GUIDE YVL D.5

DISPOSAL OF NUCLEAR WASTE

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Definitions

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.*

With regard to new nuclear facilities, this Guide shall apply as of 1 April 2018 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 Guide YVL D.5 (15.11.2013).

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1 Introduction

101. Spent nuclear fuel, low and intermediate level waste and very low level waste are accumulated during the operation and decommissioning of a nuclear power plant. The spent nuclear fuel originating from Finnish nuclear power plants is intended to be encapsulated and disposed of in repositories constructed deep inside the bedrock. Low and intermediate level waste arising from the operation of nuclear power plants and other nuclear facilities are to be processed and disposed of in bedrock repositories constructed at an intermediate depth. The low and intermediate level waste arising from the decommissioning of nuclear power plants and other nuclear facilities are also envisaged to be disposed of in repositories constructed at an intermediate depth. Very low level waste can be disposed of in repositories constructed near surface. **[**2018-02-13 **]**

101a. Pursuant to Section 6a of the Nuclear Energy Act (990/1987), nuclear waste generated in connection with or as a result of use of nuclear energy in Finland shall be handled, stored and disposed of in Finland, with the exception of the following:
– small amounts of nuclear waste which will be, or have been, delivered abroad for research purposes
– nuclear waste containing minor quantities of radioactive material and which is delivered to another country for treatment in the appropriate manner
– nuclear waste that has been generated in connection with or as a result of the operation of a research reactor in Finland.
Nuclear waste which is delivered to another country for treatment shall be returned to Finland for final disposal. **[**2018-02-13 **]**

102. The preparations for the disposal of nuclear waste comprise selecting and characterising the disposal site, developing the disposal method and technology, and developing the methods and collecting the data necessary for assessing the operational and long-term safety of the disposal facilities. The implementation of the disposal involves the excavation of underground spaces and other construction works, packing the waste for disposal, transferring the waste packages into the emplacement rooms, the installation of other engineered barriers, if any, and the backfilling and closure of the excavated rooms. **[**2018-02-13 **]**

103. This Guide addresses the disposal facilities and actions referred to above. Chapters 3–7 of the Guide contain requirements pertaining to the disposal facility and disposal methods of nuclear waste as well as obligations pertaining to a licence applicant or licensee, and a licensee

under a waste management obligation. Chapter 8 describes regulatory oversight. **[**2018-02-13 **]**

104. The basic requirements concerning the safe use of nuclear energy are set out in the Nuclear Energy Act (990/1987). The general principles for radiation protection and provisions concerning radiation work are set out in the Radiation Act (592/1991). **[**2013-11-15 **]**

105. According to Section 7 h of the Nuclear Energy Act, *nuclear waste shall be managed so that after disposal of the waste no radiation exposure is caused, which would exceed the level considered acceptable at the time the final disposal is implemented. The disposal of nuclear waste in a manner intended as permanent shall be planned giving priority to safety and so that ensuring long-term safety does not require the surveillance of the final disposal site.* **[**2018-02-13 **]**

106. The Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2016) pertain to the disposal of nuclear waste. The Radiation and Nuclear Safety Authority Regulations on the Security in the Use of Nuclear Energy (STUK Y/3/2016) and on the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2016) also pertain to the disposal of nuclear waste where applicable. **[**2018-02-13 **]**

107. The handling and encapsulation of spent nuclear fuel for disposal are addressed in Guide YVL D.3 “Handling and storage of nuclear fuel”, and the processing and packaging of other nuclear waste is addressed in Guide YVL D.4 “Predisposal management of low- and intermediate-level nuclear waste and decommissioning of a nuclear facility”. The fabrication and installation of the barriers of a disposal facility and the rock construction are addressed in Guide YVL D.7 “Release barriers of spent nuclear fuel disposal facility”. Several other YVL Guides issued by STUK are also applicable to the disposal of nuclear waste. This Guide contains references to the applicable Guides; the relevant paragraphs are specified where practicable. **[**2018-02-13 **]**

2 Scope of application

201. This Guide addresses the extensive disposal of nuclear waste in repositories constructed inside the bedrock. **[**2018-02-13 **]**

202. The types of nuclear waste within the scope of the present Guide include spent nuclear fuel, radioactive waste arising from the operation of a nuclear facility, radioactive waste arising from the dismantling of a nuclear facility, and other radioactive waste to be disposed of in repositories designed for nuclear waste. **[**2018-02-13 **]**

203. This Guide covers the whole life cycle of a disposal facility (site investigations, design, construction, operation and closure), and it addresses both the operational safety of disposal facilities and the demonstration of the long-term safety of disposal. **[**2018-02-13 **]**

3 Limitation of radiation exposure and radioactive releases

3.1 Operation of a disposal facility

301. The disposal facility and its operation shall be so designed that the constraint for the annual dose of an individual in the population, arising from the normal operation, is 0.01 millisievert (Section 22d of the Nuclear Energy Decree 161/1988). **[**2018-02-13 **]**

302. Removed. **[**2018-02-13 **]**

303. The disposal facility and its operation shall be so designed that the annual dose to the representative person remains below the values indicated below (Sections 22b and 22d of the Nuclear Energy Decree 161/1988):
a. 0.1 mSv as a result of an anticipated operational occurrence;
b. 1 mSv in the event of a Class 1 postulated accident; and
c. 5 mSv in the event of a Class 2 postulated accident. **[**2018-02-13 **]**

304. The dispersion analyses of radioactive substances released to the environment and the analyses of the radiation doses arising from the releases are addressed in the Guide YVL C.4 “Assessment of radiation doses to the public in the vicinity of a nuclear facility”. **[**2018-02-13 **]**

304a. The analyses concerning the releases of radioactive substances and the radiation doses shall cover the normal operating conditions, anticipated operational occurrences and postulated accidents of a disposal facility. **[**2018-02-13 **]**

304b. The scope of events to be analysed shall provide a comprehensive assessment of the releases and radiation doses caused by anticipated operational occurrences and postulated accidents. **[**2018-02-13 **]**

304c. The fulfilment of the requirements concerning radiation protection of the public shall be primarily demonstrated by means of a deterministic safety analysis. Additionally, if an accident may have severe consequences based on deterministic analyses, the accident in question shall be assessed by means of a probabilistic risk assessment where the probability of accidents and the potential radioactive releases resulting from them are assessed. **[**2018-02-13 **]**

305. Removed. **[**2018-02-13 **]**

306. Removed. **[**2018-02-13 **]**

3.2 Long-term safety

3.2.1 Radiation dose constraints

307. The disposal of nuclear waste shall be so designed that the radiation impacts arising as a consequence of expected evolution:
a. the annual dose to the representative person remains below the value of 0.1 mSv; and
b. the average annual doses to other persons remain insignificantly low.
These constraints shall be applied over an assessment period, during which the radiation exposure of humans can be assessed with sufficient reliability, and which shall extend, at a minimum, over several millennia (Section 22d of the Nuclear Energy Decree 161/1988). **[**2018-02-13 **]**

308. Moved to paras A08b and A08c. **[**2018-02-13 **]**

309. Moved to para A08e. **[**2018-02-13 **]**

310. The dose constraint for the representative person, 0.1 mSv per year, stands for the average individual dose in a self-sustaining family or small village community living in the environs of the disposal site, where the highest radiation exposure arises through different exposure pathways. In the living environment of this community, a small lake and a shallow water well are assumed to exist. **[**2018-02-13 **]**

311. In addition to the community referred to in para. 310, the average annual doses to larger groups of people living in the environs of a large lake or sea coast shall be addressed. The acceptability of these doses depends on the size of the group of people exposed, the maximum dose, however, being in the range of 1 to 10% of the representative person dose constraint specified in point a of para. 307 above. **[**2018-02-13 **]**

