

# RADIOLOGICAL MONITORING OF THE ENVIRONMENT OF A NUCLEAR FACILITY

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With regard to new nuclear facilities, this Guide shall apply as of 1 January 2017 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. The Guide replaces Guide YVL 7.7.

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# Authorisation

According to Section 7 r of the Nuclear Energy Act (990/1987), the Radiation and Nuclear Safety Authority 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 and 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 the procedure or solution by which the safety level set forth is achieved.*



# 1 Introduction

**101.** The use of nuclear energy is provided for in the Nuclear Energy Act (990/1987) and Nuclear Energy Decree (161/1988). Under section 7 q of the Nuclear Energy Act, the Radiation and Nuclear Safety Authority has issued general safety provisions for nuclear power plants in the Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2016), the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2016) and the Safety of Disposal of Nuclear Waste (STUK Y/4/2016). The Radiation Act (592/1991) and Radiation Decree (1512/1991) contain general provisions for restricting radiation exposure.

**102.** Pursuant to section 6 of the Nuclear Energy Act, *the use of nuclear energy must be safe and must not cause injury to people or damage to the environment or property.*

**103.** Under section 7 c(1) of the Nuclear Energy Act, *releases of radioactive materials caused by the use of nuclear energy shall be limited in compliance with the principle laid down in section 2(2) of the Radiation Act (592 / 1991). Section 2(2) of the Radiation Act states that 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).*

**104.** Under section 7 c(3) of the Nuclear Energy Act, *the Radiation and Nuclear Safety Authority shall, to the extent required, monitor and control the vicinity of a nuclear facility in order to ensure the reliability of measurements of releases of radioactive materials and verify the environmental impacts of the facility.*

**105.** Section 2(3) of the Radiation Act states that no person shall be exposed to radiation exceeding the maximum values prescribed by decree (principle of limitation). Section 22 b of the Nuclear Energy Decree defines the limiting values for the radiation exposure of the members of the public during normal nuclear power plant operation, operational occurrences and accidents.

**106.** Under section 24(1) of the Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant, *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 materials from the plant monitored, and concentrations in the environment controlled.*

**107.** Under section 4(1) of the Radiation and Nuclear Safety Authority Regulation on the Emergency Arrangements of a Nuclear Power Plant, *the Licensee shall be prepared to carry out the measures required in emergency situations, for the analysis of emergency situations and the consequences thereof, assessment of the anticipated development of emergency situations, the mitigatory actions needed to control or limit the accident, the continuous and effective exchange of information with the authorities, and communications to the media and the general public; under subsection 2 of same, when analysing the situation, the technical status of the plant and release of radioactive substances, or threat thereof, and the radiation situation inside the plant and in the site area and emergency planning zone shall be assessed.*

**108.** According to Section 4(3) of the Radiation and Nuclear Safety Authority Regulation on the Emergency Arrangements of a Nuclear Power Plant, *the licensee shall be prepared to carry out radiation monitoring at the site area and inside the protective zone. The licensee shall also take meteorological measurements and shall be capable of assessing the dispersion of radioactive substances and the resulting radiation exposure of the population in the emergency planning zone during an emergency situation.*

**109.** Under section 35(1) of the Nuclear Energy Decree, when applying for a construction licence, the applicant shall submit to STUK *a preliminary safety analysis report, which shall include the general design and safety principles of the nuclear facility, a detailed description of the site and the nuclear facility, a description of the operation*

*of the facility, a description of the behaviour of the facility during accidents, a detailed description of the effects that the operation of the facility would have on the environment, and any other information considered necessary by the authorities as well as a programme concerning the baseline analysis of the nuclear facility's environment pursuant to section 35(9) of the Nuclear Energy Decree.*

**110.** Section 36 of the Nuclear Energy Decree states that when applying for an operating licence, the applicant must provide STUK with, for example, a final safety analysis report, a programme for radiation monitoring in the environment of the nuclear facility, and any other information considered necessary by STUK.

**111.** The purpose of the radiological monitoring of the environment is to ensure that the radiation exposure to the population caused by the operation of a nuclear facility is kept as low as practical measures allow and that the set limit values are not exceeded.

