Monitoring of discharges of radioactive substances from nuclear power plants

This Guide is in force as of 15 August 1992, until further notice. The Guide replaces Guide YVL 7.6, issued on 11 October 1983.

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Authorisation

By virtue of section 55, second paragraph, point 3 of the Nuclear Energy Act (990/87) and section 29 of the Council of State Decision on the General Regulations for the Safety of Nuclear Power Plants (395/91), the Finnish Centre for Radiation and Nuclear Safety issues detailed regulations concerning the safety of nuclear power plants.

The YVL Guides are rules an individual licensee or any other organisation concerned shall comply with, unless the Finnish Centre for Radiation and Nuclear Safety has been presented with some other acceptable procedure or solution by which the safety level laid down in an YVL Guide is achieved.

Translation. Original text in Finnish.

1 General

Chapter 3 of the Council of State Decision (395/91) sets forth the general regulations applicable to radiation exposure and to discharges of radioactive substances from a nuclear power plant. Detailed requirements as regards the application of these regulations are presented in YVL Guides. Requirements pertinent to the limitation of discharges are set forth in Guide YVL 7.1. Guides YVL 7.2 and YVL 7.3 present requirements for assessment of both the dispersion of discharges and of population doses around the plant.

This Guide concerns radiation monitoring systems, sampling systems and laboratory measurements for monitoring radioactive discharges from nuclear power plants. Detailed requirements for radiation monitoring systems are also given in Guide YVL 7.11.

Radiation monitoring ensures that discharges to the atmosphere and the aquatic environment do not exceed facility-specific release limits approved by the Finnish Centre for Radiation and Nuclear Safety, derived on the basis of the provisions of the Council of State Decision (395/91). These release limits are given in the Technical Specifications of a nuclear power plant. On the basis of radiation monitoring, measures to limit discharges can be taken, when necessary.

2 Requirements for the monitoring of discharges

2.1 General requirements

Radioactive discharges from nuclear power plants shall be monitored by appropriate measurements. The sensitivity of the measurements shall be such that releases which might cause an individual of the critical group a radiation exposure equivalent to the dose limit (0.1 mSv/a) determined in section 9 of the Council of State Decision (395/91), are measurable with confidence. The measuring methods used shall be chosen to guarantee as good an equipment sensitivity and accuracy of analyses as are achievable by the state-of-the-art technology in use. Subsection 2.2 of this Guide gives examples of detailed requirements as regards the sensitivity of the activity measurements.

The nuclear power plant shall have appropriate instructions concerning the radiation monitoring and sampling systems, and also laboratory analyses, for discharge monitoring. These instructions shall also describe the calibration and quality control procedures for the monitoring equipment and methods.

2.2 Monitoring of radioactive discharges during normal operation

2.2.1 Airborne discharges

Since radioactive discharges to the atmosphere cannot be determined conclusively with sufficient accuracy by direct monitoring of the flow channel in question (e.g. exhaust stack), a representative sample flow and collection from the bulk stream into a separate sampling and monitoring system shall be arranged, where necessary. The sampling and monitoring system shall be made redundant at least as regards all its active functions (flow lines containing pumps and valves, radiation monitoring systems, sampling filters etc.). If the activity concentrations of radioactive substances in forms other than gas (particulates, aerosols) are measured from filters in a sampling line, particle collection from the main flow shall be performed representatively.

The volume flow of a gas within an exhaust stack or at another discharge point shall be reliably determined under all circumstances.

Radioactive noble gases

Radioactive noble gas discharges shall be measured by a stationary, continuous radiation monitoring system which may be

spectrometric, or, which measures gross beta or gamma activity. In addition, it shall be possible to take a gas sample for analysis in laboratory. The discharges are determined based on monitoring system indications and on a periodical radionuclide analysis of collected samples in laboratory.

In laboratory, significant noble gas nuclides shall be determined by gamma spectrometry at least once a week, and in events during which the composition or quantity of discharges has changed, or there is reason to believe they have changed.

The minimum level of detectability shall be at least such that for each of the principal radioactive gases, such as e.g. ^{87}Kr and ^{133}Xe, an activity concentration of 10 kBq/m^3 is measurable.

Radioactive iodine

Continuous sampling of discharges shall be done using filters which retain molecular iodine and organic iodine compounds and which have a sufficient retention factor. The filters shall be replaced and analysed for radionuclides in laboratory at least once a week, plus in events where the composition or quantity of radioactive discharges has changed, or there is reason to believe they have changed. The detection sensitivity shall be such that an activity concentration of 10 mBq/m^3 of ^{131}I is measurable in the discharge flow.

Other radioactive material

Representative release samples shall be continuously collected in a particulate filter with a sufficient retention factor. The filter shall be replaced and analysed for radionuclides in laboratory at least once a week, and also in events where the composition or quantity of radioactive discharges has changed, or there is reason to believe they have changed. Also radioactive iodine isotopes retained by the filter shall be determined.

