become essentially contaminated as a consequence of leakages in circuits containing radioactive substances.

The detectors shall be placed in such a way that they can quickly detect all changes in radioactivity during operation. The detectors shall not be located in places where, due to low process stream, radioactive substances gather more than in other parts of the circuit.

4.5.3
Energy dependence and measurement range of the equipment

The gamma-activity measurements of systems should at least cover gamma radiation energies 80 keV...2.5 MeV, and the energy response of the measuring equipment shall be known in this energy range. The deviation of the display from the real activity of the flow should be no more than $\pm$ 50 %. In certain circumstances, such as in the activity measurement of steam coming from the steam generators of a PRW plant, even a greater measurement error can be allowed.

The measurement range and accuracy shall be suitable, taking into account the changes in the concentrations of radioactive substances in the process stream during anticipated operating conditions.

4.6
Portable measuing equipment for external radiation

Besides installed measuring equipment, also portable measuring equipment for external radiation are used in determining the dose rate of external radiation inside a nuclear power plant. Here the dose rate of external radiation means the dose rate caused by gamma and neutron radiation.

4.6.1
General requirements

In the design of the measuring equipment, attention shall be paid to the requirements induced by the operating conditions of the equipment. At least temperature, humidity and mechanical durability shall be taken into account. The measuring equipment that are intended to be used in general measurements during severe accidents shall be waterproof and they shall retain their operability in the temperature range - 30 ^{o}C... +50 ^{o}C and in all conditions of relative humidity.

The saturation of the detector of a measuring device shall not cause a decrease in the indicated dose rate. This requirement shall be met even when the measurement range is exceeded tenfold. A change in the position of the device shall not cause an essential change in its display.

It shall be possible to test the operating voltage of the measuring equipment. The voltage supply shall be such that it makes possible the continuous operation of the measuring device for at least 12 hours. The measuring devices can have an adjustable audible and visible dose rate alarm.

4.6.2
Measuring equipment for gamma radiation

A sufficient number of equipment intended for the measurement of the dose rate of gamma radiation shall be provided keeping in mind the normal operating conditions of a nuclear power plant (including maintenance shutdowns) and possible accidents. There shall be enough measuring equipment for remote measurements (telescopic arms). The dependence of the meter response on the energy of gamma radiation should be such that the deviation from the real dose rate is no more than $\pm$ 30 % while the energy of radiation is between 100 keV and 2.5 MeV. The response of the measuring device for neutron and beta radiation, as well as for gamma radiation with E_γ < 100 keV and E_γ > 2.5 MeV shall be known.

In case of measurements during accidents, there shall be a sufficient number of measuring equipment with a measuring range that covers at least the area 10^{-3}...10 Sv/h (0.1... 10^3R/h).

The response of the equipment that are used for general measurements of radiation shall not vary more than $\pm$ 30 % for gamma radiation with energy between E = 0.6...1.3 MeV and an angle of incidence that varies at random in the semi-space of the measurement direction.

The measuring device shall follow the real dose rate so rapidly that when the dose rate changes suddenly from a display that is 10 % of the measurement range to a display that is 90 % of the measurement range, the display of the dose rate can follow the change in less than 5 seconds.

4.6.3
Measuring equipment for neutron radiation

There should be no neutron radiation produced by the reactor in the accessible places of a light water reactor plant based on acceptable design, while the plant is in operation. This shall be indicated by means of neutron radiation measurements during the start-up testing of each plant unit. Various neutron sources can be handled in a nuclear power plant during operation and therefore there is a need for measuring equipment for neutron radiation. Measurements of neutron dose rate have to be performed, for instance, in connection with the transfers of spent fuel. There shall be at least two measuring devices for neutron dose rate at the site. The neutron radiation response of the neutron dose rate meter shall meet the requirements presented in ref. /10/.