3.2.2 Release constraints of radioactive materials

312. The disposal of nuclear waste shall be so designed that, as a consequence of expected evolution, the average long-term quantities of radioactive materials released into the living environment from disposed nuclear waste remain below the constraints specified separately for each nuclide by STUK. These constraints shall be so defined that:
a. at a maximum, the radiation impacts arising from disposal may be equivalent to those caused by natural radioactive materials in the earth's crust; and
b. on a large scale, the radiation impacts remain insignificantly low (Section 22d of the Nuclear

Energy Decree 161/1988).
The constraints shall be applied in limiting the radiation exposures arising beyond the assessment period referred to in para. 307. **[**2018-02-13 **]**

313. The nuclide specific constraints for radioactive releases to the living environment (average release of radioactive materials per annum) referred to in para. 312 are as follows:
a. 0.03 GBq/a for long-lived, alpha-emitting radium, thorium, protactinium, plutonium, americium and curium isotopes;
b. 0.1 GBq/a for the nuclides Se-79, Nb-94, I-129 and Np-237;
c. 0.3 GBq/a for the nuclides C-14, Cl-36 and Cs-135 and for long-lived uranium isotopes;
d. 1 GBq/a for the nuclide Sn-126;
e. 3 GBq/a for the nuclide Tc-99;
f. 10 GBq/a for the nuclide Zr-93;
g. 30 GBq/a for the nuclide Ni-59; and
h. 100 GBq/a for the nuclide Pd-107. **[**2013-11-15 **]**

314. The constraints of para. 313 shall apply to activity releases that may migrate to the living environment after several thousands of years at the earliest. These activity releases can be calculated as moving average over the period of 100 years at the most. The sum of the ratios between the nuclide-specific activity releases and the respective constraints shall be less than one. **[**2018-02-13 **]**

3.2.3 Stylized models of the surface environment

314a. According to the paragraph 3 of the Section 35 of the STUK Regulation Y/4/2016 *the radiation exposure caused to people during the assessment periods referred to in the Nuclear Energy Decree where the maximum values of the long-term averages for the amount of released radioactive substances apply shall also be assessed by using stylized models of the surface environment that consider alternative evolutions of the surface environment.* **[**2018-02-13 **]**

314b. Stylized models of the surface environment shall be applied in assessing the radiation exposures arising beyond the assessment period referred to in para. 307. **[**2018-02-13 **]**

314c. Stylized models of the surface environment shall, to a sufficient extent, cover the long-term development of the surface environment beyond the assessment period referred to in para. 307. **[**2018-02-13 **]**

314d. Stylized models of the surface environment shall analyse the average individual dose in a

self-sustaining family or small village community living in the environs of the disposal site, where the highest radiation exposure arises through different exposure pathways. In the living environment of the community, conditions of the surface environment permitting, a small lake and a shallow water well are assumed to exist. **[**2018-02-13 **]**

3.2.4 Rare events impairing long-term safety

315. According to the paragraph 1 of the Section 11 of the STUK Regulation Y/4/2016 *the probabilities of rare events impairing long-term safety and their impacts on the disposal system and the long-term safety of disposal shall be assessed. The radiation exposure caused by them shall be assessed where possible. The probability of events causing significant radiation exposure shall be very low, and the widespread effects of the release of radioactive substances caused by them shall be low. In addition according to the paragraph 2 the radiation exposure caused by inadvertent human intrusion into the emplacement rooms during the period following their closure shall be assessed.* **[**2018-02-13 **]**

316. Rare events impairing long-term safety induced by natural phenomena to be considered shall at least include rock movements jeopardising the integrity of disposal canisters. **[**2018-02-13 **]**

316a. Rare events impairing long-term safety caused by human actions to be considered shall at least include the boring of a medium-deep water well at the disposal site and core drilling or boring hitting a disposed waste package. In such a case, it is assumed that the existence of the disposed waste is not known and that the incident may occur 200 years following the closure of the disposal facility at the earliest. **[**2018-02-13 **]**

317. The probability and importance to safety of the incidents referred to in paras. 316 and 316a as well as the annual doses or activity releases arising from them shall be assessed where practicable. The possibility of radiation exposure that might imply deterministic effects shall be very low. **[**2018-02-13 **]**

3.2.5 Protection of other living species

318. According to paragraph 2 of the Section 35 of STUK Regulation Y/4/2016, the possible impacts of disposal on fauna and flora shall be assessed. **[**2018-02-13 **]**

319. The typical radiation exposures of terrestrial and aquatic populations in the disposal site environment shall be assessed. The living populations can be assumed to remain in their present state. **[**2018-02-13 **]**

320. The assessed radiation exposures shall remain clearly below the doses that, on the basis of the best available knowledge, would cause significant detriment to any living population. **[**2018-02-13 **]**

4 Planning of the disposal method

4.1 Stepwise implementation

401. According to the paragraph 1 of the Section 8 of the STUK Regulation Y/4/2016 *disposal shall be implemented in stages, with particular attention paid to aspects affecting long-term safety. The planning of the construction, operation and closure of a disposal facility shall account for the reduction of the activity of nuclear waste through interim storage, the utilisation of high-quality technology and research data, and the need to develop an understanding of the performance of the barriers and long-term safety through investigations and monitoring.* **[**2018-02-13 **]**

402. The disposal of nuclear waste involves the following implementation stages:
a. selection of the disposal concept;
b. selection and characterisation of the disposal site, which may include the construction of an underground research facility at the site;
c. design of the disposal facility with related research and development work;
d. construction and commissioning of the disposal facility;
e. waste emplacement activities and other operation of the disposal facility;
f. backfilling and closure of emplacement rooms and other underground rooms; and
g. post-closure monitoring measures of the disposal facility, where required.
These stages may be parallel. **[**2018-02-13 **]**

403. The various disposal stages shall be scheduled and implemented giving priority to safety. The preparedness for advancing to the next stage shall be assessed as a whole, taking into account the suitability of the disposal concept and site, technical feasibility and the outcome and reliability of the long-term safety analyses. **[**2018-02-13 **]**

4.2 Barriers and long-term safety functions

404. According to the Section 30 of the STUK Regulation Y/4/2016 *the long-term safety of disposal shall be based on long-term safety functions achieved through mutually complementary barriers so that the degradation of one or more long-term safety function or a foreseeable change in the bedrock or climate will not jeopardise the long-term safety.* **[**2018-02-13 **]**

405. Based on the characteristics of the waste to be disposed of, at least the following engineered barriers shall be considered in planning the disposal:

a. the waste matrix;
b. the waste container;
c. the buffer surrounding the waste packages;
d. the backfilling of emplacement rooms; and
e. the closing structures of the disposal facility. **[**2018-02-13 **]**

406. At least the following shall be considered when defining the long-term safety functions provided by means of engineered barriers:
a. the immobilisation of radioactive materials in the waste matrix;
b. the chemical stress endurance of the waste package;
c. the mechanical stress endurance of the waste package;
d. the buffer's tightness and yield to rock movements; and
e. the characteristics of the buffer, backfill and closing structures that maintain the performance of the other engineered barriers and limit the migration of radioactive materials through excavated rooms. **[**2018-02-13 **]**

407. The bedrock surrounding the emplacement rooms functions as a natural barrier. **[**2018-02-13 **]**

408. At least the following shall be considered when defining the long-term safety functions provided by means of the natural barrier:
a. the stability and water tightness of the rock;
b. low groundwater flow;
c. favourable groundwater chemistry;
d. the retardation of radioactive materials in the rock; and
e. protection against natural phenomena and human actions. **[**2018-02-13 **]**

409. Performance targets shall be specified for each long-term safety function. In doing so, account shall be taken of the factors affecting the disposal conditions during each assessment period as well as their combined effects. **[**2018-02-13 **]**

