

## **Guide YVL C.3, Limitation and monitoring of radioactive releases from a nuclear facility**

### **1 Scope of application**

Guide YVL C.3 gives the detailed requirements applicable to the licence applicant and licensee for the limitation of releases of radioactive substances from nuclear power plants and the radiation measurements, sampling systems and laboratory specifications used to monitor the releases of radioactive substances from the plant. It also presents design requirements particularly for systems designed for limiting releases. Where applicable, the requirements also apply to a research reactor and other nuclear facilities, if the requirement in the paragraph does not clearly refer only to nuclear power plants. However, similar requirements are presented for the treatment of nuclear waste and the nuclear facilities related to nuclear waste management 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", which refer to this Guide in places.

### **2 Justifications of the requirements by topic**

#### **2.1 Chapter 3 Limitations concerning radiation exposure and releases**

**Requirement 303:** Requirement presents the requirements relating to the limiting and monitoring of releases for documents that are submitted directly to STUK when filing the application for a decision-in-principle.

**Requirements 305, 307 and 309:** The constraints of doses/releases caused by normal use, operational transients and accidents are presented in accordance with the Nuclear Energy Decree (1988/161).

**Requirements 310–311:** The Guide specifies the provision of Section 22 b of the Nuclear Energy Decree (1988/161), according to which the release of radioactive substances arising from a severe accident shall not necessitate large scale protective measures for the population. According to Guide, there shall be no need for the population beyond the protective zone to be evacuated or for the population beyond the emergency planning zone to seek shelter indoors.

On the basis of Guide VAL 1 "Suojelutoimet säteilyvaaratilanteen varhaisvaiheessa" (Protection during early stages of a radiological emergency), 5 October 2012, this means that the limiting value for a dose caused at distances greater than 5 km from the plant is 20 mSv during the first week. The limiting value can be considered to concern the sum of the effective dose arising from external radiation within the period of one week and the committed effective dose from the intake of radioactive substances within the same period of time received by the representative person of the most highly exposed population group.

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Based on VTT's report VTT-R-07137-12 "Ydinvoimalaitoksen radioaktiivisista jalokaasu- ja jodipäästöistä aiheutuvat säteilyannokset" (Radiation doses caused by radioactive inert gas and iodine releases from a nuclear power plant), 10 December 2012, it can be stated that the above-mentioned limiting value limits the radiation doses in the emergency planning zone so that there is no need for the population to seek shelter indoors beyond the zone. According to Guide VAL 1, seeking shelter indoors is justified when the dose is estimated to exceed 10 mSv in two days.

The specified requirement concerning the need to take iodine tablets is not presented for the following reasons: The health risk related to taking iodine tablets is now estimated to be very low, especially compared to evacuation. If the need to take iodine tablets was limited to, for example, the emergency planning zone, this would cause a much stricter limit for iodine releases than the cesium-137 (Cs-137) release limit of 100 TBq concerning land and water areas set in the Nuclear Energy Decree (1988/161). Doses caused by iodine releases have been assessed in, for example, VTT's report VTT-R-07137-12.

Section 22 b of the Nuclear Energy Decree stipulates that the possibility of a release that occurs at an early phase of an accident and requires population protection measures shall be extremely low. In other words, this means that if a release of radioactive substances required protection measures, they would need to be implemented in time. This is a case of "early release" discussed in WENRA Statement on Safety Objectives for New Nuclear Power Reactors, November 2010.

According to Guide VAL 1 "Suojelutoimet säteilyvaaratilanteen varhaisvaiheessa" (Protection during early stages of a radiological emergency), 5 October 2012, the design basis for implementing protection measures is that within approximately four hours of the decision by the leadership of rescue operations, the necessary protection measures for the population can be taken in the emergency planning zone. This can be taken into account in estimating whether the release takes place during early stages of an accident as mentioned in Section 22 b of the Nuclear Energy Decree.

Because the provision of Section 22 b of the Nuclear Energy Decree (1988/161) concerns the possibility of a release, the demonstration of compliance with the requirement requires a probabilistic risk assessment. For the present, it is considered sufficient in this respect to comply with requirement 306 of Guide YVL A.7 "Probabilistic risk assessment and risk management of a nuclear power plant".

**Requirements 306, 308, 312:** In accordance with ICRP's 2007 recommendation (ICRP Publication 103), the dose constraints presented in requirements 306, 308 and 312 of this Guide concern the dose to the individual representing the most exposed group (the so-called representative individual). The assessment of the radiation dose to the representative individual is also addressed in ICRP's publication 101 (2006).