The sensitivity of analyses shall be such that a ^{60}Co activity concentration of 10 mBq^3 is measurable in the effluent flow by a gamma-ray spectrometer.

Gross alpha activity shall be determined from the filters and the detection sensitivity shall be such that a gross activity concentration of 1 mBq/m^3 of alpha-emitting nuclides is measurable in the effluent flow. The principal alpha-emitting nuclides shall be measurable when required. The sensitivity of analysis shall be such that a concentration of 1 mBq/m^3 of ^{241}Am is measurable in the effluent flow. A quarterly cumulative sample shall be analysed for the nuclides ^{89}Sr and ^{90}Sr. The detection sensitivity shall be such that a combined activity concentration of 1 mBq/m^3 of the isotopes ^{89}Sr and ^{90}Sr is measurable in the effluent flow.

Samples of gaseous effluents shall be analysed for radioactive tritium (^3H) at least once a month. The detection sensitivity shall be such that an activity concentration of 0.1 kBq/m^3 of ^3H is measurable.

A sample of discharged air shall be analysed for carbon-14 (^{14}C) at least once every three months. The detection sensitivity shall be such that an activity concentration of 10 Bq/m^3 of ^{14}C is measurable in the discharge flow.

2.2.2 Liquid discharges

The principal pathways of radioactive effluents discharged to the marine environment shall be monitored by means of stationary, continuous radiation monitoring systems.

In addition, a representative sample of all liquid effluents released shall always be taken. Sampling from the principal release stream shall take place automatically from the discharge line; otherwise, batch release specific samples from the waste system in question shall be taken in advance. The release samples shall be analysed for radionuclides in

laboratory. A monthly cumulative sample shall be analyzed for tritium (^{3}H) and for gross alpha radioactivity. A quarterly cumulative sample shall be analyzed for the nuclides ^{89}Sr and ^{90}Sr.

The sensitivity of analyses shall be such that it permits the measurement of an activity concentration of 10 kBq/m^3 of each gamma-emitting radionuclide, an activity concentration of 100 kBq/m^3 of tritium, a gross alpha activity concentration of 1 kBq/m^3 and an activity concentration of 1 kBq/m^3 of ^{89}Sr and ^{90}Sr.

2.3 Monitoring abnormal radioactive discharges

2.3.1 Airborne discharges

The discharges of radioactive effluents to the atmosphere shall be measurable also during all operational transients and in accidents; by stationary, continuous radiation monitoring systems and also by sampling and laboratory analyses. Both the sampling and the arrangements for measurement shall be implemented in such a way that sufficient data on radioactive discharges are obtained with good confidence also during a serious accident.

For the earliest possible detection of abnormal discharges at a BWR, radiation monitoring and sampling systems and laboratory analyses shall be employed to monitor the quantity of radioactive materials in the turbine condenser off-gases.

At a PWR, continuous radiation monitoring systems shall be employed to monitor radioactive discharges via the condenser off-gas system, and the activity of secondary circuit water.

2.3.2 Liquid discharges

The system for the continuous radiation monitoring of liquid discharges shall reliably close the discharge line if the activity measured exceeds the upper limit set for the discharge line in question, or, if the monitoring system is inoperable.

Exceptional discharge pathways (various intermediate circuits, PWR secondary circuits) shall be monitored by means of appropriate sampling systems and laboratory analyses.

YVL guides

General guides

YVL 1.0 Safety criteria for design of nuclear power plants, 1 Dec. 1982

YVL 1.1 The Finnish Centre for Radiation and Nuclear Safety as the regulatory authority in control of the use of nuclear energy, 27 Jan. 1992

YVL 1.2 Documents to be submitted to the Finnish Centre for Radiation and Nuclear Safety concerning the regulation of nuclear facilities, 22 May 1991 (in Finnish)

YVL 1.3 Mechanical components and structures of nuclear power plants. Inspection licenses, 25 March 1983

YVL 1.4 Quality assurance of nuclear power plants, 20 Sep. 1991

YVL 1.5 Reporting nuclear power plant operation to the Finnish Centre for Radiation and Nuclear Safety, 18 Aug. 1989

YVL 1.6 Nuclear power plant operator licensing, 3 March 1989

YVL 1.7 Duties important to nuclear power plant safety, personnel qualifications and training, 28 Dec. 1992 (in Finnish)

YVL 1.8 Repairs, modifications and preventive maintenance at nuclear facilities, 2 Oct. 1986

YVL 1.9 Quality assurance during operation of nuclear power plants, 13 Nov. 1991

YVL 1.13 Regulatory inspections related to shut-downs at nuclear power plants, 9 May 1985

YVL 1.15 Mechanical components and structures in nuclear installations, Construction inspection, 16 April 1984

Systems

YVL 2.1 Safety classification of nuclear power plant systems, structures and components, 22 May 1992