409a. According to the paragraph 1 of the Section 32 of the STUK Regulation Y/4/2016 *the characteristics of engineered barriers shall be such that they effectively prevent the release of radioactive substances into the bedrock surrounding the emplacement rooms or, in the case of disposal of very low-level waste in the ground, into the living environment for a duration of time that is sufficient in relation to the half-life of the radioactivity contained within the waste. For short-lived waste, this period shall be at least several hundreds of years, and for long-lived*

waste, at least several thousands of years. **[**2018-02-13 **]**

410. In defining performance targets for the long-term safety functions provided by engineered barriers, account shall be taken of the quantities and half-lives of radioactive materials in the waste. **[**2018-02-13 **]**

410a. The point of departure for the disposal of spent nuclear fuel shall be that the long-term safety functions provided by the engineered barriers will effectively limit the release of radioactive materials into the bedrock at least for about 10,000 years. **[**2018-02-13 **]**

411. The design shall aim to provide a disposal concept where changes in the bedrock do not significantly impair the long-term safety functions. **[**2018-02-13 **]**

411a. Another aim for the design shall be that the characteristics of the engineered barriers in the repository will not change over time in a way that may significantly impair the long-term safety functions during the defined assessment period. **[**2018-02-13 **]**

4.3 Disposal site and repository

411b. In connection with the siting and positioning of the disposal facility it shall be verified that the rock volumes at the disposal depth in the selected site are large and cohesive enough and have other characteristics favourable to the long-term safety of emplacement rooms and waste package placement. **[**2018-02-13 **]**

412. The bedrock of the disposal site shall, to a sufficient extent, possess natural barrier characteristics that support long-term safety functions as specified in para. 408. Factors indicating the unsuitability of a disposal site include at least the following:
a. the proximity of exploitable natural resources;
b. abnormally high rock stresses with regard to the strength of the rock;
c. exceptionally high seismic or tectonic activity; and
d. exceptionally adverse groundwater characteristics, such as the lack of reducing buffering capacity and high concentrations of substances that may impair the long-term safety functions. **[**2018-02-13 **]**

413. The characteristics of the bedrock shall be favourable in view of the performance of the engineered barriers. Such conditions in the bedrock that are of importance in terms of long-term safety shall be sufficiently stable. **[**2018-02-13 **]**

414. The locations of the emplacement rooms shall be favourable with respect to the groundwater flow paths at the disposal site. **[**2018-02-13 **]**

415. The disposal depth and the positioning of the emplacement rooms shall be made giving priority to long-term safety, taking into account the geological structures of the bedrock as well as the hydraulic conductivity, groundwater chemistry and mechanical stability of the rock. **[**2018-02-13 **]**

416. The repository for spent nuclear fuel shall be located at the depth of several hundreds of meters so as to adequately mitigate the impacts of above-ground natural phenomena, such as glaciation, and human actions. The repositories for low and intermediate level waste shall be located at the depth of some tens of meters at a minimum. The disposal depth selected shall be justified. **[**2018-02-13 **]**

5 Planning and design of the disposal facility and disposal operations

5.1 Radiation safety

501. The planning and design of the disposal facility and the operations conducted therein shall take account of the following considerations:
a. the facility shall have in place a classification into zones based on radiation conditions as provided in Guide YVL C.2 “Radiation protection and exposure monitoring of nuclear facility workers”.
b. The layout design and the design of systems and components shall comply with the requirements of Guide YVL C.1 “Structural radiation safety at a nuclear facility” with due consideration given to the special characteristics of underground rooms and the work conducted inside them.
c. The facility shall have radiation monitoring systems in place as specified in Guide YVL C.6 “Radiation monitoring at a nuclear facility”.
d. The requirements concerning the limitation and monitoring of potential radioactive releases are specified in Guide YVL C.3 “Limitation and monitoring of radioactive releases from a nuclear facility”. **[**2018-02-13 **]**

502. The operations shall be so planned that the radiation exposure of workers is kept as low as reasonably achievable. Radiation shields or remote control shall be used where necessary. **[**2013-11-15 **]**

5.2 Design of systems, structures and functions

5.2.1 Safety classification

503. Removed. **[**2018-02-13 **]**

503a. According to the paragraph 1 of the Section 5 of the STUK Regulation Y/4/2016 *the safety functions for the operation of the nuclear waste facility and long-term safety functions shall be defined, and the systems, structures and components performing them and related to them shall be classified. The classification shall take into account the use of the systems, structures and components on the basis of significance in terms of operational safety, long-term safety or both, if necessary.* **[**2018-02-13 **]**

503b. According to the paragraph 2 of the Section 5 of the STUK Regulation Y/4/2016 *safety classification shall be applied in determining the quality requirements for systems, structures*

and components. **[**2018-02-13 **]**

503c. According to the paragraph 3 of the Section 5 of the STUK Regulation Y/4/2016 *the requirements set for and the actions to ascertain the compliance with the requirements of the systems, structures and components that implementing operational safety functions and connecting systems, structures and components shall be commensurate with the safety class of the item in question.* **[**2018-02-13 **]**

504. Systems, structures and components with a major bearing on the radiation protection of the personnel at the facility or the prevention or the limitation of radioactive releases shall be classified in terms of the operational safety of the disposal facility. Functions of importance may notably include transfers of waste packages, radiation measurements and fire protection in compartments accommodating radioactive materials. **[**2018-02-13 **]**

504a. The requirements concerning the classifications related to the operation of the disposal facility are presented in Guide YVL B.2 “Safety classification of systems, structures and components in nuclear facilities”. **[**2018-02-13 **]**

504b. According to the paragraph 4 of the Section 5 of the STUK Regulation Y/4/2016 *systems, structures and components performing long-term safety functions shall be designed, manufactured and installed so that their quality level, and the assessments, inspections and tests required to verify their quality level, are commensurate with the safety significance of the item in question.* **[**2018-02-13 **]**

505. Systems, structures and components with a major bearing on the long-term safety may notably include waste packages and the buffer materials surrounding them, backfilling and closure structures and the host rock surrounding the underground facilities of the disposal facility. **[**2018-02-13 **]**

505a. Underground facilities assigned to Class EYT or parts of such facilities shall be classified in Class EYT/STUK when their construction is estimated to have an impact on the actual emplacement rooms or on the long-term safety of disposal in some other way. **[**2018-02-13 **]**

5.2.2 Construction, operation and closure of the disposal facility

505b. According to the Section 21 of the STUK Regulation Y/4/2016 *the design of the disposal facility shall take into account the safety of the closure of the facility after its operation has ended. The disposal facility shall be designed, constructed and operated in a manner that allows it to be closed without jeopardising long-term safety.* **[**2018-02-13 **]**

506. During the construction and operation of the disposal facility, a research and monitoring programme shall be executed to ensure that the site and the rock to be excavated are suitable for disposal and to collect supplementary information about the safety-relevant characteristics of the host rock and the performance of the barriers. This programme shall at least include:
a. the characterisation of the rock volumes intended to be excavated;
b. the monitoring of rock stresses, movements and deformations in rock surrounding the emplacement rooms;
c. the hydrogeological monitoring of the host rock surrounding the emplacement rooms;
d. the monitoring of groundwater chemistry;
e. the monitoring of the performance of engineered barriers; and
f. the monitoring of surface environment. **[**2018-02-13 **]**

507. Removed. **[**2018-02-13 **]**

507a. The siting of a disposal facility and its rooms shall be based on the suitability classification of the rock. The suitability of the rock surrounding the emplacement rooms shall be assessed prior to construction, and compliance with the requirements shall be proven after the construction. **[**2018-02-13 **]**

507b. The rock suitability classification shall take into account the structures and characteristics of bedrock that are important to the long-term safety. **[**2018-02-13 **]**

507c. The requirements for the rock suitability classification for a spent fuel disposal facility are presented in Chapter 6.2 of Guide YVL D.7. **[**2018-02-13 **]**

508. Emplacement rooms and other underground spaces shall be constructed, operated and closed so that the rock characteristics important to long-term safety remain sufficient. **[**2018-02-13 **]**

508a. The ingress of substances detrimental to long-term safety into the emplacement rooms shall be limited as much as practically possible, and their concentration within the emplacement rooms shall be monitored. **[**2018-02-13 **]**