4.7
Measuring equipment for surface contamination

The purpose of the surface contamination measurements is to assist in charting the need for the protection of workers, in assessing the likelihood of air contamination, in preventing the spreading of radioactive substances inside the controlled area and away from the controlled area, and to detect the contamination of the workers' clothing and skin and thus to prevent the workers' excessive exposure to radiation.

There shall be a sufficient number of measuring equipment suitable for the measurement of surface contamination (primarily beta, but also alpha radiation) keeping in mind the normal operating conditions of the nuclear power plant (including maintenance shutdowns) and possible accidents.

4.7.1
Portable measuring equipment for surface contamintion

Portable surface contamintiaon meters shall meet the general requirements presented in section 4.6.1. The dependence of the response of beta radiation meters, used for general contamination measurements, on the energy of beta radiation shall be such that the deviation from the real value to be measured is no more than ± 50 % when measuring substances that emit beta radiation with the maximum energy between 0.3 and 2.0 MeV. The response for other types of radiation shall be known.

The measurement ranges of measuring equipment that are used for general radiation protection measurements shall have such lower limits that it is possible to measure those maximum amounts of radioactive substances on the skin that are presented in appendix 7 to the resolution 594/68 of the Ministry of Social Affairs and Health. The upper limits of the measurement ranges shall exceed the amounts of contamination in the highest zone of the controlled area, specified in section 4.2 of Guide YVL 7.9 "Health Physics Programmes in Nuclear Power Plants", published 21 April 1981. Use of markings facilitating the interpretation of measurement results is recommended.

In case of situations where measurements cannot be carried out as direct measurements because of background radiation, there shall be necessary sampling equipment.

4.7.2
Personnel monitoring equipment

It shall be ensured that the clothing (including boot covers) and skin of each person leaving the controlled area

are free from radioactive substances. For this purpose there shall be a sufficient number of monitoring equipment. The monitoring equipment shall be capable of ensuring that the maximum amount of radioactive substances in a person's clothing does not exceed the maximum limit given in appendix 7 to resolution 594/68 of the Ministry of Social Affairs and Health. The person's hands shall be measured separately and it shall be ensured that the maximum amount of radioactive substances on the skin given in appendix 7 to the above-mentioned resolution is not exceeded.

5
PRE-OPERATIONAL TESTING OF SYSTEMS AND COMPONENTS

The properties of the radiation measuring systems and equipment that are used in a nuclear power plant shall be determined by means of type tests, tests included in the quality control program of manufacture, and pre-operational tests performed at the plant site. Special requirements for the pre-operational testing of each system and equipment are set forth below.

5.1
Installed measuring systems for external radiation

The calibration of each measurement channel shall be performed in connection with the pre-operational testing for each decade of the graduation generally at least up to dose rate value 10^{-2} Sv/h (exposure rate value 1 R/h). The calibration technique shall be such that the radiation doses of the calibrarion personnel can be kept low. The measuring systems intended for the measurement of external radiation in the reactor containment shall be sent to the Institute of Radiation Protection or to some other laboratory approved by the Institute of Radiation Protection

in order to be calibrated in the whole measurement range. The pre-operational testing shall be accompanied by the performance test of alarm limits in each measurement range, an inspection of the operation of the visible and audible alarms, and an inspection of failure alarm. In addition, there shall be an inspection of the installation, which includes the inspection and testing of couplings, switches and actuators.

5.2
Measuring systems for air contamination, installed measuring systems for radioactivity in releases and installed radiation measuring systems for process streams

Each measurement channel shall be calibrated in connection with pre-operationl testing by using a suitable radioactive source. The purpose of the calibration is to determine the response of the measuring equipment relative to a known radionuclide concentration. The ambient conditions shall resemble the actual operating condition as much as possible. The accuracy of the used calibration method shall be known. The radioactivity response of the detector shall be determined in the actual measurement geometry, if possible. When a liquid calibration compound is used, its homogeneity shall be ensured. If the radioactive calibration source or the measurement geometry differs from the operating conditions of the measuring equipment, the correspondence between the results of the calibration measurements and the results of the operating measurements shall be recorded.

