STUK

GUIDE **YVL C.3** / 15 NOVEMBER 2013

LIMITATION AND MONITORING OF RADIOACTIVE RELEASES FROM A NUCLEAR FACILITY

1 INTRODUCTION 3

2 SCOPE FOR APPLICATION 4

3 LIMITATIONS CONCERNING RADIATION EXPOSURE AND RELEASES 4

3.1 General requirements 4
3.2 Design limits 5
3.2.1 Normal operation and anticipated operational occurrences 5
3.2.2 Accidents 5
3.3 Operational limits 6
3.3.1 Release limits 6
3.3.2 Releases requiring action 6
3.3.3 Planned releases 6
3.3.4 Target levels for releases 6

4 SPECIAL SYSTEMS FOR REDUCING RELEASES 7

5 REQUIREMENTS FOR RELEASE MEASUREMENTS 7

5.1 General requirements 7
5.2 Measuring of releases from a nuclear power plant during normal operation 8
5.2.1 Airborne releases 8
5.2.2 Waterborne releases 9
5.3 Measuring of abnormal releases from a nuclear power plant 9
5.3.1 Airborne releases 9
5.3.2 Waterborne releases 10

6 REGULATORY OVERSIGHT BY THE RADIATION AND NUCLEAR SAFETY AUTHORITY 10

continues

With regard to new nuclear facilities, this Guide shall apply as of 1 December 2013 until further notice. With regard to operating nuclear facilities and those under construction, this Guide shall be enforced through a separate decision to be taken by STUK. This Guide replaces Guides YVL 7.1 and YVL 7.6.

First edition
Helsinki 2014

ISBN 978-952-309-097-2 (print) Kopijyvä Oy 2014
ISBN 978-952-309-098-9 (pdf)
ISBN 978-952-309-099-6 (html)

STUK • **SÄTEILYTURVAKESKUS**
STRÅLSÄKERHETSCENTRALEN
RADIATION AND NUCLEAR SAFETY AUTHORITY

Osoite/Address • Laippatie 4, 00880 Helsinki
Postiosoite / Postal address • PL / P.O.Box 14, FIN-00881 Helsinki, FINLAND
Puh./Tel. (09) 759 881, +358 9 759 881 • Fax (09) 759 88 500, +358 9 759 88 500 • www.stuk.fi

DEFINITIONS 10

REFERENCES 12

ANNEX SUMMARY OF THE MEASUREMENTS OF NORMAL RELEASES FROM A NUCLEAR POWER PLANT 14

Authorisation

According to Section 7 r of the Nuclear Energy Act (990/1987), *the Radiation and Nuclear Safety Authority (STUK) shall specify detailed safety requirements for the implementation of the safety level in accordance with the Nuclear Energy Act.*

Rules for application

The publication of a YVL Guide shall not, as such, alter any previous decisions made by STUK. After having heard the parties concerned STUK will issue a separate decision as to how a new or revised YVL Guide is to be applied to operating nuclear facilities or those under construction, and to licensees' operational activities. The Guide shall apply as it stands to new nuclear facilities.

When considering how the new safety requirements presented in the YVL Guides shall be applied to the operating nuclear facilities, or to those under construction, STUK will take due account of the principles laid down in Section 7 a of the Nuclear Energy Act (990/1987): *The safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience, safety research and advances in science and technology.*

According to Section 7 r(3) of the Nuclear Energy Act, *the safety requirements of the Radiation and Nuclear Safety Authority (STUK) are binding on the licensee, while preserving the licensee's right to propose an alternative procedure or solution to that provided for in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with this Act, the Radiation and Nuclear Safety Authority (STUK) may approve a procedure or solution by which the safety level set forth is achieved.*

Translation. Original text in Finnish.

1 Introduction

101. The operation of a nuclear power plant and other nuclear facility may expose the surrounding population to radiation as a result of radioactive releases and direct radiation emitted from the plant. In order to minimise the radiation exposure of the surrounding population, the radiation exposure caused by the normal operation of and potential operational occurrences and accidents in a nuclear facility is restricted.

102. Exhaust air from nuclear power plant ventilation and gaseous substances diverted from processes, cleaned where necessary, are released to the atmosphere in normal operation. Cleaned effluent waters from plant processes are discharged into the aquatic environment, which in Finland's case means the sea. In terms of normal releases, the primary release pathways are the vent stack and outlet water channel. In transients and accidents, radioactive substances may also find their way into the environment via exceptional pathways, and the composition of the releases may be different from normal. The releases are monitored by means of process and release measurements carried out inside the plant on the one hand, and by observing the radiation and radioactive substances present in the environment on the other.

103. The provisions regulating the use of nuclear energy are laid down in the Nuclear Energy Act (990/1987) and the Nuclear Energy Decree (161/1988) issued thereunder. According to Section 6 of the Nuclear Energy Act, *the use of nuclear energy must be safe; it shall not cause injury to people, or damage to the environment or property.*

104. General provisions for limiting radiation exposure are laid down in the Radiation Act (592/1991) and Radiation Decree (1512/1991). The provisions of Section 2 (General principles) and Chapter 9 (Radiation work) of the Radiation Act also apply to the use of nuclear energy.