508b. The emplacement rooms shall be backfilled and closed as soon as practicable with regard to the waste emplacement and related oversight activities. **[**2018-02-13 **]**

508c. The design of the closure shall aim to create closure structures that do not provide a flow path to the ground surface with better conductivity than that of the surrounding bedrock. **[**2018-02-13 **]**

509. The layout of the disposal facility shall be so designed that the activities, insofar as they affect the safety of the disposal, taking place in different parts of the disposal facility are appropriately separated. **[**2018-02-13 **]**

510. Moved to Guide YVL D.7. **[**2018-02-13 **]**

5.2.3 Design of systems, structures, and components

511. The systems, structures and components for the operational phase of a disposal facility shall be designed with due consideration given to their safety class, foreseen service life and environmental conditions. The design of systems, structures and components shall take account of anticipated operational occurrences and postulated accidents. **[**2018-02-13 **]**

512. Requirements pertaining to the design of steel and concrete structures of a disposal facility are presented in Guide YVL E.6 “Buildings and structures of a nuclear facility”. **[**2018-02-13 **]**

513. Requirements pertaining to the general design of systems and components are presented in Guide YVL B.1 “Safety design of a nuclear power plant”. **[**2018-02-13 **]**

513a. Requirements pertaining to the electrical and I&C equipment are presented in Guide YVL E.7 “Electrical and I&C equipment of a nuclear facility”. **[**2018-02-13 **]**

513b. Requirements pertaining to the air conditioning and ventilation systems are presented in the section 5.5 of the Guide YVL B.1. **[**2018-02-13 **]**

514. Requirements pertaining to the hoisting and transfer equipment are presented in Guide YVL E.11 “Hoisting and transfer equipment of a nuclear facility”. **[**2018-02-13 **]**

514a. The requirements concerning the design of the barrier systems are presented in Guide YVL D.7. **[**2018-02-13 **]**

5.3 Prevention of occurrences and accidents

5.3.1 Functions to be ensured

515. Steps shall be taken to ensure any functions in the disposal facility, the failure of which might induce an accident resulting in a significant release of radioactive materials or radiation exposure of the facility's personnel. In ensuring the functions the redundancy principle and, whenever practicable, the separation and diversity principles shall be applied. **[**2018-02-13 **]**

515a. The functions to be ensured for single failure shall be determined based on their safety function and its ensuring. Typically they include:
a. braking systems of the transfer elevator or carriage for spent fuel disposal canisters;
b. radiation measurements in rooms where exposure to significant radiation doses is possible;
c. fire alarm and extinguishing systems in areas where a fire could cause a significant radiation hazard or other threat; and
d. power supplies important to the facility's operational safety. **[**2018-02-13 **]**

5.3.2 Internal hazards

515b. According to the paragraph 2 of the Section 18 of the STUK Regulation Y/4/2016 *internal hazards to be considered shall include fire, flood, explosion, electromagnetic radiation, drop of heavy objects, different types of rock slides, and other possible internal events.* **[**2018-02-13 **]**

516. The prevention of fires and explosions shall primarily be based on minimised fire and explosion loads, room layout planning and fire compartmentation. As a rule, no such materials or equipment that would increase the fire load or pose an ignition or explosion hazard shall be placed within fire compartments important to safety or in their immediate vicinity. The materials used in such compartments shall predominantly be incombustible and heat resistant. **[**2018-02-13 **]**

517. The disposal facility shall be equipped with an automatic fire alarm system by means of which any fire can be located. The facility's rooms and systems where a fire could cause a significant radiation hazard or other threat shall be equipped with a suitable fire extinguishing system and with first-response fire fighting equipment suitable for operative fire fighting. Requirements pertaining to the design of fire safety arrangements are presented in Guide YVL B.8 "Fire protection at a nuclear facility". **[**2018-02-13 **]**

5.3.3 External hazards

517a. According to the paragraph 2 of the Section 17 of the STUK Regulation Y/4/2016 *external events shall include exceptional weather conditions, seismic events, the effects of accidents that take place in the environment of the facility, and other factors resulting from the environment or human activity. The design shall also consider unlawful actions with the aim of damaging the plant, as well as aircraft crashes.* **[**2018-02-13 **]**

518. The natural phenomena to be considered in the design of an operation of a disposal facility shall at least include lightning, earthquake and flood. Other external events shall be taken into account insofar as they affect operational safety and/or long-term safety. **[**2018-02-13 **]**

519. Security arrangements shall be in place to protect the disposal of nuclear waste against unlawful action, the extent of which shall be commensurate with the threat arising from unlawful action. The requirements concerning planning and design of security arrangements are presented in Guide YVL A.11 "Security of a nuclear facility" and in Guide YVL A.12 "Information security management of a nuclear facility". **[**2018-02-13 **]**

5.3.4 Criticality

520. According to the paragraph 3 of the Section 32 of the STUK Regulation Y/4/2016 *the disposal package containing spent nuclear fuel shall be designed so that no self-sustaining chain reaction of fissions can occur, with a high level of certainty, under the disposal conditions.* **[**2018-02-13 **]**

520a. The design shall accommodate potential criticality conditions where the leak-tightness of the canister has been lost, and the canister has sustained mechanical or corrosion-induced deformations. **[**2018-02-13 **]**

520b. The long-term criticality safety analyses shall consider the possibility of a self-sustaining chain reaction of fissions and analyse the consequences of such an event as far as practicable. **[**2018-02-13 **]**

5.4 Nuclear safeguards

521. In designing and operating a facility intended for the disposal of spent nuclear fuel or other nuclear materials, provisions shall be made for nuclear safeguards arrangements in compliance with Guide YVL D.1 “Regulatory control of nuclear safeguards”. **[**2018-02-13 **]**

522. The particular requirements concerning the nuclear safeguards of the disposal facility for spent nuclear fuel are specified in Chapter 3.7 of Guide YVL D.1. **[**2018-02-13 **]**

5.5 Reversibility

523. Facilitation of reversibility of waste packages from the emplacement rooms for safety reasons shall be provided for the operating stage of the disposal facility. **[**2018-02-13 **]**

524. The disposal shall be designed so that the facilitation of reversibility does not compromise long-term safety. **[**2018-02-13 **]**

525. Reversibility shall not compromise operational safety or long-term safety of other waste disposed of. **[**2018-02-13 **]**

6 Commissioning and operation of a disposal facility

601. Requirements pertaining to the construction and commissioning of a disposal facility are presented in Guide YVL A.5. “Construction and commissioning of a nuclear facility”. Guide YVL A.6 “Conduct of operations at a nuclear power plant” deals with requirements for the operation. The holder of an operating licence for a disposal facility shall have in its possession the documents required under Section 36 of the Nuclear Energy Decree and Section 24 of Regulation STUK Y/4/2016. The documents shall be constantly kept up-to-date, so that they always reflect the current structure and state of the facility. **[**2018-02-13 **]**

601a. In accordance with para. 514 of Guide YVL A.5, STUK will conduct an inspection pursuant to Section 20 of the Nuclear Energy Act to ensure that the facility fulfils the requirements set for it before the operation of the nuclear facility begins. The aim and contents of the inspection are specified in Chapters 3.7 and 4.6 of Guide YVL A.1 “Regulatory oversight of safety in the use of nuclear energy”. **[**2018-02-13 **]**

601b. The licensee shall perform its own commissioning inspections of the underground facilities and related systems and structures. After this, the licensee shall present a written request for a commissioning inspection to STUK. **[**2018-02-13 **]**

601c. The inspections of components and structures of a disposal facility, or parts thereof, to be performed by STUK or the licensee shall be carried out prior to the commissioning. **[**2018-02-13 **]**