## 2 Scope of application

**201.** This Guide gives the detailed requirements applicable to the licence applicant and licensee for the radiological monitoring of the environment of a nuclear facility.

**202.** This Guide applies, in accordance with para. 201, to the construction, commissioning, operation and decommissioning of a nuclear facility. It relates to a plant's normal operation and operational occurrences and accident situations.

**203.** Guide YVL A.1 deals in detail with the control of the safe use of nuclear energy. The requirements for reporting on the operation of a nuclear facility are given in Guide YVL A.9.

**204.** The requirements for the design of the safety systems of nuclear facilities are set out in Guide YVL B.1, those for the classification of the systems, structures and equipment of a nuclear facility are given in Guide YVL B.2, and those for safety analyses are given in Guide YVL B.3.

**205.** Guide YVL C.3 presents the requirements for the limiting and supervision of the emissions of radioactive substances from a nuclear facility and the radiation exposure of the population in its vicinity. The requirements for the assessment of radiation doses to the public in the vicinity of a nuclear facility are given in Guide YVL C.4. Guide YVL C.5 presents the requirements governing emergency preparedness arrangements at a nuclear power plant and for the radiation protection procedures to be followed in emergencies. The requirements for radiation monitoring systems and equipment are given in Guide YVL C.6.

## 3 Radiological environment baseline study

### 3.1 General principles

**301.** By means of a radiological environment baseline study (hereinafter referred to as the "baseline study"), the licensee shall determine the radiation conditions and concentrations of radioactive substances in the environment of the nuclear facility before the construction or operation of a new nuclear facility has an impact on the concentrations of radioactive substances in the environment.

**302.** The licensee shall draw up a programme for determining the baseline environmental conditions.

**303.** In the baseline study programme, the licensee shall describe the sampling and measurements that are included in the baseline study as well as their timing and frequency. The planned sampling and measurement locations shall be presented and the choices shall be justified. The programme shall also describe the measurement, sampling and analysis methods.

**304.** The results from the programme for environmental radiation surveillance from existing nuclear facilities that are already on the site may be utilized in the baseline study of a new facility's environment. When defining the scope of the baseline study, the suitability of the existing nuclear facility's radiation monitoring programme

and its results for the new nuclear facility shall be assessed. The need for additional sampling and measurements shall also be assessed. The assessments and their justifications shall be presented in the baseline study programme.

**305.** When defining the scope of the radiological environmental baseline study and the sampling and measurements required, account shall be taken of the nuclear facility's location and its environment, the plant type and the anticipated impacts of the activity, such as release routes, release volumes and dispersion into the environment.

**306.** The actions related to the baseline study of a new nuclear facility's environment shall be divided into three stages:

- a. A preliminary survey performed in the environment, during which the licensee shall survey sampling targets (in terms of, for example, the incidence of flora and fauna) that are suitable for radiation monitoring in the environment of the nuclear facility. The licensee shall utilize the information received from the preliminary survey when drawing up the programme for the nuclear facility's baseline study.
- b. An analysis performed before the construction activities of the nuclear facility, during which the licensee shall determine the concentrations of radioactive substances in the environment before the construction of the nuclear facility has affected them.
- c. An analysis performed before the operation of the nuclear facility, during which the licensee shall determine the level of background radiation and concentrations of radioactive substances in the environment before the construction of the nuclear facility has affected them.

**307.** The licensee shall present the results of the radiation and activity measurements made during these analyses in the baseline study. The presentation of the results shall be illustrative and such that the results from the environmental radiation monitoring of the new nuclear facility

or plant unit can be reliably compared with the results from the baseline study.

### **3.2 Requirements for implementing the baseline study**

**308.** On the basis of the preliminary survey performed in the environment, the licensee shall select the most suitable sampling targets from where the concentrations of radioactive substances will be determined during the baseline study. Some of the sampling targets (for example, the species of plants and animals) shall be numerous enough to ensure long-term follow-up of the sampling target even when the nuclear facility is being operated.