105. According to Section 2 of the Radiation Act, the use of radiation and practices involving radiation exposure shall meet the following requirements so as to be considered acceptable:

1. *The benefits derived from the practice shall exceed the detriment it causes (principle of justification).*
2. *The practice shall be arranged so that the resulting exposure to radiation hazardous to health is kept as low as is reasonably achievable (principle of optimisation).*
3. *No person shall be exposed to radiation exceeding the maximum values prescribed by Decree (principle of limitation).*

106. According to Section 7 c of the Nuclear Energy Act, *the maximum values of radiation exposure caused by a nuclear facility or any other use of nuclear energy on any member of the public will be provided for by Government decree. Limits on releases of radioactive materials from a nuclear facility, in order that they do not exceed the maximum values for radiation exposure [– –], shall be confirmed by the Radiation and Nuclear Safety Authority (STUK). Supervision of releases of radioactive materials shall be arranged so that compliance with limits as referred to in this section can be reliably established.* These release limits are specified in the Operational Limits and Conditions of the nuclear power plant approved by STUK. Based on the measurement results, steps may be taken to reduce the releases where necessary.

107. Pursuant to Section 82 of the Nuclear Energy Act, the Government has issued a Decree that lays down provisions on the safety of nuclear power plants and, where applicable, on the safety of other nuclear facilities equipped with a nuclear reactor (717/2013). Chapter 3 of said Government Decree contains provisions concerning radiation exposure and the releases of radioactive substances. With regard to nuclear waste facilities, equivalent provisions are set out in Chapter 2 of the Decree on the Safety of Disposal of Nuclear Waste (736/2008). The principles laid down in Section 2 of the Radiation Act have been observed in drafting the Decrees.

108. According to the Commission Recommendation on the application of Article 37 of the Euratom Treaty (2010/635/Euratom), the Member States shall provide the Commission with information about the estimated environmental impacts of the use of nuclear energy. For example, the data pertaining to a nuclear power plant shall be submitted whenever possible one year, but no later than six months, prior to the issuance of an operating licence.

2 Scope for application

201. The present Guide provides detailed requirements to be satisfied by the applicant and licensee regarding the reduction of radioactive releases from a nuclear power plant as well as the radiation measurements, sampling systems and laboratory determinations used for monitoring the radioactive releases from the plant. Additionally, design requirements are specified, particularly for systems designed for limiting releases. Where applicable, the requirements specified in the Guide shall also apply to research reactors and other nuclear facilities, unless it is specifically indicated in the relevant context that the requirement only applies to nuclear power plants. However, equivalent requirements for nuclear facilities related to nuclear waste handling and nuclear waste management are specified in Guides YVL D.3 Handling and storage of nuclear fuel, YVL D.4 Predisposal management of low and intermediate level nuclear waste and decommissioning of a nuclear facility, and YVL D.5 Disposal of nuclear waste, in which reference is made to this Guide as applicable.

202. This Guide applies to the design, construction, commissioning and use of a nuclear facility as provided in para 201. The Guide applies to normal operation as well as operational occurrences and accidents. The decommissioning of nuclear facilities is governed by Guide YVL D.4.

203. The requirements concerning the structural radiation safety and radiation monitoring systems and equipment of nuclear facilities are specified in Guide YVL C.1 Structural radiation safety at a nuclear facility and Guide YVL C.6 Radiation monitoring at a nuclear facility.

204. The requirements concerning the assessment of the dispersion of radioactive releases and the radiation doses received by the local population as well as the monitoring of the radiation and radioactive substances present in the environment are specified in Guide YVL C.4 Assessment of radiation doses to the public in the vicinity of a nuclear facility. A comprehensive discussion of the analysis of transients and accidents of a nuclear power plant is provided in Guide YVL B.3 Deterministic safety analyses for a nuclear power plant, while probabilistic risk assessment is discussed in Guide YVL A.7 Probabilistic risk assessment and risk management of a nuclear power plant. The reporting to STUK concerning offsite radiation safety, including the reporting of releases, is detailed in Guide YVL A.9 Regular reporting on the operation of a nuclear facility. The requirements concerning the laboratory of a nuclear power plant as well as the radiochemical measurements of the primary and the secondary circuit are specified in Guide YVL B.5 Reactor coolant circuit of a nuclear power plant. The preliminary and final safety analysis reports for a nuclear facility are discussed in Guide YVL A.1 Regulatory oversight of safety in the use of nuclear energy and the Operational Limits and Conditions in Guide YVL A.6 Conduct of operations at a nuclear power plant.