601d. In the commissioning inspection of underground facilities, STUK will inspect that:
a. the construction inspections of rock engineering structures and surfaces of an underground facility system, and other systems thereof, such as fire and radiation protection structures, as well as any system commissioning inspections, have been acceptably performed;
b. any non-conformances have been handled in an acceptable manner; and
c. the licensee has conducted its commissioning inspections. **[**2018-02-13 **]**

601e. STUK will conduct a commissioning inspection on all underground facilities that are constructed after the start of the operation of the disposal facility and are important to safety (safety classes 3 and EYT/STUK). In the commissioning inspection, the underground facility shall be approved as part of the operational disposal facility and for use in disposal activities. **[**2018-02-13 **]**

601f. Requirements related to the construction and commissioning inspections of the systems

of a disposal facility are presented in Guide YVL B.8, those related to the radiation monitoring systems in Guide YVL C.6, those related to the rock structures in Guide YVL D.7 and those related to other nuclear facility structures and equipment in the E-series YVL Guides. **[**2018-02-13 **]**

602. The holder of an operating licence for a disposal facility shall have an operating experience feedback programme for the systematic collection, analysis and reporting of operating experiences and events at the facility in question and other similar facilities as well as for the follow-up of safety studies. Based on the follow-up and in response to the advancement of construction and disposal methods, the opportunities for enhancing safety shall be considered and any improvements deemed justified shall be implemented. Guide YVL A.10 “Operating experience feedback of a nuclear facility” deals with requirements for the operating experience feedback programme. **[**2018-02-13 **]**

603. The holder of an operating licence of a disposal facility shall maintain records of the disposed waste, providing at least the following information to an accuracy of an individual waste package:
a. the waste type, its processing and packaging method and structural and material characteristics significant to safety;
b. a waste package identifier and location in the emplacement room; and
c. the upper limits for the activities of the significant nuclides, to an accuracy of an individual disposal canister in case of spent fuel and to an accuracy of an individual emplacement room in case of other waste. **[**2018-02-13 **]**

603a. Criteria shall be defined for the nuclear waste and waste packages being disposed of, based on the operational safety of the disposal facility and the long-term safety of disposal which any waste brought into the disposal facility shall satisfy. Requirements pertaining to the criteria to be imposed on spent nuclear fuel are set out in Guide YVL D.3. **[**2018-02-13 **]**

604. In the event that the licensee, following the commissioning of the disposal facility concerned, wishes to modify any system, structure, component or mode of operation of the facility that STUK has previously approved, the modification plan shall be subjected to STUK’s approval as provided in Section 112 of the Nuclear Energy Decree prior to its implementation. The plant modification shall comply with the requirements set out in Guide YVL A.1. **[**2018-02-13 **]**

605. Moved to Guide YVL D.7. **[**2018-02-13 **]**

606. Moved to Guide YVL D.7. **[**2018-02-13 **]**

607. Removed. **[**2018-02-13 **]**

608. Prior to the construction and the commissioning of a disposal facility, a baseline survey of the radiological status of the facility's environment shall be carried out as provided in Guide YVL C.7 "Radiological monitoring of the environment of a nuclear facility". **[**2018-02-13 **]**

609. The amount of radioactive materials released to the environment from a disposal facility shall be monitored by means of representative measurements performed at the potential release pathways of radioactive materials. Guide YVL C.3 deals with release measurements. **[**2018-02-13 **]**

610. A radiation monitoring programme shall be implemented in the vicinity of a disposal facility, the extent of which shall be determined based on the foreseen releases of radioactive materials. Guide YVL C.7 deals with environmental radiation monitoring. **[**2018-02-13 **]**

611. The radiation protection and exposure monitoring of the operating personnel of a disposal facility shall be carried out in compliance with Guide YVL C.2 **[**2018-02-13 **]**

612. A disposal facility shall have emergency arrangements in place, the extent of which shall be commensurate with the foreseen accidents. Requirements for planning of emergency arrangements are presented in Guide YVL C.5 "Emergency arrangements of a nuclear power plant". **[**2018-02-13 **]**

613. Removed. **[**2018-02-13 **]**

7 Documents to be submitted to STUK

7.1 Decision-in-principle and licensing processes

701. Removed. **[**2018-02-13 **]**

702. Removed. **[**2018-02-13 **]**

703. Moved to para 304c. **[**2018-02-13 **]**

703a. A disposal facility for nuclear waste is a nuclear facility of considerable general significance (Nuclear Energy Act, Section 11, Nuclear Energy Decree, Section 6), the construction of which is subject to a Government decision-in-principle. Section 24 of the Nuclear Energy Decree and Guide YVL A.1 specify the documents concerning the foreseen facility that shall be annexed to the application for a decision-in-principle. **[**2018-02-13 **]**

703b. When applying for a decision-in-principle, it shall be demonstrated that the rock volume at the selected disposal site is sufficient for the positioning of the underground space of the disposal facility. **[**2018-02-13 **]**

703c. When a construction licence for a disposal facility for nuclear waste is applied for, the documents specified in Guide YVL A.1 shall be submitted to STUK for approval, along with the following documents:
a. the preliminary geological, hydrogeological and groundwater chemistry model for the disposal site; and
b. the preliminary positioning plan for the disposal facility. **[**2018-02-13 **]**

703d. When an operating licence for a disposal facility for nuclear waste is applied for, the documents specified in Guide YVL A.1 shall be submitted to STUK for approval where applicable, along with the following documents:
a. the geological, hydrogeological and groundwater chemistry model for the disposal site;
b. the positioning plan for the disposal facility; and
c. detailed plans for the positioning of the first rooms and the start of operation of the facility. **[**2018-02-13 **]**

703e. STUK will review and approve the supplements to the documents insofar as the intention is to enlarge the disposal facility under the conditions of an existing operating licence. **[**2018-02-13 **]**

703f. A report discussing the potential impact of the foreseen enlargement work on the safety of

existing nuclear facilities shall be submitted to STUK for approval. **[**2018-02-13 **]**

703g. STUK will review and approve the supplements to the documents insofar as the intention is to commission an enlargement of the disposal facility under the conditions of an existing operating licence. **[**2018-02-13 **]**

703h. The commissioning of the enlargement is subjected to the STUK's approval as provided in Section 20 of the Nuclear Energy Act. **[**2018-02-13 **]**

703i. In the event that an underground research facility, intended to constitute a part of the foreseen disposal facility, is constructed at the disposal site prior to the issuance of the construction licence, the following documents shall be submitted to STUK for approval:
a. necessary part of the documentation described in para. 706 corresponding to the preliminary safety analysis report;
b. a description of the potential effects of the construction of the research facility on the characteristics of the disposal site's bedrock, in particular in view of long-term safety;
c. a proposal for a safety classification document;
d. a report on quality management during construction;
e. a plan for arranging the necessary nuclear safeguards to prevent the proliferation of nuclear weapons insofar as nuclear materials are intended to be emplaced in the repository; and
f. a description of the arrangements for facilitating STUK's regulatory control.
The documents shall be kept up-to-date during the construction of the research facility. **[**2018-02-13 **]**

7.2 Safety case

704. Compliance with the requirements concerning long-term radiation safety, and the suitability of the disposal method and disposal site, shall be demonstrated through a safety case that shall at least include:
a. description of the disposal system;
b. definition of the barriers and the long-term safety functions they provide;
c. specification of performance targets for the long-term safety functions;
d. definition of the scenarios (scenario analysis);
e. description of factors affecting the release and migration of radioactive materials and the long-term safety functions by means of conceptual and mathematical models, and the determination of necessary model parameters;
f. an analysis of the quantities of radioactive materials that are released from the disposed

waste, penetrate the barriers and enter the biosphere, and an analysis of the resulting radiation doses;
g. assessment of the probability of rare events impairing long-term safety and the activity releases and radiation doses arising from the events;
h. uncertainty and sensitivity analyses;
i. complementary considerations; and
j. comparison of the outcome of the analyses against the safety requirements specified in paras. 307 and 313.
Detailed requirements for the content of the safety case are provided in Annex A to this Guide. **[**2018-02-13 **]**