**309.** The analysis performed before the construction of the nuclear facility begins shall include a survey related to the concentrations of radioactive substances, in order to determine the possible effects of construction on the said concentrations. This is especially important for construction work related to water systems, where the concentrations of radioactive substances may change in a water environment as the sediments are altered.

**310.** The analysis that is completed before the construction of the nuclear facility may be implemented as a one-time event. In the terrestrial environment, the measurements shall be primarily focused on the definition of radioactive substances in the indicator organisms of the soil and the terrestrial environment. In the water environment, the measurements shall be primarily focused on the definition of radioactive substances in the water environment's indicator organisms, sinking matter and bottom sediment, and the radioactive substances that are diluted and mixed in the water.

**311.** The analysis performed before the operation of the nuclear facility shall be extensive enough in order to allow for the results from the programme for environmental radiation surveillance to be reliably compared with the results from the baseline study at a later date.

**312.** The sampling and measurement programme implemented before operation of the nuclear facility shall be started in good time before the commissioning of a new nuclear facility (for example, three years before the operation of the nuclear facility may have an effect on the concentrations of radioactive substances in the environment).

**313.** The analysis that is performed before the operation of the nuclear facility shall take into account the effects of seasons and annual variations.

**314.** The baseline study shall include terrestrial and water environment samples representing various stages of the human food chain as well as air samples.

**315.** Appendix A presents an example of a sampling and measurement programme for an baseline study that is performed before the operation of a nuclear power plant. As regards other nuclear facilities, the sampling and measurement programme shall be drawn up with adherence to the same principles as in the example programme intended for a nuclear power plant.

## **4 Environmental radiation surveillance**

### **4.1 General principles**

**401.** The licensee shall be able to use the programme concerning the radiological monitoring of the environment (the “radiological monitoring programme”) to observe any short-term and long-term changes in the environment’s normal radiation status in relation to the prevailing level of background radiation. The accuracy of the measurements shall be such that can indicate radiation exposure that is considerably lower than the annual limit value of 0.1 mSv specified in section 22 b of the Nuclear Energy Decree. In addition, the measurements shall make it possible to detect any addition to the concentrations of radionuclides caused by the nuclear facility compared to the background concentration.

**402.** The licensee shall draw up an environmental radiological monitoring programme for the radiological control of the environment of a nuclear facility.

**403.** The licensee shall have available the necessary expertise, equipment and instructions for implementing the environmental radiological monitoring programme.

**404.** The environmental radiological monitoring programme shall contain radiation measurements in the environment of the nuclear facility and assessments of radioactive substances that are made in order to determine the volume, nuclide concentration and possible origin of radioactive substances in the environment.

**405.** When defining the contents and scope of the environmental radiological monitoring programme, the licensee shall take account of the results from the baseline study, the environment of the plant site, the plant type and the estimated effects of the activity, such as release routes, release volumes and dispersion into the environment.

**406.** When planning the measurement and sampling sites for the environmental radiological monitoring programme, account shall be taken of the local dispersion conditions and the location and habits of the population.

**407.** The licensee shall plan the environmental radiological monitoring programme such that the licensee has available the resources to perform radiation measurements and sampling with analyses, even during operational occurrences and accident situations.

### **4.2 Programme for environmental radiation surveillance**

**408.** In the programme for environmental radiation surveillance, the licensee shall define those responsible for implementing the programme and the sampling and measurements and their frequency. The selection of the measurement and sampling sites shall be justified in the programme for environmental radiation surveil-

lance. Furthermore, the radiation monitoring programme shall also describe the measurement, sampling and analysis methods and the processing of the measurement results.

**409.** The radiation monitoring programme shall include measurements of external radiation. In order to measure external radiation, environmental dosimeters and external radiation dose rate measuring stations shall be placed in the facility's terrestrial environment.

**410.** In the terrestrial environment, the measurements shall be primarily focused on the definition of radioactive substances in the air, atmospheric deposition, indicator organisms in the terrestrial environment, domestic water and garden products.

**411.** In the water environment, the measurements shall be primarily focused on the definition of radioactive substances diluted and mixed in the water.