3 Limitations concerning radiation exposure and releases

3.1 General requirements

301. The radiation exposure arising from the operation of a nuclear facility shall be kept as low as reasonably achievable. A nuclear power plant and its operation shall also be so designed that the limits specified in the Government Decree (717/2013) are not exceeded. The corresponding limits applicable to research reactors are specified by STUK's decision. Hence, mere compliance with the limits is not enough; instead, efforts shall be made to keep the radioactive releases to and radiation levels in the environment arising from the operation of the plant as low as reasonably achievable.

302. According to Section 7 a of the Nuclear Energy Act, *the safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience, safety research and advances in science and technology.* The limitation of radioactive releases to and radiation levels in the environment shall be implemented by employing the best available techniques.

303. The documents to be submitted to STUK pursuant to Guide YVL A.1 when filing the application for a decision-in-principle of a nuclear facility shall specify the principles according to which the limitation and monitoring of radioactive releases is intended to be arranged. The documents shall also present an estimate of the anticipated releases both during normal operation and in anticipated operational occurrences and accidents.

304. In the preliminary and final safety assessment reports of the nuclear facility pursuant to Guide YVL A.1, the applicant and licensee shall present an analysis of the radioactive releases and radiation exposure of the population arising from the normal operation of and anticipated operational occurrences and accidents in the plant. The reports must also demonstrate that the radiation exposure arising from the operation of a plant is as low as reasonably achievable and that radioactive releases to and radiation levels in the environment are limited by employing the best available techniques.

3.2 Design limits

3.2.1 Normal operation and anticipated operational occurrences

305. Section 8 of Government Decree (717/2013) stipulates that *the limit for the annual dose of an individual in the population, arising from the normal operation of a nuclear power plant, is 0.1 millisievert (mSv)*, and Section 9 stipulates that *the limit for the annual dose of an individual in the population arising as the result of an anticipated operational occurrence is 0.1 mSv.* The limits concern the annual dose received by the representative person of the most highly exposed population group.

306. The applicant and licensee shall analyse the magnitude of the effective doses received by the representative person in the most highly exposed population group arising from normal operation and anticipated operational occurrences. The collective doses to the population shall also be analysed. All activities that take place on the plant site shall be considered when calculating the collective doses arising from the normal operation of a nuclear power plant. These include the treatment and intermediate storage of power plant operational waste, the operation of the final disposal facility, and the intermediate storage of spent nuclear fuel.

3.2.2 Accidents

307. Section 10 of Government Decree (717/2013) stipulates, in respect of accidents at nuclear power plants, that *the limit value for the annual dose received by an individual in the population as a result of a release is:*

- *1 mSv for Class 1 postulated accidents;*
- *5 mSv for Class 2 postulated accidents;* and
- *20 mSv for a design extension condition .*

308. The limits concern the annual dose received by the representative person of the most highly exposed population group.

309. Section 10 of Government Decree (717/2013) stipulates that at a nuclear power plant *the release of radioactive substances arising from a severe accident shall not necessitate large scale protective measures for the population nor any long-term restrictions on the use of extensive areas of land and water.*

In order to limit the long term effects, the limit for atmospheric releases of cesium-137 is 100 terabecquerel (TBq). The possibility of exceeding the set limit shall be extremely small.

The possibility of a release in the early stages of an accident requiring measures to protect the population shall be extremely small.

310. When a nuclear power plant is designed, analyses must be provided to demonstrate that any release of radioactive substances in a severe accident shall not warrant the evacuation of the

population beyond the protective zone or the need for people beyond the emergency planning zone to seek shelter indoors and that any Cs-137 release is less than the limit value specified for it.

311. Guide YVL A.7 specifies a limit value for the frequency of occurrence for accidents involving a Cs-137 release exceeding 100 TBq and a limiting requirement for losing the containment function in severe reactor accidents in order to limit the occurrence frequency of a release requiring measures to protect the population in early stages.

312. The applicant and licensee shall analyse the magnitude of the effective doses received by the representative person of the most highly exposed population group, and the magnitude of the collective doses to the population arising from accidents.

312a. The extent and duration of soil and water contamination arising from a severe reactor accident shall also be analysed.

3.3 Operational limits

3.3.1 Release limits

313. The applicant and licensee shall derive limits for the release of radioactive substances from the nuclear power plant (the nuclear power plant units located on the same plant site and other nuclear facilities) in such a way that the limit for the dose to an individual as defined in Section 8 of Government Decree (717/2013) is not exceeded. For research reactors, the release limits shall be derived in such a way that the corresponding limit value imposed by STUK's decision is not exceeded.

314. The applicant and licensee shall separately define release limits for the most important radionuclide groups or radionuclides in terms of radiation exposure. When the limits are derived, all significant radionuclides and release pathways shall be considered, up-to-date models and parameters based on theoretical and practical knowledge shall be employed and sufficient safety margins applied.

315. The release limits shall be defined in view of releases occurring over a period of one year. If the radiation monitoring of the environment indicates that the radiation dose of an individual in the population may exceed the limit value, the release limits shall be redefined.