**Description 316:** The requirement for specifying the release limits in the Operational Limits and Conditions is presented in Guide YVL A.6 "Conduct of operations at a nuclear power plant", but it is also described in this Guide.

**Requirement 317:** The obligation to report the exceeding of threshold values of release rate is presented in Guide YVL A.9 "Regular reporting on the operation of a

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nuclear facility". In addition to the exceeding of threshold values, this Guide also presents the requirement to report exceptional increases of release rate that are otherwise significant, because it is difficult to define suitable threshold values for all situations.

**Requirement 322:** According to requirement 322, representing continuous improvement of operations and good operation of the plant and its personnel, target values shall be determined which the licensee aims not to exceed for the releases and the doses caused by them. In its decisions, STUK has requested TVO and Fortum to determine target values like these.

## 2.2 Chapter 4 Special systems for reducing releases

**Requirement 402:** Requirement is based on Section 22 a of the Nuclear Energy Decree determining that the radiation exposure of the surrounding population resulting from, for example, nuclear power plant operations shall be kept as low as reasonably achievable. This means observing the ALARA principle of optimisation in the planning of operations.

## 2.3 Chapter 5 Requirements for release measurements

The licensee shall monitor the releases of radioactive substances from the nuclear facility by means of adequate measurements. In release monitoring, it is essential to collect and measure the radioactive substances that may exit the type of nuclear facility in question in different operation situations. Nuclear power plant units shall comply with all the requirements of Chapter 5. Where applicable, the requirements in the Guide shall also apply to other nuclear facilities in accordance with their application decisions.

**Requirement 502:** According to requirement, the release measurement equipment shall be located in rooms where the background radiation will not interfere with the measurements, because very low detection limits are required of the radiation measurements.

**Requirement 505:** Requirement states that the preliminary safety analysis report shall contain a description of the analyses and tests that demonstrate the performance of the release measurement systems. The analyses and a summary of the test results shall be presented in the final safety assessment report.

**Requirements 506, 508, 517 and 518 and description 102:** The significant release pathway presented in requirements and description is a pathway through which the releases can cause a significant part (for example, 10% or more) of the annual radiation dose caused by releases.

**Requirement 507:** According to requirement of Guide YVL C.6 "Radiation monitoring at a nuclear facility", redundancy shall be provided for continuously operating radiation monitoring systems and equipment designed for the monitoring of radioactive releases. Therefore, redundancy shall be provided for all equipment performing functions relating to continuously operating sampling or sample measurement. Exceptions to the redundancy requirement are presented in this Guide (requirements 513, 515 and 516). The following are mentioned as examples of

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equipment for which redundancy shall be provided: flow lines with pumps or valves, radiation monitoring systems, sampling filters and sampling rakes.

**Requirement 515:** According to requirement, tritium (H-3) and carbon-14 (C-14) 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.

There is variation in tritium and C-14 releases, which defends the view that sampling should be continuous. Continuous sampling is used at OL1/OL2 and LO1/LO2. However, the requirement does not require redundancy for sampling, which is more clearly indicated in the table appended to the Guide. The requirement allows short breaks caused by regular maintenance or failures.

**Requirements 513, 515 and 516:** Requirements specify the compliance requirement of the (N+1) failure criterion presented in requirement 305 of Guide YVL C.6 "Radiation monitoring at a nuclear facility" for continuously operating iodine and aerosol measurement and continuously operating tritium and C-14 sampling. This measurement and sampling does not need to comply with the single failure criterion, because 1) it involves measurement of normal releases; 2) for the iodine and aerosol releases, the samples collected into the filters and analysed in the laboratory are the primary release determination method; and 3) no essential changes may take place in tritium and C-14 releases, they are annually at the same level, the releases caused by them are low and the upper limit of the annual release of C-14 could also be determined by means of calculations. For these reasons, tritium and C-14 sample collectors are also allowed to be categorised into class EYT, specifying requirement 313, item 7 of Guide YVL B.2 "Classification of systems, structures and components of a nuclear facility".

**Requirements 513 and 516:** According to requirements, releases of iodine and aerosol through the vent stack of a nuclear power plant unit shall be monitored continuously.

**Requirement 517:** Requirement states that the monitoring of release pathways into the aquatic environment shall also function in the event of a single failure occurring in the radiation monitoring system. The requirement is intended to ensure the reliable automatic closure of the release line when necessary.