**412.** Appendix B provides the minimum requirements for the control targets of the programme for environmental radiation surveillance for a nuclear power plant and the sampling, measurements and the frequency thereof. The programme for environmental radiation surveillance for other nuclear facilities shall be drawn up while adhering to the basic principles laid down in the example programme for a nuclear power plant that is presented in the appendix.

**413.** If necessary, the licensee shall include special areas in the programme for environmental radiation surveillance. Examples of special areas are presented under para. B09.

### **4.3 Abnormal situations**

**414.** Environmental radiation monitoring shall be stepped up where necessary, if something abnormal is observed in the release measurements for a nuclear power plant or if another good reason exists to suspect a release or abnormal radiation situation at the nuclear facility or in its environment. The procedures to be followed during emergency preparedness events are described in Guide YVL C.5.

**415.** The accuracy of abnormal results obtained from environmental radiation monitoring shall be verified and the cause of the abnormality investigated.

**416.** The licensee shall be capable of taking direct or sampling-based gammaspectrometric measurements in order to investigate abnormal situations in the environment of the nuclear power plant (such as an increase in the external radiation dose rate) or to analyse the effects of releases, the levels of which are greater than normal. Action in the event of abnormal situations shall be planned and instructions provided in advance.

### **4.4 Requirements for instruments used in radiation measurements and sampling**

**417.** The system descriptions for the nuclear facility's final safety analysis report shall describe the fixed environmental radiation measurement systems and equipment, and to present the locations for the measurement stations and collectors (e.g. the measuring stations for the external radiation dose rate, environmental dosimeters, air and atmospheric deposition collectors).

#### **4.4.1 Continuously operating environmental radiation measurement systems**

**418.** The continuously operating external radiation measuring stations shall be placed in a manner that allows the measurement system to be used for observing any possible releases of radioactive substances, and for assessing the direction of dispersion for the said emission during an accident situation.

**419.** Continuously operating external radiation dose rate measuring stations shall be located in the surroundings of the nuclear facility (inside the plant area, for example) and, if necessary, further in the direction of population centres.

**420.** Furthermore, continuously operating external radiation dose rate measuring stations shall be located in the site area and precautionary action zone. Whenever possible, the angle between the measuring stations inside the precautionary action zone shall be approximately 30° when viewed from the nuclear power plant. Measuring stations shall also be installed in the direction of

waterways, if this is reasonably possible (in the archipelago, for example).

**421.** The continuously operating external radiation dose rate measuring system and its related data transmission system shall be designed to operate reliably also under abnormal environmental conditions. The facility-side reception system used for the measurement system's data transmission shall be tolerant of single failure.

**422.** The licensee shall have in place alternative procedures for cases where the facility's continuous external radiation dose rate measurement system is lost as a result of failure or a plant or equipment malfunction.

**423.** The electricity supply of the continuously operating external radiation dose rate measurement system and its related data transmission shall be ensured for a loss of external electricity lasting 72 hours at a minimum.

**424.** In addition to the nuclear facility, the measurement data from the continuously operating external radiation dose rate measurement system shall also be transmitted in real time, and in a reliable manner, to the national radiation monitoring system maintained by STUK.

**425.** The continuous external radiation dose rate measuring equipment shall be capable of measuring radiation over the entire range within which the measured quantity may vary during operational conditions or accidents. If it is necessary to use two or more measuring channels to cover the measuring range of the object, the measuring ranges of the channels must overlap sufficiently.

#### **4.4.2 Sample collectors for ambient air and atmospheric deposition**

**426.** The air sample collectors shall be continuously operating. The collector shall be capable of separating between particle-type substances and gaseous iodine. The collector shall gather air at sufficient efficiency for laboratory analyses, and it shall be possible to define the collected volume of air.

**427.** The air and atmospheric deposition sample collectors shall be designed to operate reliably under different environmental conditions.

**428.** The condition of the air and atmospheric deposition sample collectors shall be monitored, and checks shall be made on them regularly in accordance with a programme drawn up in advance.