316. According to Guide YVL A.1, the applicant and licensee shall specify the release limits in the Operational Limits and Conditions of the plant.

3.3.2 Releases requiring action

317. In the event that the release rate exceeds the threshold values specified below, the licensee shall take action to reduce the releases when this occurs, if not earlier. Any exceedance of the threshold value or other significant increase in the release rate shall be reported to STUK as provided in Guide YVL A.9.

318. The reporting threshold is 5 × the steady release rate consistent with the release limit (averaged over a maximum period of one week).

319. The release threshold requiring corrective action to be taken is 3 × the steady release rate consistent with the release limit (averaged over a maximum period of one month).

320. The operation of the nuclear facility shall be limited as provided in the Operational Limits and Conditions if, based on releases or environmental radiation monitoring measurements, it is evident that the release limits defined in the Operational Limits and Conditions would otherwise be exceeded.

3.3.3 Planned releases

321. The licensee shall provide STUK with a prior notification of any planned abnormal releases exceeding the reporting threshold referred to in requirement 318.

3.3.4 Target levels for releases

322. In addition to the release limits discussed in section 3.3.1, the licensee shall, as laid down in requirements 301 and 302, determine, representing continuous improvement of operations and good operation of the plant and its personnel, target values which the licensee aims not to exceed for the annual releases of radioactive substances of the nuclear facility and the radiation doses received by the representative person in the most

highly exposed population group. The release target values can be specified for groups of elements and the most important radionuclides and described, for example, in the plant's radiation protection guidelines. The target values shall be updated at appropriate intervals. Performance in attaining the release target values shall be evaluated and the plans necessary for such attainment presented in the annual report on radiation safety to be filed with STUK as provided in Guide YVL A.9.

4 Special systems for reducing releases

401. The applicant and licensee shall design the systems and components containing radioactive substances in such a way that releases of radioactive substances and the radiation exposure of the population living in the vicinity of the plant can be kept low as provided in requirements 301 and 302. The release pathways of radioactive substances shall be identified, and systems to effectively reduce releases shall be designed for collecting and purifying liquids and gases containing radioactive substances. Different radionuclides shall be accounted for in the design of the systems.

402. Releases can be reduced by means of various methods designed for the treatment of radioactive substances. The methods for treating liquids include mechanical filtration, ion exchange, centrifugation, evaporation, and chemical precipitation. The treatment method employed shall be suitable for the type and amount of contamination present in the liquid; minimise the amount of solid waste produced; and enable further treatment of the waste so as to fulfil the requirements set for final disposal. Final disposal is addressed in Guide YVL D.5.

403. Adequate delay systems for off-gases shall be provided to reduce the releases of noble gases. The gas treatment and ventilation systems of the plant shall be fitted with effective particle filters and activated carbon filters to reduce aerosol and iodine releases. A more detailed discussion of the ventilation systems of a nuclear facility is provided in Guide YVL B.1.

5 Requirements for release measurements

5.1 General requirements

501. According to Section 27 of Government Decree (717/2013), *the radiation levels of nuclear power plant rooms and the activity concentrations of indoor air and the gases and liquids in the systems shall be measured, releases of radioactive substances from the plant monitored, and concentrations in the environment controlled.*

502. The licensee shall monitor the releases of radioactive substances from the nuclear facility by means of adequate measurements. The sensitivity of the release measurements performed at a nuclear power plant shall be such as to allow the reliable measurement of any releases that could expose the representative person in the most highly exposed population group to radiation in the amount that only accounts for a small fraction of the radiation exposure equalling the limit (0.1 mSv/a) prescribed in Section 8 of Government Decree (717/2013). The methods employed shall be so selected that the overall reliability, representativeness, sensitivity and accuracy of the measurements are as high as achievable with available advanced techniques. The release measurement equipment shall be located in rooms where the background radiation will not interfere with the measurements. Examples of detection limits that can be achieved or beaten are given in the annex to this Guide.

503. The requirements pertaining to the laboratory and its activity measuring instruments specified in Guides YVL B.5 and YVL C.6 also apply to the handling, analysis and measuring of release samples.

504. In the preliminary and final safety assessment reports of the nuclear facility, the applicant and licensee shall present in accordance with Guide YVL A.1 an analysis of the transport of radioactive substances in plant systems (e.g. mass balances and transport diagrams) as well as a description of release pathways and the radiation and release monitoring of the pathways.

505. The preliminary safety assessment report shall contain a description of the analyses and tests that have been or will be carried out to demonstrate the performance of the release measurement systems, including the representativeness of sampling. In the final safety assessment report, the applicant and licensee shall present these analyses and tests complete with results.

5.2 Measuring of releases from a nuclear power plant during normal operation

5.2.1 Airborne releases

506. The licensee shall monitor the significant release pathways of radioactive substances into the atmosphere (e.g. vent stack) by means of stationary and continuously-operating radiation monitoring systems. It shall also be possible to monitor the release pathways in the event of a single failure occurring in the systems.