The alarm limits shall be tested at least in two points of the measurement range (highest and lowest decade). The operation of the visible and audible alarms shall be checked. The prevailing background radiation shall be measured by using a suitable gamma radiation source. The

operation of couplings, switches and failure alarms shall be checked. The leak-proofness of flow channels and joints shall be checked. Air flows shall be adjusted and checked.

5.3
Portable measuring equipment for external radiation

Before placed in service, the equipment intended for measuring gamma radiation shall be calibrated for each decade of the graduation at least up to dose rate value 10^{-2} Sv/h (exposure rate value 1 R/h). Possible alarm limits and alarms shall be checked in each area. The function of the switches and the voltage of the batteries or the accumulator shall be checked.

The measuring equipment of gamma radiation intended for the measurement of high dose rates and for accident conditions shall be calibrated in the whole operating range at the Institute of Radiation Protection or in some other laboratory approved by the Institute of Radiation Protection before they are placed in service.

The equipment intended for measuring neutron radiation shall at the plant site undergo an electronic linearity check before they are placed in service. In addition, possible alarm limits and alarms shall be checked in each area. The function of the switches and the voltage of the batteries or the accumulator shal be checked. Additionally, a unit representing each type of the measuring equipment for neutron radiation shall be sent for check calibration at the Institute of Radiation Protection.

5.4
Measuring equipment for surface contamintion

The operation of the measuring equipment that are used

for general radiation protection measurements shall be checked for each decade on three suitable beta source surfaces. The activity in two of them shall correspond with the limiting values for beta radiation in the highest and lowest zones of the controlled area, as presented in section 4.2 of Guide YVL 7.9 "Health Physics Programmes in Nuclear Power Plants", published 21 April 1981. The function of the alarm limits shall be checked.

The function of personnel monitoring equipment and their alarm limits are checked on a suitable beta surface source in the measurement range required in section 4.7.2.

Installed eqiupment undergo an inspection that includes the checking and testing of couplings, switches and actuators.

6
OPERATION, PERIODIC TESTING AND MAINTENANCE

The maintaining of the properties of radiation measuring systems and equipment shall be followed during the operation of the nuclear power plant, for instance by performing periodic tests. If functional deviations or faults are detected, necessary repair actions shall be taken. After the repair and prior to use, the systems and components shall be inspected with methods corresponding with the initial inspection.

6.1
General requirements

Periodic inspections and tests shall be carried out according to a previously set program. The results of the inspections and tests shall be recorded.

The measurement results of installed radiation measuring systems and equipment shall be regularly followed by means of a program related to radiation control or by means of some other program.

A general inspection of systems and equipment means an inspection of the general condition of the meter and the performance ability of the meter's auxiliary and supplementary components. It shall be ascertained in the general inspection that the equipment is intact on the outside, controllers and switches are in the right positions, readout indicates the expected value, and alarms are operable. The general inspection is by nature a continuous observation of the meter operation, and it shall be performed often enough, at least once every month, unless otherwise required.

The performance tests of systems or equipment mean a simple inspection of the meter's performance by means of a radiation source. The test shall include an inspection of the alarm functions. If the performance test utilizes a check source included in the channel, it shall be ensured that the source is returned to the position prevailing during operation after the calibration is ended. The use of some other procedure in the performance test instead of a radiation source can be allowed in separately justified cases. Unless otherwise required, the performance test of each measurement channel shall be performed at least once in every three months. The re-calibration of systems and equipment shall be performed regularly after the initial calibration. The frequency and scope of calibrations are determined on the basis of the failure frequencies of the components. If there are no special reasons for calibration more often, a calibration performed every two years is sufficient.

In the case of measurements of special importance to safety, a deviation from the above-mentioned general inspection and test frequencies shall be made as concerns individual systems, components or measurements.