704a. The plan for the preparation of the safety case shall be submitted to STUK for information before submitting the application for a construction and operating licence and carrying out a periodic safety review. **[**2018-02-13 **]**

704b. For the purpose of comparative analyses referred to in para. 818, the licence applicant shall upon request submit to STUK the documentation necessary for the comparison insofar as they are not included in the safety case or topical reports annexed to it. **[**2018-02-13 **]**

705. Moved to para 603a. **[**2018-02-13 **]**

7.3 Safety analysis reports and their annexes

706. When the preliminary and final safety analysis reports pertaining to a disposal facility are prepared, the requirements set out in Chapter 6 of Guide YVL B.1 shall be complied with where applicable. Additionally, the safety analysis reports shall at least provide:
a. a description of the safety principles, design bases and other criteria adopted in the design of the disposal facility;
b. a detailed description of the disposal site and its bedrock based on investigations;
c. a description of the waste to be disposed of, their processing and packaging methods, the characteristics of the disposed waste packages, any barriers to be installed around them, and the backfilling and closing structures;
d. a description of the criteria referred to in para. 603a and the grounds thereof;
e. a description of the disposal facility (excavations, engineered structures and systems) and its implementation (construction, operation and closure); a detailed description of the part of the facility already implemented and a plan for the parts that will be constructed later;
f. a description of the disposal activities; an outline in the preliminary safety analysis report and

a detailed description in the final safety analysis report;
g. a description of the disposal facility's personnel and of the procedures used for verifying the competences of the persons in positions important to safety; an outline in the preliminary safety analysis report and a detailed description in the final safety analysis report;
h. a description of the research and monitoring programmes to be implemented at the disposal facility (programmes referred to in para. 506, ageing management programme, operating experience feedback programme); an outline in the preliminary safety analysis report and a detailed description in the final safety analysis report;
i. a summary of the analyses concerning the operational safety of the disposal facility addressing the radiation exposure of workers and potential radioactive releases, and the resulting radiation doses arising from normal operation, operational occurrences and accidents;
j. a summary of the safety case pertaining to long-term safety;
k. principles and criteria for the rock suitability classification; and
l. descriptions of the underground facility systems, including their structures and functions. **[**2018-02-13 **]**

707. The information may be presented to the required level of accuracy in the safety analysis report or, alternatively, summarised in the safety analysis report and specified in more detail in separate topical reports supplementing it. **[**2018-02-13 **]**

7.4 Periodic safety review

708. During the operation of the disposal facility for nuclear waste, the licensee shall carry out a periodic safety review at least once every 15 years (Nuclear Energy Act (990/1987), Section 7 e). **[**2018-02-13 **]**

709. The periodic safety review shall include assessments of the disposal facility's safety and the long-term safety of disposal as well as potential development targets in view of maintaining and enhancing safety, taking due account of the considerations of para. 602, among other things. **[**2018-02-13 **]**

710. The safety analysis report and safety case shall be updated to reflect the results of the safety review. **[**2018-02-13 **]**

711. The requirements concerning the periodic safety review are presented in Guide YVL A.1. **[**2018-02-13 **]**

7.5 Reporting

712. Reporting during construction and commissioning is addressed in Guide YVL A.5. **[**2018-02-13 **]**

713. Regular reporting on the operation of disposal facilities located at nuclear power plant areas is addressed in Guide YVL A.9 “Regular reporting on the operation of a nuclear facility”. **[**2018-02-13 **]**

714. Reports on the results and interpretations thereof of the research and monitoring programmes referred to in para. 506 shall be submitted to STUK for information at least once a year. **[**2018-02-13 **]**

715. A summary of the records specified in para 603 shall be annually submitted to STUK for information. **[**2018-02-13 **]**

8 Regulatory oversight by the Radiation and Nuclear Safety Authority

8.1 Oversight of the construction, operation and closure of a disposal facility

801. Moved to para 703a. **[**2018-02-13 **]**

802. Moved to para 703c. **[**2018-02-13 **]**

803. Moved to para 703d. **[**2018-02-13 **]**

804. STUK oversees the construction and commissioning of a disposal facility for nuclear waste in accordance with Guides YVL A.1 and YVL A.5. STUK will issue a separate decision as to the applicability of Guide YVL A.6 to the conduct of operations at a disposal facility. The design, manufacturing, construction, installation, inspection, testing and demonstration of conformity to requirements of the barriers for the disposal of spent fuel are addressed in Guide YVL D.7. **[**2018-02-13 **]**

805. In the event that an underground research facility, intended to constitute a part of the foreseen disposal facility, is constructed at the disposal site prior to the issuance of the construction licence, STUK oversees the design and construction of the research facility to the extent it sees fit following the same procedure as that pertaining to the construction of the disposal facility. **[**2018-02-13 **]**

806. The construction of the various parts of the disposal facility may be performed stepwise. A precondition for the commencement of an individual construction stage is that STUK has approved the documents specified in paras. 703d and 703f and Guide YVL D.7, and that the readiness inspections specified in Guide YVL D.7 have been completed. **[**2018-02-13 **]**

807. Moved to para 601a. **[**2018-02-13 **]**

808. Moved to para 601b. **[**2018-02-13 **]**

809. Moved to para 601d. **[**2018-02-13 **]**

810. Removed. **[**2018-02-13 **]**

811. Moved to Guide YVL D.7. **[**2018-02-13 **]**

812. Moved to Guide YVL D.7. **[**2018-02-13 **]**

813. In the event that a part of a disposal facility is backfilled and closed during the operation of the facility, the approval procedure described in para. 604 shall be complied with. **[**2013-11-15 **]**

814. A licensee with a waste management obligation shall apply for an order on the expiry of

his waste management obligation when all the measures necessary for closing the disposal facility have been completed (Nuclear Energy Decree, Section 84). A prerequisite for the expiry of the waste management obligation is that STUK has confirmed that the nuclear waste has been permanently disposed of in a manner it has approved (Nuclear Energy Act, Section 33) and that the measures specified in Section 32 of the Nuclear Energy Act have been duly completed. **[**2018-02-13 **]**

815. A precondition for the permanent closure of a disposal facility is that STUK has approved the plan concerning the closure, which shall include:
a. a description of the technical implementation of the closure of the repository;
b. an update of the safety case with due consideration given to the outcomes of the research and monitoring programmes referred to in para. 506 and the implementation of the closure; and
c. a plan for the potential post-closure monitoring measures and a proposal for the restriction zone with prohibition on measures referred to in Section 85 of the Nuclear Energy Decree. **[**2018-02-13 **]**

8.2 Oversight of the safety case

816. Before submitting the application for a decision-in-principle, anyone planning to construct a disposal facility may according to Section 55(4) of the Nuclear Energy Act request STUK to review the plan for the preparation of the safety case and issue preliminary instructions on what should be taken into account with respect to safety planning. **[**2018-02-13 **]**

817. STUK approves the safety case when reviewing the construction and operating licence application and the periodic safety review. **[**2018-02-13 **]**

818. STUK conducts comparative analyses on the safety analyses included in the safety case independent of the licence applicant or licensee, or have such conducted by an outside expert. **[**2018-02-13 **]**

9 Annex A Safety case

A01. According to the paragraph 1 of the Section 35 of the STUK Regulation Y/4/2016 *compliance with the requirements concerning nuclear and radiation safety and the suitability of the disposal method, engineered barriers and disposal site shall be demonstrated by means of a safety case that shall study the possible evolutions of the disposal system, including evolutions caused by rare events impairing long-term safety. The safety case includes, for example, calculational safety analysis based on the evolutions and the complementary considerations.* **[**2018-02-13 **]**

9.1 Description of the disposal system

A02. The safety case shall include a description of the disposal system: quantities of radioactive materials, barriers and their characteristics, underground facilities and the surface environment at the disposal site. **[**2018-02-13 **]**