507. Since it is not possible to determine with sufficient accuracy all airborne radioactive releases by means of direct release measurement in the flow channel (e.g. vent stack), the applicant and licensee shall arrange a sample flow and sampling into a dedicated sampling and measuring system from the release flow whenever necessary. Redundancy shall be provided for at least all active functions of the sampling and measuring system (flow lines with pumps or valves, radiation monitoring systems, sampling filters, etc.) in accordance with Guide YVL B.1. Sampling from the release flow shall be representative in such a way that account is taken of all radioactive substances in gaseous and other forms (aerosols, particles).

508. The licensee shall be capable of reliably determining the volumetric flow rate of gas within the vent stack or other points of release in all conditions.

509. By way of an exception, the releases may also be determined by other means if direct measuring or representative sampling is difficult to accomplish. Examples include the releases arising from a leak or discharge of water or steam from the secondary circuit of a pressurised water reactor that may be determined, for example, based on the radionuclide content of the water in the primary or secondary circuit and the analysis of the amounts of water removed from the secondary circuit.

Radioactive noble gases

510. The licensee shall measure the releases of noble gases by means of a stationary, continuously-operating radiation monitoring system that may be gamma-spectrometric or of the type that measures the total gamma or total beta activity. It shall also be possible to take a gas sample for laboratory determination purposes. The releases shall be determined based on the results of the monitoring system and the sampling-based radionuclide analysis performed in a laboratory at regular intervals.

511. Significant noble gas nuclides shall be determined by gamma-spectrometric means in a laboratory on a weekly basis, if not more frequently, and in a representative manner in situations where the composition or rate of the release has or is suspected of having undergone essential changes.

Radioactive iodine

512. The licensee shall collect a representative sample of the releases on an on-going basis using filters with sufficient separating capacity to trap inorganic and organic iodine compounds. The filters shall be replaced and a gamma-spectrometric radionuclide analysis shall be performed on them in a laboratory on a weekly basis, if not more frequently, and in a representative manner in situations where the composition or amount of the releases has or is suspected of having undergone changes.

513. The releases of radioactive iodine through the vent stack shall also be measured by means of a stationary, continuously-operating radiation monitoring system based on the measurement of the activity of ^{131}I contained in the sample that is collected in the filter on a continuous basis. This system does not need to meet the single failure criterion.

Other radioactive substances

514. The licensee shall collect a representative sample of the releases on an on-going basis using a particulate air filter with sufficient separating capacity. The filter shall be replaced and a gamma-spectrometric radionuclide analysis shall be performed on it in a laboratory on a weekly basis, if not more frequently, and in a representative manner also in situations where the composition or rate of the release has or is suspected of having undergone changes. In this connection, the radioactive iodine isotopes accumulated in the filter shall also be determined where necessary. The total activity of alpha-emitting nuclides shall also be determined from the sample combined from the filters on a monthly basis, if not more frequently. The most important alpha-emitting nuclides shall be analysed in the event of increased total activity of the alpha-emitting nuclides. Radionuclides ^{89}Sr and ^{90}Sr shall be analysed from a composite sample on a quarterly basis.

515. Tritium (^{3}H) and ^{14}C shall be determined from a representative sample continuously collected from the release on a monthly basis, if not more frequently, and in a representative manner also in situations where the release rate has or is suspected of having undergone essential changes. These samplings do not need to meet the single failure criterion and can be assigned to Class EYT.

516. The releases of radioactive aerosols through the vent stack shall also be measured by means of a stationary, continuously-operating radiation monitoring system based on the measurement of the total gamma or total beta activity contained in the sample that is collected in the filter on a continuous basis. This system does not need to meet the single failure criterion.

5.2.2 Waterborne releases

517. The licensee shall monitor the significant release pathways of radioactive substances into the aquatic environment by means of stationary and continuously-operating radiation monitoring systems. It shall also be possible to monitor the release pathways in the event of a single failure occurring in the radiation monitoring systems as provided in Guide YVL B.1.

518. Also, a representative sample shall always be taken of any liquid releases. The sampling of any significant releases shall take place automatically from the release line; if not, samples shall be taken beforehand from the effluent system concerned separately for each release batch. A gamma-spectrometric radionuclide analysis shall be performed on the release samples in a laboratory. Additionally, the activity of tritium (^{3}H) and the total activity of alpha-emitting nuclides shall be determined from a composite sample representing the total release over a period of one month. The most important alpha-emitting nuclides shall be analysed in the event of increased total activity of the alpha-emitting nuclides. Radionuclides ^{89}Sr and ^{90}Sr shall be analysed on a quarterly basis from a sample representing total releases of the period.

5.3 Measuring of abnormal releases from a nuclear power plant

5.3.1 Airborne releases

519. The licensee shall also be capable of determining the airborne radioactive releases in all operational occurrences and accidents by means of stationary, continuously-operating radiation monitoring systems and based on sampling and laboratory analysis. Both the sampling and the measuring arrangements and operations shall be so accomplished that sufficient data on the releases of radioactive substances can be obtained with considerable certainty even in the event of a severe accident. These systems shall meet the single failure criterion as provided in Guide YVL B.1.