**429.** In order to minimize the unavailability of the air sample collector, the licensee shall be immediately informed of a possible disruption or interruption in the power supply of the air sample collectors that may result in the stopping of the collector.

#### **4.4.3 Other equipment in the environment**

**430.** The equipment placed in the environment (such as the environmental dosimeters) shall be designed to operate reliably under those environmental conditions where they are intended to be used.

## **5 Reporting of the results of environmental radiation surveillance**

### **5.1 Quarterly report**

**501.** The licensee's results from radiation monitoring concerning environmental samples shall be submitted to STUK within two and a half months from the end of each quarter.

### **5.2 Annual report**

**502.** The results concerning the licensee's environmental radiation monitoring shall be presented in the licensee's annual report for environmental radiation safety. The general reporting requirements concerning environmental radiation safety are given in Guide YVL A.9.

**503.** In addition to what is required in para. 341 of Guide YVL A.9, the annual report for environmental radiation safety shall present a general description of the environmental radia-

tion monitoring and discuss conformity to the requirements concerning environmental radiation monitoring. The annual report for environmental radiation safety shall report the following concerning the results of the programme for environmental radiation surveillance:

- a. the results from the radiation and activity measurements by item controlled, according to the categories of the table in Appendix C, for example
- b. an overall picture of the facility's effect on the radiation level of its environment, using general conclusions and comparisons and utilizing, for example, diagrams of the time series in the observation material
- c. the observations of radionuclides originating from the plant and their occurrence in samples taken at different distances, abnormal individual measurement results and their cause analysis
- d. the measurement results from environmental external radiation for both the continuously operating measuring stations and the environmental dosimeters.

## 6 Documents to be submitted to STUK

### 6.1 Radiological environment baseline study

**601.** The baseline study programme of a new nuclear facility shall be submitted to STUK for approval no later than when the construction licence is being applied for.

**602.** The results of such an analysis shall be submitted to STUK for approval no later than when the operating licence is being applied for.

**603.** If a requirement is made to supplement the baseline study of a new nuclear facility after the operating licence application has been submitted, the updated baseline study shall be submitted to STUK for approval before STUK issues the statement and safety assessment for the nuclear facility's operating licence application to the Ministry of Employment and the Economy (YVL A.1 para. 416).

### 6.2 Programme for environmental radiation surveillance

**604.** The programme for environmental radiation surveillance for a new nuclear facility shall be submitted to STUK for approval no later than when the operating licence is being applied for.

**605.** During the operation of the nuclear facility, the content and implementation of the radiation monitoring programme shall be reviewed at regular intervals. The results obtained and the development of the methods used shall be taken into account. The updated radiation monitoring programme shall be submitted to STUK for approval no less than once every five years.

### 6.3 Continuously operating environmental radiation measurement system

**606.** The documents concerning the continuously operating environmental external radiation dose rate measurement system shall be submitted to STUK in accordance with Guide YVL B.1. With regard to a nuclear power plant that is being operated, the pre-inspection documentation for any changes to the measurement system shall be submitted to STUK for information.

## 7 Regulatory oversight by the Radiation and Nuclear Safety Authority

**701.** STUK checks the documents submitted to it when processing the construction and operating licence application and oversees the construction of the nuclear facility and its operation, in accordance with Guide YVL A.1.

**702.** STUK inspects the baseline study programme of the new nuclear facility when processing the construction licence application for the nuclear facility. When processing the operating licence application for a nuclear facility, STUK inspects the results of the baseline study, the programme for environmental radiation surveillance proposed by the licensee and the final safety analysis report.

**703.** When processing the construction licence application for a nuclear facility, STUK reviews the plans for external radiation dose rate measurements performed in the environment of the nuclear facility as part of the preliminary safety analysis report. When processing the operating licence application for a nuclear facility, STUK checks the documents relating to the environmental external radiation dose rate measuring system as part of the final safety analysis report.

**704.** STUK will check the suitability assessment for the equipment permanently installed in the environment of the nuclear facility during the reviews of the final safety analysis report.

**705.** No less than once every five years, STUK assesses the content of the radiation monitoring programme being updated and the need for further clarifications, and takes a decision on the acceptability of the programme.