**Requirement 518:** Requirement states that samples from significant release pathways shall be taken automatically from the release line. Pathways through which the releases can cause a significant part (for example, 10% or more) of the annual radiation dose caused by releases are considered to be significant release pathways. Samples taken from the release tank are not in all situations representative samples of the release batch, for example, because of the insufficiency of mixing. The release can also take place in an uncontrolled manner, in which case the separate samples for each release batch cannot be analysed.

**Requirement 520:** According to requirement, the monitoring of the amount of radioactive substances in case of exceptional releases, using sampling and laboratory analysis, also covers the primary circuit.

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## 2.4 Guide Annexes

Summary tables A01 and A02 annexed to the Guide present the observation limits that, in STUK's view, are reachable with the available advanced technology in good circumstances (low overall activity, low background radiation). The recommendation for the observation limits concerning Finland is presented in the EC recommendation 2004/2/Euratom, 18 December 2003 (in the Guide's list of references).

## 3 International provisions concerning the scope of the Guide

The IAEA Safety Requirements essential for the Guide are the following:

- SSR-2/1, Safety of Nuclear Power Plants: Design Specific Safety Requirements
- SSR-2/2, Safety of Nuclear Power Plants: Commissioning and Operation Specific Safety Requirements
- SSR-3, Safety of Research Reactors

The equivalent Safety Guides are the following:

- NS-G-1.13, Radiation Protection Aspects of Design for Nuclear Power Plants
- NS-G-2.7, Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants
- NS-G-4.6, Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors
- WS-G-2.3, Regulatory Control of Radioactive Discharges to the Environment
- RS-G-1.8, Environmental and Source Monitoring for Purposes of Radiation Protection

In addition, the IAEA international safety standard should be mentioned:

- GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards

The Guide can be considered to comply with these requirements with the following exceptions:

Section 3.36 of Guide WS-G-2.3 states that the release limits should be close to, but generally higher than, the release rates and quantities resulting from the optimisation of radiation protection to allow margin for operational flexibility. Section 3.3.1 of the Guide does not emphasise that the release limits should be close to the releases. Therefore, the release limits of nuclear power plants in Finland are generally higher than the releases (with the exception of tritium releases into the sea), corresponding to the annual dose constraint of 0.1 mSv. This is why the release limits of Finnish nuclear power plants are higher than, for example, the Flamanville nuclear power plant in France. The Finnish practice has been considered good because it gives a better idea of how low the releases in fact are. The high release limits compared to the releases do not prevent the further reduction of releases according to the ALARA and BAT principles. These principles shall be applied to the reduction of releases.

The Guide complies with the requirements presented in the document "WENRA Reactor Safety Reference Levels for Existing Reactors, September 2014". The

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requirements presented in the document “WENRA Statement on Safety Objectives for New Nuclear Power Plants, November 2010” are also complied with.

Of the requirements of other countries, it should be mentioned that the requirements presented for release measurement in German KTA standards are partly more detailed, more extensive or stricter. However, the requirements and presentation method of this Guide are considered to be good in terms of the limitation and monitoring of radioactive releases from Finnish nuclear facilities (mostly nuclear power plants).

#### **4 Impacts of the Tepco Fukushima Dai-ichi accident**

The Fukushima nuclear power plant accident has not been recognised to have had an effect on this Guide (for example, this Guide does not discuss the redundancy of the power supply or the duration of environmental conditions).

#### **5 Needs for changes taken into account in the update**

The update takes into account comments by licensees in Finland in conjunction with the preparation of implementing decisions and also needs for changes due to changes made to international and national laws/regulations. In addition, the possibilities to reduce the so-called administrative burden have been considered. The references have been inspected and updated.

The content and requirement level of the Guide have remained unchanged. Clarifications have been made to both the explanatory memorandum and the Guide itself concerning the “significant release pathway” (102, 506, 508, 518). The formulation of requirement 402 has been changed so that instead of minimising the solid waste produced, the ALARA principle of optimisation shall be taken into account for the whole process (cleaning, waste management and final disposal). Requirement 505 has been specified by describing in more detail the things that shall be presented in the preliminary and final safety analysis report concerning the analyses and tests demonstrating the performance of release measurement systems. Requirement 518 has been clarified without changing the original purpose of the requirement: the sampling of significant release pathways shall take place automatically from the release line. In requirement 507, sampling rakes have been added to the list of functions for which redundancy shall be provided, and the term “active functions” has been removed as misleading. Requirements 513 and 516 have been specified to apply to the measurements of the ventilation stack of nuclear power plant units.

The requirements of the Guide do not contain any possibilities for administrative burden reduction.