520. To enable timely detection of exceptional releases, the processes of a nuclear power plant shall be monitored by means of stationary radiation measuring instruments. The requirements pertaining to these instruments are specified in Guide YVL C.6. Additionally, the amount of radioactive substances present in the primary circuit, in the exhaust gas from the turbine condenser of a boiling water reactor plant, and in the water of the secondary circuit of a pressurised water reactor plant shall be monitored by means of sampling and laboratory analyses.

5.3.2 Waterborne releases

521. The continuously-operating radiation monitoring system that monitors the waterborne releases from a nuclear power plant shall automatically and reliably shut off the release line concerned if the measured activity exceeds the maximum limit set for the activity in the release line or if the monitoring systems fails. This system shall meet the single failure criterion as provided in Guide YVL B.1.

522. In addition to the radiation monitoring systems, exceptional release pathways (various intermediate circuits, the secondary circuit of a pressurised water reactor) shall also be monitored by means of adequate sampling systems and laboratory determinations.

6 Regulatory oversight by the Radiation and Nuclear Safety Authority

601. When the application for a decision-in-principle is filed, STUK will assess based on the documents submitted directly to STUK in accordance with Guide YVL A.1 whether the nuclear facility concerned fulfils the necessary preconditions for satisfying the requirements for limiting and monitoring of radioactive releases prescribed by law and the YVL Guides.

602. STUK will check from the preliminary and final safety analysis report and the accompanying separate reports pertaining to the nuclear facility concerned that the requirements specified in chapters 3 through 5 are met.

603. STUK will check that the Operational Limits and Conditions of the nuclear facility contain the release limits specified in section 3.3.1 and that these limits are acceptable. Additionally, STUK will make an assessment of the target values for releases discussed in section 3.3.4.

604. The regulatory oversight of the radiation monitoring systems and equipment used for measuring the releases of radioactive substances from a nuclear facility is discussed in Guide YVL C.6.

605. During the construction of a nuclear facility, STUK will assess and verify that the systems necessary for limiting and monitoring of releases of radioactive substances are implemented in compliance with the plans and designs presented to STUK. The licensee's performance is evaluated in on-site inspections carried out in accordance with the construction inspection programme.

606. During the operation of the nuclear facility, STUK will oversee the radioactive releases and radiation levels in the environment by observing the release measurements and environmental radiation monitoring performed by the licensee. The oversight of the release measurements and environmental radiation monitoring by STUK will be carried out by checking the measurement results reported to STUK as provided in Guide YVL A.9. Additionally, STUK will make an assessment of the measures required to attain the target levels for releases as defined in section 3.3.4. STUK also controls the release measurements and environmental radiation monitoring by inspecting any repairs and modifications to the radiation monitoring systems and equipment, and by auditing the steps taken by the licensee to ensure reliable measurements. The actions of the licensee are assessed by means of inspections specified in the periodic inspection programme and, where necessary, by means of other on-site inspections.

607. STUK will continue to oversee the monitoring of radioactive releases from the nuclear facility throughout the decommissioning of the facility, until the nuclear facility has been finally dismantled and all the dismantling waste disposed of. Decommissioning is addressed in Guide YVL D.4.

Definitions

Representative person

Representative person shall refer to an individual in the population group most highly exposed to a given radiation source (here to the radioactive substances contained in releases), whose radiation dose represents the doses received by such a population group (ICRP Publication 101). The representative person is

equivalent to, and replaces, the previous term 'average member of the critical group'.

Effective dose

Effective dose shall refer to the weighted sum of the equivalent doses in tissues and organs exposed to radiation, where equivalent dose denotes the product of the mean energy imparted by radiation to tissue or to an organ, per unit mass, and a weighting factor specified for the radiation. (Radiation Decree 1512/1991)

Normal operation

Normal operation (DBC 1) shall refer to the planned operation of a nuclear power plant according to the Operational Limits and Conditions and operational procedures in place. These also include testing, plant start-up and shutdown, maintenance and refuelling. As far as other nuclear facilities are concerned, normal operation shall refer to similar plant operation.