**706.** STUK supervises the implementation of the programme for environmental radiation surveillance, monitors the results of environmental radiation monitoring and performs regular inspections at the plant site as part of the inspection programme for the operation of a nuclear facility according to Guide YVL A.1.

**707.** STUK will perform independent regulatory monitoring in the environment of the nuclear facility during the operation of the nuclear facility by taking and analysing samples from the environment of the nuclear facility to a necessary extent.

## Definitions

### System

System shall refer to a combination of components and structures that performs a specific function.

### Commissioning

Commissioning shall refer to the measures to verify the appropriateness of the licensee's organisation as well as the planned operation and safe use of the plant and its systems, structures and components.

### Plant area

Plant area shall refer to an area that consists of the fenced-off area surrounding the buildings connected with a plant's operation, and it must be located within a zone where movement and residence are prohibited.

### Licensee

Licensee shall refer to the holder of a licence entitling to the use of nuclear energy. The use of nuclear energy means the operations referred to in section 2, subsections 1 and 2, of the Nuclear Energy Act.

### Accident

Accident shall refer to postulated accidents, design extension conditions and severe accidents. (STUK Y/1/2016)

### Precautionary action zone

Precautionary action zone shall refer to an area extending to a distance of approximately five kilometres from the nuclear power plant, where restrictions on land use are in force. (STUK Y/2/2016)

### Emergency planning zone

Emergency planning zone shall refer to an area extending to a distance of approximately 20 kilometres from the nuclear power plant and for which authorities shall draft an external rescue plan referred to in Section 48(1)(1) of the Rescue Act (379/2011). (STUK Y/2/2016)

### Site area

Site area shall refer to an area in use by nuclear power plant units and other nuclear facilities in the same area, and to the surrounding area, where movement and stay are restricted by the Decree of Ministry of the Interior issued under Chapter 9, Section 8 of the Police Act (872/2011). (STUK Y/2/2016)

**Nuclear facility**

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. Nuclear facilities, however, 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)

**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)

**Radiological environment baseline study**

Radiological environment baseline study shall refer to a survey made in the environment of a nuclear facility that determines the radiation conditions and concentrations of radioactive substances in the environment before they are affected by the construction or operation of a nuclear facility.

**References**

1. Nuclear Energy Act (990/1987).
2. Nuclear Energy Decree (161/1988).
3. Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2016).
4. Radiation and Nuclear Safety Authority Regulation on the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2016)
5. Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2016).
6. Radiation Act (592/1991).
7. Radiation Decree (1512/1991).
8. Environmental and Source Monitoring for Purposes of Radiation Protection, IAEA Safety Standard Series, Safety Guide no. RS-G-1.8, IAEA Vienna, 2005.

## APPENDIX A Example of a measurement programme for a baseline study of environmental radioactivity, to be completed before the operation of a nuclear power plant, and which the licensee shall begin in good time before the operation of the facility