9.2 Definition of barriers and long-term safety functions

A03. The safety case shall present the safety concept and the barriers and long-term safety functions provided by them. **[**2018-02-13 **]**

A03a. The safety case shall include a description of how the long-term safety functions provided by the barriers operate and complement each other to ensure that long-term safety is not overly dependent on any one long-term safety function. **[**2018-02-13 **]**

A03b. The safety case shall present how the long-term safety functions have been defined. **[**2018-02-13 **]**

9.3 Definition of performance targets for long-term safety functions

A03c. The safety case shall present how the performance targets for the long-term safety functions have been defined. The presentation of each performance target as a barrier characteristic ensuring the performance of a safety function shall also be justified. **[**2018-02-13 **]**

A03d. The established performance target criteria shall be justified by means of barrier performance analyses. **[**2018-02-13 **]**

A03e. The compliance times for the performance targets shall be presented. **[**2018-02-13 **]**

9.4 Definition of scenarios

A04. The scenarios used in assessing alternative evolutions of the disposal system shall be systematically created to cover any events and factors that may be of relevance to long-term safety and that may arise from:
a. external factors, such as climate changes, geological events or human actions;
b. radiological, mechanical, thermal, hydrological, chemical, biological and radiation-related factors internal to the disposal system; and
c. quality non-conformances in the barriers
and the combined effects of all the aforementioned factors. **[**2018-02-13 **]**

A04a. The selection of the scenarios shall be justified. **[**2018-02-13 **]**

A05. The base scenario shall assume that the performance targets defined for each safety function are met. **[**2018-02-13 **]**

A05a. The influence of declined performance of one or several long-term safety functions shall be analysed by means of variant scenarios. **[**2018-02-13 **]**

A05b. Disturbance scenarios shall be constructed for the analysis of rare events impairing long-term safety referred to in para. 316 and 316a. **[**2018-02-13 **]**

A05c. The anticipated extent of declined performance of the long-term safety functions in scenarios shall be presented and justified. **[**2018-02-13 **]**

9.5 Models and input data

A06. In order to analyse the release and migration of radioactive materials originating from the disposed waste, conceptual models shall be constructed to describe the underlying events and processes. **[**2018-02-13 **]**

A06a. In order to justify the performance targets set and the degradation of the long-term safety functions, conceptual models shall be constructed to describe the long-term safety functions and the factors affecting them. **[**2018-02-13 **]**

A06b. Simplification of the mathematical models derived from the conceptual models and the determination of the required input data shall be based on the principle that the performance of the long-term safety functions will neither be overestimated nor overly underestimated. **[**2018-02-13 **]**

A07. The modelling and determination of input data shall be based on the best available experimental knowledge and expert judgement obtained through, for example, laboratory experiments, geological investigations and evidence from natural analogues. **[**2018-02-13 **]**

A07a. The models and the input data shall be consistent with the scenario, assessment period and disposal system. **[**2018-02-13 **]**

A07b. The range of variation of safety-significant input data applicable to a specific scenario shall be presented and justified. **[**2018-02-13 **]**

A07c. When the input data involves random variations due to, for example, the heterogeneity of the bedrock, models that accommodate random variation shall be employed. **[**2018-02-13 **]**

A08. The selection of computational methods and input data, and the determination of the performance targets, shall be based on the principle that the actual quantities of released radioactive materials and the actual radiation exposure shall, with a high degree of certainty, be lower than those obtained through safety analyses. **[**2018-02-13 **]**

9.6 Safety analysis and rare events impairing long-term safety

A08a. Demonstration of compliance with the radiation dose and release constraints presented in Chapter 3.2 shall be made by means of deterministic analyses defining the quantities of radioactive materials and the resulting radiation doses that are released from the disposed waste, penetrate the barriers and enter the biosphere. **[**2018-02-13 **]**

A08b. In the analyses concerning the surface environment during the period referred to in para. 307 and analyses performed in accordance with the stylized models of the surface environment referred to in para. 314a, account shall be taken of the changes in the living environment that arise from changes in ground and sea level. **[**2018-02-13 **]**

A08c. In the analyses concerning the surface environment during the period referred to in para. 307, flora and living populations as well as human habits, nutritional needs and metabolism can be assumed to be similar to the current ones. **[**2018-02-13 **]**

A08d. In the analyses performed in accordance with the stylized models of the surface environment referred to in para. 314a, human habits, nutritional needs and metabolism can be assumed to be similar to the current ones. **[**2018-02-13 **]**

A08e. When applying the dose constraints in the analyses concerning the surface environment during the period referred to in para. 307 and analyses performed in accordance with the stylized models of the surface environment referred to in para. 314a, the exposure shall be assumed to arise from radioactive materials released from the repository and migrated to near-surface groundwater bodies and further to above-ground watercourses. At least the following potential exposure pathways shall be considered:
a. the use of contaminated water as household and irrigation water and for animal watering; and
b. the use of contaminated natural or agricultural products originating from terrestrial or aquatic environments. **[**2018-02-13 **]**

A08f. Whenever possible, the consequences and probabilities of rare events impairing long-term safety referred to in paras. 316 and 316a shall be assessed quantitatively; otherwise, their significance shall be assessed qualitatively. **[**2018-02-13 **]**

9.7 Treatment of uncertainties

A09. The significance of the uncertainties involved with the safety case shall be systematically assessed by means of appropriate methods including, for example, sensitivity and probabilistic assessments. **[**2018-02-13 **]**

9.8 Complementary considerations

A10. Where necessary, the actual safety analysis shall be supported by complementary considerations that may include, for example, calculations by stylized methods, comparisons with natural analogues, observations of the geological history of the disposal site, “what if” type considerations that test the robustness of barrier performance and probabilistic assessments. **[**2018-02-13 **]**

A10a. The significance of complementary considerations grows as the assessment period increases; safety evaluations extending beyond the time horizon of one million years can mainly be based on such considerations. **[**2018-02-13 **]**

A10b. Complementary considerations shall also be made parallel to the actual safety analysis to enhance the confidence in the results of the analysis or certain part of it. **[**2018-02-13 **]**

9.9 Comparison of the outcome of the analyses with the safety requirements

A10c. In the safety case, the results of the safety analyses shall be compared against the requirements related to long-term safety. **[**2018-02-13 **]**

A10d. The safety case shall also include an assessment of the level of confidence with regard to compliance with the safety requirements and of the uncertainties and assumptions with the greatest impact on the level of confidence. **[**2018-02-13 **]**

9.10 Structure and documentation of the safety case

A11. The structure and presentation of the safety case shall clearly support the demonstration of compliance with safety requirements. **[**2018-02-13 **]**

A11a. The basic assumptions that underlie the safety case, along with the methods employed, the results obtained and the relation of the part to the case as a whole shall be easy to ascertain (clarity and traceability), and the rationale for the assumptions, input data and models adopted, shall be easy to find in the documentation (transparency). **[**2018-02-13 **]**

A11b. A description of the models and calculation methods employed in the analyses shall be presented. The models and their respective input data shall be described to a level of precision that allows for performing comparative analyses in order to verify the analyses made. **[**2018-02-13 **]**

A11c. The safety case shall be supplemented with topical reports, the purpose of which is to clarify on what kind of experimental studies and analyses the design and assessment of the long-term safety are based. **[**2018-02-13 **]**

A11d. An update to the safety case shall present the most significant changes compared to the previous safety case. **[**2018-02-13 **]**

9.11 Quality of the safety case

A12. The quality of the safety case shall be ascertained through the management system related to the design, construction and operation of the disposal facility. The party implementing the project shall have an appropriate organisation, adequate competence in use and an appropriate information management system in place. **[**2018-02-13 **]**

A13. The various stages of the preparation of the safety case shall be systematically planned, and the representativeness and reliability of the studies and analyses most important for safety

shall, if necessary, be confirmed by means of, for example, expert reviews or analyses independent from the licence applicant or licensee. **[**2018-02-13 **]**