Anticipated operational occurrence

Anticipated operational occurrence (DBC 2) shall refer to such a deviation from normal operation that can be expected to occur once or several times during any period of a hundred operating years. (Government Decree 717/2013)

Accident

Accident shall refer to postulated accidents, design extension conditions and severe accidents. (Government Decree 717/2013)

Postulated accident

Postulated accident shall refer to a deviation from normal operation which is assumed to occur less frequently than once over a span of one hundred operating years, excluding design extension conditions; and which the nuclear power plant is required to withstand without sustaining severe fuel failure, even if individual components of systems important to safety are rendered out of operation due to servicing or faults. Postulated accidents are grouped into two classes on the basis of the frequency of their initiating events:

a. Class 1 postulated accidents (DBC 3), which can be assumed to occur less frequently than once over a span of one hundred operating years, but at least once over a span of one thousand operating years;
b. Class 2 postulated accidents (DBC 4), which can be assumed to occur less frequently than once during any one thousand operating years. (Government Decree 717/2013)

Design extension condition

Design extension condition (DEC) shall refer to:

a. an accident where an anticipated operational occurrence or class 1 postulated accident involves a common cause failure in a system required to execute a safety function (DEC A);
b. an accident caused by a combination of failures identified as significant on the basis of a probabilistic risk assessment (DEC B); or
c. an accident caused by a rare external event and which the facility is required to withstand without severe fuel failure (DEC C). (Government Decree 717/2013)

Best available techniques

Best Available Techniques (BAT) shall refer to methods of production and treatment that are as efficient and advanced as possible and technologically and economically feasible, as well as methods of designing, constructing, maintenance and operation with which the pollution of the environment caused by activities can be prevented or most efficiently reduced. (Environmental Protection Act 86/2000)

Research reactor

Research reactor shall refer to a nuclear facility equipped with a nuclear reactor mainly used for the generation of neutron flux and ionising radiation for research and other purposes. (Nuclear Energy Act 990/1987)

Severe accident

Severe accident shall refer to an accident in which a considerable part of the spent fuel in a reactor or fuel pool loses its original structure. (Government Decree 717/2013)

Severe reactor accident

Severe reactor accident shall refer to an accident in which a considerable part of the fuel in a reactor loses its original structure. (Government Decree 717/2013)

Annual dose

Annual dose shall refer to committed effective dose arising from external radiation within the period of one year and from intake of radioactive substances within the same period of time. (Government Decree 717/2013)

Nuclear waste

Nuclear waste shall refer to radioactive waste in the form of spent nuclear fuel or in some other form generated during or as a result of the use of nuclear energy. Nuclear waste also refers to materials, objects and structures which, having become radioactive during or as a result of the use of nuclear energy and having been removed from use, require special measures owing to the danger posed by their radioactivity. (Nuclear Energy Act 990/1987)

Nuclear waste facility

Nuclear waste facility shall refer to a nuclear facility utilised for the encapsulation of spent nuclear fuel or the conditioning of other nuclear waste for disposal, and to a disposal facility for spent nuclear fuel or other nuclear waste. (Government Decree 736/2008)

Nuclear facility

Nuclear Nuclear facility shall refer to facilities used for the generation of nuclear energy, including research reactors, facilities implementing the large-scale final disposal of nuclear waste, and facilities used for the large-scale production, generation, use, processing or storage of nuclear material or nuclear waste. However, nuclear facility shall not refer to: a) mines or milling facilities intended for the production of uranium or thorium, or premises and locations with their areas where nuclear waste from such facilities is stored or located for final disposal; or b) premises finally closed and where nuclear waste has been placed in a manner approved as permanent by the Radiation and Nuclear Safety Authority. (Nuclear Energy Act 990/1987, Section 3)

Nuclear power plant

Nuclear power plant shall refer to a nuclear facility for the purpose of electricity or heat production, equipped with a nuclear reactor, or a complex consisting of nuclear power plant units and other related nuclear facilities located at the same plant site. (Nuclear Energy Act 990/1987).

Single failure

Single failure shall refer to a failure due to which a system, component or structure fails to deliver the required performance.

Single failure criterion

Single failure criterion (N+1) shall mean that it must be possible to perform a safety function even if any single component designed for the function fails.

References

1. Nuclear Energy Act (990/1987)
2. Nuclear Energy Decree (161/1988)
3. Government Decree on the Safety of Nuclear Power Plants (717/2013)
4. Government Decree on the Safety of Disposal of Nuclear Waste (736/2008)
5. Radiation Act (592/1991)
6. Radiation Decree (1512/1991)
7. Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition, General Safety Requirements Part 3, No. GSR Part 3 (Interim), IAEA, Vienna 2011.
8. Safety of Nuclear Power Plants: Design Specific Safety Requirements, IAEA Safety Standards Series No. SSR-1/2, 2012.
9. Safety of Nuclear Power Plants: Commissioning and Operation Specific Safety Requirements, IAEA Safety Standards Series No. NS-R-2/2, 2011.