Measurement target	Number of monitoring instruments or samples and measurement or sampling sites	Collection frequency (number/period)	Analysis and frequency
<b>A01.</b> External radiation	External radiation dose rate measuring stations in the site area (or its vicinity) and outside of it at a distance of approx. 5 km from the plant site	Continuous measurement for 3 years	Continuous measurement and recording
<b>A02.</b> External radiation	10–20 environmental dosimeters evenly spread in the key directions at 1–10 km from the plant site	4 times a year	Gamma dose 4 times a year
<b>A03.</b> Radioactive substances in the form of airborne particles and iodine in the air	4–5 air sample collectors 1–10 km from the plant site	Continuous collection, filters are replaced twice per month for 3 years	Gamma emitters twice a month
<b>A04.</b> Deposition	3–5 rainwater collectors 1–10 km from the plant site	Continuous collection, change from the closest collector once a month and from the others four times a year for 3 years	Gamma emitters and $^3\text{H}$ from the closest collector once a month; other gamma emitters and $^3\text{H}$ four times a year. $^{89}\text{Sr}$ and $^{90}\text{Sr}$ , four times a year, normally only from the closest collector
<b>A05.</b> Soil	Sampling from the estimated main atmospheric deposition area, 0–5 km from the plant site (a minimum of 6 places, distribution of depth)	once during 3 years	Gamma emitters and $^{90}\text{Sr}$
<b>A06.</b> Indicator organisms in the terrestrial environment	A minimum of 4 indicator species that enrich radionuclides or are species that are radiation-sensitive	1–2 times per year for 3 years	Gamma emitters 1–2 times a year and $^{89}\text{Sr}$ and $^{90}\text{Sr}$ once a year. Occasionally also $^{14}\text{C}$
<b>A07.</b> Terrestrial wild plants and game	0–10 km from the plant site, approx. 10 samples depending on local crops and animals caught	Once per year for 3 years	Gamma emitters once per year
<b>A08.</b> Grazing grass	0–10 km from the plant site	Once per year for 3 years	Gamma emitters once in the growing season and $^{14}\text{C}$ once a year
<b>A09.</b> Milk	Sample representing farms at a distance of 0–10 km from the plant site. Sample of milk production from a local dairy (less than 40 km away).	4 times per year for 3 years	$^{131}\text{I}$ at least once per 3 months, gamma emitters once per 3 months and $^{89}\text{Sr}$ and $^{90}\text{Sr}$ once a year. Iodine analysis normally only of milk in the immediate area, Sr analysis only of samples 0–40 km away.
<b>A10.</b> Garden products	1–10 km from the plant site; a minimum of 5 species	Once per year for 3 years	Gamma emitters once per year
<b>A11.</b> Crops	A minimum of 3 species (depending on number of species produced) less than 20 km away from the plant site	Once per year for 3 years	Gamma emitters, $^{89}\text{Sr}$ and $^{90}\text{Sr}$ , once a year

Measurement target	Number of monitoring instruments or samples and measurement or sampling sites	Collection frequency (number/period)	Analysis and frequency
<b>A12.</b> Meat	A minimum of 2 species (depending on number of species produced and the main economy of the region) less than 40 km away from the plant site	Once per year for 3 years	Gamma emitters once per year
<b>A13.</b> Groundwater	From the plant site, from a nearby groundwater monitoring point	Once per year for 3 years	Gamma emitters once per year
<b>A14.</b> Domestic water	From the plant site, from a nearby large population centre	4 times per year for 3 years	Gamma emitters and $^3\text{H}$ 4 times a year, $^{89}\text{Sr}$ and $^{90}\text{Sr}$ once a year
<b>A15.</b> Seawater or lake water depending on plant site	From a minimum of 6 sites (depending on the number of reactors and receiving bodies of water in the site area)	4 times per year for 3 years	Gamma emitters and $^3\text{H}$ from the closest point 4 times a year and from further 2 times a year. $^{89}\text{Sr}$ and $^{90}\text{Sr}$ from the closest point and the so-called reference point twice a year
<b>A16.</b> Indicator organisms in the marine environment and benthic fauna	A minimum of 5 indicator species from 7 locations, 2 species of benthic fauna from 2 locations	2 times per year for 3 years	Gamma emitters 2 times a year, $^{89}\text{Sr}$ and $^{90}\text{Sr}$ , $^{238}\text{Pu}$ and $^{239,240}\text{Pu}$ only from the closest and so-called reference point
<b>A17.</b> Fish	A minimum of 5 economically significant species that are different in their habits from the receiving body of water and reference area	Once per year for 3 years	Gamma emitters once a year, $^{89}\text{Sr}$ and $^{90}\text{Sr}$ for 2 species once a year
<b>A18.</b> Sinking matter	From a minimum of 6 locations, if possible	Continuous collection, collection tubes are replaced 4 times per year for 3 years	Gamma emitters 4 times a year, $^{238}\text{Pu}$ and $^{239,240}\text{Pu}$ only from the closest and so-called reference point once a year
<b>A19.</b> Bottom sediment	The surface sediment (0–10 cm) is collected annually from 4 points.	Once per year for 3 years	Gamma emitters
<b>A20.</b> Bottom sediment	Sampling from areas of sediment located in the main dispersion directions from a minimum of 8 points (distribution of depth)	once during 3 years	Gamma emitters, $^{90}\text{Sr}$ and $^{239,240}\text{Pu}$ distributions of depth
<b>A21.</b> Humans	Whole body counting, local population from the environment of the nuclear power plant	Once per year for 3 years	Gamma emitters once per year
<b>A22.</b> Special areas	If necessary, special areas in the environment of the nuclear power plant that may be significant in terms of radiation exposure to the environment, living populations or humans may be selected as control targets. Special areas may include, for example, landfill runoff from the site area, water from the wastewater treatment plant and products grown or farmed near the nuclear facility (such as when residual heat from a power plant is utilized in the production of foodstuffs).		

