

GUIDE YVL D.7

RELEASE BARRIERS OF SPENT NUCLEAR FUEL DISPOSAL FACILITY

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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.

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1 Introduction

101. The Nuclear Energy Act (990/1987) lays down the basic requirements concerning the safe use of nuclear energy. The Radiation Act (592/1991) specifies the general principles of radiation safety and the provisions for radiation work.

102. According to the Nuclear Energy Act (990/1987), the use of nuclear energy must be safe; it shall not cause injury to people, or damage to the environment or property.

103. 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.

104. The Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste STUK Y/4/2016 presents the general requirements concerning the safety of disposal of nuclear waste.

105. Low and intermediate level waste and spent nuclear fuel are accumulated during the operation of nuclear power plants. 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.

106. The preparations for the disposal of nuclear waste comprise researching, selecting and characterising the disposal site, developing the disposal method and technology, and assessing the operational and long-term safety of the disposal facilities. The implementation of the disposal involves the design of rock tunnels, rock construction and other construction work, the design, construction and installation of engineered barriers into the emplacement rooms, packing the spent fuel for disposal, transferring and installing the encapsulated spent fuel into the emplacement rooms, and the closure of the excavated rooms. These tasks will take place in overlapping phases.

107. The oversight by the Radiation and Nuclear Safety Authority set forth in this Guide is based on Section 63 of the Nuclear Energy Act and Sections 108 and 109 of the Nuclear Energy Decree (161/1988).

2 Scope of application

201. This Guide addresses the detailed technical design, manufacture, construction, installation, inspection, testing and verification of conformity of barriers intended for the disposal of spent nuclear fuel, and the monitoring of the impacts of their construction during construction and operation. Barriers under Guide YVL D.5 include engineered barriers (for example, the disposal canister, buffer, backfilling and plug structures) and the natural barrier, i.e. the bedrock. This Guide does not address the closure of the facility or the structures and components related to the closure; they are discussed in Guide YVL D.5 "Disposal of nuclear waste". However, the closure of the repository shall be taken into account in the construction and operation phase of the facility and in the design, manufacture and installation of barriers.

202. The handling, storage and encapsulation of spent nuclear fuel for disposal is addressed in Guide YVL D.3 "Handling and storage of nuclear fuel". The long-term safety of the disposal of nuclear waste is governed by Guide YVL D.5 "Disposal of nuclear waste". In addition, several other YVL Guides apply to the disposal of nuclear waste. This Guide makes references to the applicable guides.

203. Guide YVL A.1 "Regulatory oversight of safety in the use of nuclear energy" sets forth requirements concerning the documents to be submitted to the Radiation and Nuclear Safety Authority.

204. The requirements relating to nuclear safeguards in disposal activities, including the preparation for Euratom and IAEA inspections, are presented in Guide YVL D.1 "Regulatory control of nuclear safeguards".

205. Requirements set for the licensee's management system and the suppliers are presented in Guide YVL A.3 "Management system for a nuclear facility".

206. Requirements set for the construction and commissioning of a nuclear facility are presented in Guide YVL A.5 "Construction and commissioning of a nuclear facility" and Guide YVL D.5 "Disposal of nuclear waste".

207. Requirements set for concrete, reinforced concrete and steel structures of a disposal facility are presented in Guide YVL E.6 "Buildings and structures of a nuclear facility". This Guide (YVL D.7) presents the specifications concerning the concrete barriers in a disposal facility with respect to Guide YVL E.6.

208. Requirements concerning the safety design and safety classification of a nuclear facility are presented in Guides YVL B.1 "Safety design of a nuclear power plant" and YVL B.2

“Classification of systems, structures and components of a nuclear facility”. Guide YVL D.5 presents specific requirements relating to the safety classification of nuclear waste facilities.

209. Requirements concerning the ageing management of a nuclear facility are presented in Guide YVL A.8 “Ageing management of a nuclear facility”.

210. The requirements for inspection organisations are presented in Guide YVL E.1 and the requirements for testing organisations in Guide YVL E.12.

3 General requirements concerning release barriers

301. The general requirements shall be taken into account in accordance with their safety significance.

302. A release barrier or its component may be used in disposal only when all the required inspections and tests have been performed for the release barrier or structure and when the remarks and requirements documented during the inspections have been acceptably processed.

3.1 Requirement specification concerning release barriers and their structures

303. The requirement specification shall present at least the requirements set by the safety functions, performance targets, disposal activities, safety class and seismic class of the release barrier, the operating environment and the external conditions for the barrier and its design and technical implementation.

304. The design and quality requirements of the release barrier, its structures and its components, the justifications for the requirements and the regulatory requirements to be followed shall be presented.

305. Changes to requirements approved by STUK that affect safety shall be justified.

306. The norms, standards and regulations to be applied in the design, manufacture, construction, testing, inspection and installation of release barriers shall be defined, justified and documented.