Each repair and/or maintenance work performed for the measuring equipment shall be written down. The records shall include at least the following information:

- identification data of the measuring equipment
- types and numbers of the parts that are replaced
- reasons for the work
- meeting of the rquirements set for spare parts and fulfilment of the actions (e.g. calibration) to be performed for the equipment
- date of repair and signature of the repairer.

6.2
System- and component-specific requirements

This section sets forth requirements for system- and component-specific inspections and tests to be performed periodically.

6.2.1
Installed measuring systems for external radiation

The general inspection and the performance test are carried out in accordance with general requirements. Re-calibration is performed as initial calibration (section 5.1), at least every two years.

6.2.2
Measuring systems for air contamination

General inspection shall be carried out at least twice

every month and the performance test at least once every month.

6.2.3
Installed measuring systems of radioactivity in releases

The operation of the radiation measuring systems intended for measuring raddioactivity in gaseous effluents shall be followed daily, the actual general inspection and performance test are carried out in accordance with the previous section and the re-calibration twice every year.

The general inspection of measuring equipment for liquid effluents shall be carried out daily, the performance test once every month and the re-calibration at least twice every year.

6.2.4
Installed radiation measuring systems of process streams

Inspections and tests are performed in accordance with the general requirements, with the exception of measurements of special importance to safety. Their inspection frequencies are determined separately (for instance, in the Technical Specifications of the plant).

6.2.5
Portable measuring equipment for external radiation

The general inspection is always performed prior to use. The performance test is carried out in accordance with the general requirements. Re-calibration is performed as initial calibration (section 5.3), at least every two years.

6.2.6
Measuring equipment for surface contamination

The general inspection of the equipment is always performed prior to use (in installed equipment daily). The performance test shall be carried out at least once in every three months for portable equipment and at least once in every month for installed equipment, following the procedure adopted before the equipment were placed in service (section 5.4).

7
SUPERVISION PERFORMED BY THE AUTHORITIES

The Institute of Radiation Protection (IRP) supervises the design, manufacture, installation, pre-operational testing and use of the radiation measuring systems and equipment of nuclear power plants, as applicable in accordance with Guide YVL 1.1.

The design bases and system descriptions of radiation measuring systems are examined as part of the preliminary and final safety analysis reports. Pre-inspection documents shall be submitted on all radiation measuring equipment dealt with in this guide. It is ascertained in the pre-inspection of the equipment that the equipment meet the requirements set forth in section 4 of this guide and that the quality control of their manufacture is properly executed. Pre-inspection shall be requested for systems or other component assemblies regarded as suitable.

The Institute of Radiation Protection shall be given an opportunity to supervise the type tests performed for systems and components and the quality control of manufacture, as judged necessary by the IRP. The type test programs

and results, result material from quality control during manufacture, and results of delivery tests shall be submitted to the IRP.

The IRP supervises the installation of radiation measuring systems and equipment by following the inspections related to the installation, as deemed necessary, and by studying installation procedures and instructions dealing with the tests to be performed during installation.

The IRP supervises the pre-operational testing of radiation measuring systems and equipment by examining the general preoperational testing plans as part of the preliminary and final safety analysis reports, by examining the pre-operational testing programs, by following the performance of the tests at the power plant and by inspecting the reports resulting from the testing. In connection with the preoperational testing program, the IRP shall also be delivered for information a detailed description of the radiation sources that are used in pre-operational testing and of their calibration certificates.

The report on the use, periodic testing and maintenance of radiaiton measuring systems and equipment shall be submitted to the IRP for approval in connection with the final safety analysis report, either as part of the FSAR or as a separate document. The IRP supervises the use, periodic testing and maintenance of the measuring equipment by conducting periodic inspections and also other inspections, if necessary.

The IRP supervises the modifications and additions that are made to radiation measuring systems and equipment in the same compass as in the initial construction phase.

8
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