## APPENDIX B Minimum requirements for a nuclear power plant's programme of environmental radiation surveillance, implemented by the licensee

Control target	Number of monitoring instruments or samples and measurement or sampling sites	Collection frequency (number/period)	Analysis and frequency
<b>B01.</b> External radiation	External radiation dose rate measuring stations in the site area (or its vicinity) and outside of it at a distance of approx. 5 km from the power plant	—	Continuous measurement and recording
<b>B02.</b> External radiation	10–20 dosimeter stations evenly spread in the key directions at 1–10 km from the power plant	Continuous collection; dosimeters replaced four times a year	Gamma dose 4 times a year
<b>B03.</b> Radioactive substances in the form of airborne particles and iodine in the air	4–5 air sample collectors 1–10 km from the power plant	Continuous collection; filters replaced twice a month, except the closest collector which is replaced once a week during annual maintenance	Gamma emitters twice a month (once a week)
<b>B04.</b> Deposition	3–5 rainwater collectors 1–10 km from the plant	Continuous collection; change from the closest collector once a month and from the others four times a year	Gamma emitters and $^3\text{H}$ from the closest collector once a month; other gamma emitters and $^3\text{H}$ four times a year.
<b>B05.</b> Indicator organisms in the terrestrial environment	A minimum of one indicator species that enriches radionuclides	1–2 times a year	Gamma emitters 1–2 times a year
<b>B06.</b> Garden products	1–10 km from the power plant; a minimum of 1 species	1–2 times a year	Gamma emitters 1–2 times a year
<b>B07.</b> Domestic water	From the power plant	4 times a year	Gamma emitters and $^3\text{H}$ 4 times per year
<b>B08.</b> Seawater or lake water depending on plant site	From at least one location near the discharge opening	2–4 times a year	Gamma emitters and $^3\text{H}$ from the closest point 4 times a year
<b>B09.</b> Special areas	If necessary, special areas in the environment of the nuclear power plant that may be significant in terms of radiation exposure to the environment, living populations or humans may be selected as control targets. Special areas may include, for example, landfill runoff from the site area, water from the wastewater treatment plant and products grown or farmed near the nuclear facility (such as when residual heat from a power plant is utilized in the production of foodstuffs).		

## APPENDIX C Examples of aspects that the licensee shall consider when analysing the results of environmental radiation monitoring of a nuclear power plant

<b>C01.</b>	External radiation	Comparing the results from the fixed external radiation dose rate measuring stations to the results from the environmental dosimeter stations.
<b>C02.</b>	Radioactive substances in the form of airborne particles and iodine in the air	A diagram of the monthly averages of $^{137}\text{Cs}$ concentrations at different sampling sites. Comparing the results of the continuous collection to each other. Analysing abnormal findings.
<b>C03.</b>	Deposition	0.05 m <sup>2</sup> collectors: annual atmospheric deposition table for all nuclides, diagram of concentrations of $^3\text{H}$ and $^{137}\text{Cs}$ . 1 m <sup>2</sup> collector: analyzing abnormal observations.
<b>C04.</b>	Indicator organisms	Comparing results to concentrations in air and atmospheric deposition.
<b>C05.</b>	Domestic water	Analysing abnormal findings.
<b>C06.</b>	Discharge water system	Quarterly diagram for the concentrations of $^3\text{H}$ and $^{137}\text{Cs}$ near the discharger opening.