A14. The key selections, assumptions and conclusions related to the compiling of the safety case shall be documented. **[**2018-02-13 **]**

A15. The safety case shall include an assessment of measures concerning the further development of safety, such as the need for further studies and reduction of uncertainties. **[**2018-02-13 **]**

10 References

1. Nuclear Energy Act (990/1987). **[**2013-11-15 **]**

2. Nuclear Energy Decree (161/1988). **[**2013-11-15 **]**

3. Radiation Act (592/1991). **[**2013-11-15 **]**

4. Radiation Decree (1512/1991). **[**2013-11-15 **]**

5. Radiation and Nuclear Safety Authority Regulation on the Security in the Use of Nuclear Energy (STUK Y/3/2016). **[**2018-02-13 **]**

6. Radiation and Nuclear Safety Authority Regulation on the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2016). **[**2018-02-13 **]**

7. Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2016). **[**2018-02-13 **]**

8. Disposal of Radioactive Waste. Specific Safety Requirements. IAEA Safety Standards Series No. SSR-5. **[**2013-11-15 **]**

9. Geological Disposal Facilities for Radioactive Waste. Specific Safety Guide. IAEA Safety Standards Series No. SSG-14. **[**2013-11-15 **]**

10. The Safety Case and Safety Assessment for the Disposal of Radioactive Waste. Specific Safety Guide. IAEA Safety Standards Series No. SSG-23. **[**2013-11-15 **]**

11. ICRP, 1998. Radiation protection recommendations as applied to the disposal of long-lived solid radioactive waste. ICRP Publication 81. Ann. ICRP 28 (4). **[**2013-11-15 **]**

12. ICRP, 2013. Radiological protection in geological disposal of long-lived solid radioactive waste. ICRP Publication 122. Ann. ICRP 42(3). **[**2018-02-13 **]**

13. Radioactive Waste Disposal Facilities Safety Reference Levels, WENRA WGWD, 2014. **[**2018-02-13 **]**

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’.

Very low-level waste

Very low-level waste shall refer to nuclear waste whose average activity concentration of significant radionuclides does not exceed the value of 100 kBq per kilogram and the total activity does not exceed the values laid down in Section 6(1) of the Nuclear Energy Decree (161/1988).

Rock engineering structure and component

Rock engineering structures include the rock surface with its properties (such as shape, smoothness and water leakage), the disturbance zone caused by excavation, reinforcement structures and grouting and sealing structures. Rock engineering structures consist of components. For example, a reinforcement is a structure that includes the following components: bolt holes, reinforcing bolts, bolt grout, shotcrete, reinforcing mesh and mesh anchoring bolts. Correspondingly, in rock grouting, for example, a grouting fan is a structure including grout boreholes and grouts as components.

Underground space

Underground space constructed inside bedrock by excavation or another method.

Underground facility system

Underground spaces are divided into underground facility systems with different functions. Underground facility systems consist of the excavated space and the constructed bedrock surrounding it, including fractures. An underground facility system may also include structures and structural elements in the excavated space so that they together form a logical whole. In addition to the surrounding bedrock and the rock surface, an underground facility system includes fractured rock (with both its natural fractures and fracture zones and fractures caused by excavation) and rock grouting structures and reinforcements.

Intermediate level waste

Intermediate level waste shall refer to nuclear waste that, because of its high level of activity, requires effective radiation protection arrangements when processed. The activity concentration of such waste is usually 1 MBq/kg–10 GBq/kg.

Conceptual model

Conceptual model shall refer to a conceptual description of a function or process.

High level waste

High level waste shall refer to waste that, because of its high level of activity, requires highly effective radiation protection arrangements when processed and usually also cooling. The activity concentration of such waste is usually more than 10 GBq/kg.

Disposal system

Disposal system shall refer to an entirety comprising the disposal facility and the bedrock and ground surface environment of the disposal site.

Disposal facility

Disposal facility shall refer to an entirety comprising the rooms for the disposal of the waste packages (emplacement rooms) and the adjoining underground and above-ground auxiliary facilities. (Nuclear Energy Decree 161/1988)

Disposal site

Disposal site shall refer to the location of the disposal facility and, after disposal has been completed, the area entered in the real estate register in accordance with Section 85 of the Nuclear Energy Decree, and the ground and bedrock under it.

Short-lived waste

Short-lived waste shall refer to nuclear waste, the calculated activity concentration of which after 500 years is below the level of 100 MBq/kg in each disposed waste package, and below an average value of 10 MBq/kg in waste in one emplacement room.

Low level waste

Low level waste shall refer to nuclear waste that, because of its low level of activity, can be processed without any special radiation protection arrangements. The activity concentration of such waste is usually not more than 1 MBq/kg.

Anticipated operational occurrence

Anticipated operational occurrence 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. (Nuclear Energy Decree 161/1988)

Expected evolution

Expected evolution shall refer to evolution where the disposal system performs as planned or where one or more long-term safety functions are assumed to degrade.

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 facility 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, which can be assumed to occur less frequently than once during any period of one hundred years of operation, but at least once during any period of one thousand years of operation; b) class 2 postulated accidents, which can be assumed to occur less frequently than once during any period of one thousand years of operation. (Nuclear Energy Decree 161/1988)

Accident

Accident shall refer to postulated accidents, design extension conditions and severe accidents. (Nuclear Energy Decree 161/1988)

Long-term safety functions

Long-term safety functions shall refer to functions achieved by the characteristics or processes of engineered and natural barriers that are intended to isolate the nuclear waste from the bedrock and the biosphere or to impede the migration of radionuclides.

Long-term safety

Long-term safety shall refer to the safety of disposal after the closure of the disposal facility, taking account of radiation exposure on humans and the environment.

Rare event impairing long-term safety

Rare event impairing long-term safety shall refer to a potential event significantly reducing the performance of barriers that has a very low probability of occurring but that may jeopardize long-term safety in case of occurrence. Such an rare event may be caused by geological phenomena, climatic phenomena or human action.

Long-lived waste

Long-lived waste shall refer to nuclear waste the calculated activity concentration of which after 500 years is above 100 MBq/kg in a disposed waste package, or above an average value of 10 MBq/kg in waste placed in one emplacement room.

Scenario

Scenario shall refer to an evolution scheme describing the potential future behaviour of the disposal system.

Performance target

Performance target shall refer to a measurable or assessable characteristic of a barrier. The performance target shall include a criterion describing the characteristic which, when met, ensures the performance of a long-term safety function.

Safety case

Safety case shall refer to documentation for demonstrating compliance with the long-term safety requirements.

Barrier

Barrier shall refer to an engineered or natural barrier used for achieving long-term safety functions.

Annual dose

Annual dose shall refer to the sum of the effective dose arising from external radiation within the period of one year and the committed effective dose from the intake of radioactive substances within the same period of time. (Nuclear Energy Decree 161/1988)

Nuclear waste facility

Nuclear waste facility shall refer to a nuclear facility that is used for the encapsulation of spent nuclear fuel or the processing of other nuclear waste for disposal, and to a disposal facility for spent nuclear fuel or other nuclear waste, but not permanently closed facilities where nuclear waste has been disposed of in a manner approved as permanent by STUK. (Nuclear Energy Decree 161/1988)

Nuclear facility

Nuclear facility shall refer to the facilities used for the generation of nuclear energy, including research reactors, facilities for the large-scale disposal of nuclear waste, and facilities for the large-scale production, use, processing or storage of nuclear material and nuclear waste. However, nuclear facility shall not refer to:
a) mines or ore processing plants intended for the production of uranium or thorium, or premises and sites including their precincts where nuclear wastes from such facilities are stored or deposited for final disposal; or
b) facilities and premises that have been permanently closed and where nuclear waste has been disposed in a manner approved as permanent by the Radiation and Nuclear Safety Authority; or
c) premises or parts of a nuclear facility that have been decommissioned in a manner approved by the Radiation and Nuclear Safety Authority. (Nuclear Energy Act 990/1987)