YVL 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants, 7 Oct. 1987

YVL 2.3 Preinspection of nuclear power plant systems, 14 Aug. 1975

YVL 2.4 Over-pressure protection and pressure control during disturbances in the primary circuit and steam generators of a PWR plant, 19 Sept. 1984

YVL 2.5 Pre-operational and start-up testing of nuclear power plants, 8 Jan 1991

YVL 2.6 Provision against earthquakes affecting nuclear facilities, 19 Dec. 1988

YVL 2.7 Failure criteria for the design of a light-water reactor, 6 April 1983

YVL 2.8 Probabilistic safety analyses (PSA) in the licensing and regulation of nuclear power plants, 18 Nov. 1987

Pressure vessels

YVL 3.0 Pressure vessels in nuclear facilities. General guidelines on regulation, 21 Jan. 1986

YVL 3.1 Nuclear power plant pressure vessels. Construction plan. Safety classes 1 and 2, 11 May 1981

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YVL 3.3 Supervision of the piping of nuclear facilities, 21 May 1984

YVL 3.4 Nuclear power plant pressure vessels. Manufacturing license, 15 April 1981

YVL 3.7 Pressure vessels of nuclear facilities. Commissioning inspection, 12 Dec. 1991

YVL 3.8 Nuclear power plant pressure vessels. Inservice inspections, 3 Dec. 1993 (in Finnish)

YVL 3.9 Nuclear power plant pressure vessels. Construction and welding filler materials, 6 Nov. 1978

Buildings and structures

YVL 4.1 Nuclear power plant concrete structures, 22 May 1992 (in Finnish)

YVL 4.2 Steel structures for nuclear facilities, 19 Jan. 1987

YVL 4.3 Fire protection at nuclear facilities, 2 Feb. 1987

Other structures and components

YVL 5.3 Regulatory control of nuclear facility valves and their actuators, 7 Feb. 1991

YVL 5.4 Supervision of safety relief valves in nuclear facilities, 3 June 1985

YVL 5.5 Supervision of electric and instrumentation systems and components at nuclear facilities, 7 June 1985

YVL 5.6 Ventilation systems and equipment for nuclear power plants, 23 Nov. 1993 (in Finnish)

YVL 5.7 Pumps at nuclear facilities, 23 Nov. 1993 (in Finnish)

YVL 5.8 Hoisting appliances and fuel handling equipment at nuclear facilities, 5 Jan. 1987

Nuclear materials

YVL 6.1 Control of nuclear fuel and other nuclear materials required in the operation of nuclear power plants, 19 June 1991

YVL 6.2 Fuel design limits and general design criteria, 15 Feb. 1983

YVL 6.3 Regulatory control of fuel design and manufacturing, 15 Sept. 1993

YVL 6.4 Supervision of nuclear fuel transport packages, 1 March 1984

YVL 6.5 Supervision of nuclear fuel transport, 1 March 1984

YVL 6.6 Surveillance of nuclear fuel performance, 5 Nov. 1990 (in Finnish)

YVL 6.7 Quality assurance of nuclear fuel, 23 Nov. 1993 (in Finnish)

YVL 6.8 Handling and storage of nuclear fuel, 13 Nov. 1991 (in Finnish)

YVL 6.9 The national system of accounting for and control of nuclear material, 23 Nov. 1993 (in Finnish)

YVL 6.10 Reports to be submitted on nuclear materials, 23 Nov. 1993 (in Finnish)

YVL 6.11 Physical protection of nuclear power plants, 13 July 1992 (in Finnish)

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YVL 7.2 Evaluation of population doses in the environment of nuclear power plants, 12 May 1983

YVL 7.3 Evaluating the dispersion of radioactive releases from nuclear power plants under operating and in accident conditions, 12 May 1983

YVL 7.4 Nuclear power plant emergency plans, 12 May 1983

YVL 7.5 Meteorological measurements of nuclear power plants, 28 Dec. 1990 (in Finnish)

YVL 7.6 Monitoring of discharges of radioactive substances from nuclear power plants, 13 July 1992

YVL 7.7 Programmes for monitoring radioactivity in the environment of nuclear power plants, 21 May 1982

YVL 7.8 Reporting radiological control of the environs of nuclear power plants to the Institute on Radiation Protection, 21 May 1982

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YVL 7.10 Monitoring occupational exposure at nuclear power plants, 29 Aug. 1994 (in Finnish)

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YVL 7.14 Action levels for protection of the public in nuclear power plant accidents, 26 May 1976

YVL 7.18 Radiation protection in design of nuclear power plants, 14 May 1981

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YVL 8.2 Exemption from regulatory control of nuclear wastes, 19 March 1992

YVL 8.3 Treatment and storage of radioactive waste at the nuclear power plants, 1 July 1985

The YVL-guides without any language marking are available both in English and Finnish.