10. Safety of Research Reactors, IAEA Safety Standards Series No. NS-R-4, 2005.
11. Radiation Protection Aspects of Design for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.13, 2005.
12. Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants, IAEA Safety Standard Series No. NS-G-2.7, 2002.
13. Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors, IAEA Safety Standard Series No. NS-G-4.6, 2009.
14. Programmes and Systems for Source and Environmental Radiation Monitoring, IAEA Safety Reports Series No. 64, 2010
15. Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.
16. The 2007 Recommendations of the International Commission on Radiological Protection, Annals of the ICRP, Publication 103, 2007.
17. Assessing Dose of the Representative Person for the Purpose of Radiation Protection of the Public and The Optimisation of Radiological Protection: Broadening the Process, Annals of the ICRP, Publication 101, 2006.
18. Regulatory Control of Radioactive Discharges to the Environment, Safety Standards Series No. WS-G-2.3, IAEA, Vienna 2000.
19. Environmental and Source Monitoring for Purposes of Radiation Protection, IAEA Safety Standard Series No. RS-G-1.8, 2005.
20. Effluent Release Options from Nuclear Installations, Technical Background and Regulatory Aspects, OECD/NEA, 2003.
21. Commission Recommendation no. 2010/635/Euratom of 11 October 2010 on the application of Article 37 of the Euratom Treaty.
22. Commission Recommendation on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation, 2004/2/Euratom, 18 December 2003.
23. ISO 2889: General principles for sampling airborne radioactive materials.
24. IEC 60761: Equipment for continuous monitoring of radioactivity in gaseous effluents.
25. IEC 60861: Equipment for continuously monitoring for beta and gamma emitting radionuclides in liquid effluents.
26. IEC 60768: Process stream radiation monitoring equipment in light water nuclear reactors for normal operating and incident conditions.
27. ISO 11929: Determination of the detection limit and decision threshold for ionizing radiation measurements.
28. KTA 1503.1: Überwachung der Ableitung gasförmiger und an Schwebstoffen gebundener radioaktiver Stoffe, Teil 1: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei bestimmungsgemäßem Betrieb, Fassung 2012-11, Sicherheitstechnische Regel des KTA, Deutschland.
29. KTA 1503.2: Überwachung der Ableitung gasförmiger und an Schwebstoffen gebundener radioaktiver Stoffe, Teil 2: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei Störfällen, Fassung 2012-11, Sicherheitstechnische Regel des KTA, Deutschland.
30. KTA 1503.3: Überwachung der Ableitung gasförmiger und an Schwebstoffen gebundener radioaktiver Stoffe, Teil 3: Überwachung der nicht mit der Kaminfortluft abgeleiteten radioaktiven Stoffe, Fassung 2012-11, Sicherheitstechnische Regel des KTA, Deutschland.
31. KTA 1504: Überwachung der Ableitung radioaktiver Stoffe mit Wasser, Fassung 11/07, Sicherheitstechnische Regel des KTA, Deutschland.
32. WENRA Statement on Safety Objectives for New Nuclear Power Plants, WENRA, November 2010.
33. WENRA Reactor Safety Reference Levels, WENRA, January 2008.
34. Waste and Spent Fuel Storage Safety Reference Levels Report, WENRA Working Group on Waste and Decommissioning, February 2011.

ANNEX Summary of the measurements of normal releases from a nuclear power plant

Table A01. Summary of the measurements of normal gaseous and particulate releases from a nuclear power plant and examples of radionuclides present in the releases complete with detection limits that can be achieved or beaten at low total activities.

Release type	Measuring procedure	Redundancy	Radionuclide	Detection limit in release flow
noble gases	continuous measurement	yes	^{133}Xe	10 kBq/m^3 during the measuring period < 10 min
	laboratory determination weekly, if not more frequently	yes	^{85}Kr	10 kBq/m^3
			^{87}Kr	1 kBq/m^3
			^{133}Xe	1 kBq/m^3
iodine	continuous measurement		^{131}I	2 Bq/m^3 during the measuring period < 1 h
	laboratory determination weekly, if not more frequently	yes	^{131}I	4 mBq/m^3
aerosols	continuous measurement		all	4 Bq/m^3 during the measuring period < 1 h
	laboratory determination weekly, if not more frequently	yes	^{60}Co	1 mBq/m^3
			^{137}Cs	1 mBq/m^3
alpha activity	laboratory determination monthly, if not more frequently	yes	all	total activity 1 mBq/m^3
			^{241}Am	0.1 mBq/m^3
single significant nuclides	laboratory determination quarterly	yes	^{89}Sr and ^{90}Sr	combined activity 0.1 mBq/m^3
	laboratory determination monthly, if not more frequently		^{3}H	0.1 kBq/m^3
	laboratory determination monthly, if not more frequently		^{14}C	10 Bq/m^3

Table A02. Summary of the measurements of normal liquid releases from a nuclear power plant and examples of measurement detection limits that can be achieved or beaten at low total activities.

Release type	Measuring procedure	Redundancy	Radionuclide	Detection limit in release flow
gamma activity	continuous measurement	yes	significant	Detection limits clearly lower than the upper limit for gamma activity in the release line, e.g. 400 kBq/m^3
	laboratory determination release batch-specifically		significant	1 kBq/m^3
alpha activity	laboratory determination monthly		all	total activity 1 kBq/m^3
			^{241}Am	10 Bq/m^3
single significant nuclides	laboratory determination quarterly		^{89}Sr and ^{90}Sr	combined activity 0.2 kBq/m^3
	laboratory determination monthly		^{3}H	50 kBq/m^3