307. If the set of standards or norms used in the construction, manufacture, testing and inspection of the release barrier differs from that used in design, it shall be ensured that the requirement level in construction, manufacture, testing and inspection does not fall below the level specified in the design standards.

308. The requirements shall be presented in such detail that, based on them, it is possible to evaluate the selection of the release barrier or structure, the prerequisites for the system's feasibility and operation and its structural requirements, and to review the calculations.

309. The detailed requirements set for products and structures shall be verifiable.

3.2 Materials used in manufacture and construction

3.2.1 Requirements for materials

310. The licensee shall have in place procedures for selecting, receiving, handling, storing, inspecting, approving, getting approval for and replacing materials, taking into account the safety significance of the materials.

311. When selecting materials, the requirements and restrictions resulting from manufacturing, testing and inspection shall be considered.

312. In connection with the construction plan, an analysis shall be presented regarding the properties and acceptability of the materials and their applicability for the intended purpose.

313. Material batches shall be reliably marked with unique and traceable identifiers. The supply chain shall be traceable.

314. The handling, storing and transport of materials shall be organised so that the materials retain the properties and condition required from them.

315. The material testing methods shall be selected and the testing scope defined by the safety class, material type and manufacturing method, operating conditions, expected operating time or life, geometry and dimensions.

3.2.2 Material certificates

316. The information required in material certificates of materials is defined in material certificate and material standards. If necessary, the licensee shall supplement the requirements in other documents.

317. The material certificate or other document shall include a confirmation from the manufacturer of the material that the delivered products are compliant with the requirements of the order and the product specification to which reference is made.

318. If a material certificate is required in release barrier- or structure-specific detailed requirements, the finished structure shall be traceable all the way from delivery batch-specific raw materials. The notation and the content of the marking or identifier are laid down in the standards used or similar procedures by the licensee.

319. The material certificate of a material shall clearly indicate the material certificate type under standard SFS-EN 10204 or a corresponding standard. Standard SFS-EN 10204 and the method presented in it can also be used to demonstrate the conformity of other materials

besides metal materials.

3.3 Design

320. The design of manufacture, installation and construction shall be based on the requirements and standards concerning operational and long-term safety and feasibility compiled in the requirement specification.

321. Design solutions shall be justified or confirmed by using standards, design calculations, studies and/or analyses, generally approved design methods, experimental methods, results of procedure tests or empirical documented information, for example.

322. The input data used in design shall be based on up-to-date information, and at least the following information shall be presented:

- a. the design bases;
- b. the role of the release barrier as a part of the disposal system and the nuclear waste facility;
and
- c. the design basis loads, conditions and combinations of loads and conditions.

323. The design shall take into account the expected operating time or life of the system or structure, the prevailing and anticipated environmental conditions and the significant changes in chemical, mechanical and physical characteristics.

324. The inspectability of the release barrier and its structures or components shall be taken into account in the design so that the inspections can be implemented in different phases. If necessary, the inspections shall be designed to be divided into several phases.

325. The procedures for the inspections and tests performed on the materials of the structure shall be enclosed with the design documents. Applicable standards may also be used as procedures.

326. The design documents to be prepared for manufacture, installation and construction are defined in Chapter 4 of this Guide and specified in release barrier -specific Chapters.

3.4 Procedure test

327. When manufacturing or constructing products or structures with operational or long-term safety significance, it shall be demonstrated with a procedure test in cases presented in para. 328 that the material properties approved as the design basis are retained and/or achieved or that the plan is feasible and leads to a product compliant with the requirements. The procedure test shall be performed in accordance with the release barrier -specific requirements. The licensee shall define the period during which the material properties of an object manufactured using a procedure test must be retained in a given case in order for the method to be deemed acceptable.

328. Procedure tests shall be done at least in the following cases:

- a. The method is a rarely used or unique special method.
- b. It is difficult to ascertain the results and validity of accomplished work.
- c. Unusually strict requirements have been set for the work or end product.
- d. Accomplished work is difficult to repair.

329. For procedure tests, the following documents shall be prepared:

- a. a test plan;
- b. bases and criteria for the assessment of the results from the tests;
- c. documentation and a final report on performing the test; and
- d. a summary assessing and establishing the usability of the materials, components and methods when manufacturing the actual structures.

330. For procedure tests performed and related supervision, the licensee's statement on their acceptability and suitability for the work performance or manufacture in question shall be presented.

331. Procedure tests carried out for each place of manufacture shall remain valid indefinitely as long as the manufacturing based on them takes place within the range of essential parameters defined in the applicable standard or licensee's specification.

3.5 Manufacture

332. Unless more specific requirements are presented in Chapters 5–7, the components of engineered barriers shall be marked with identifiers according to a method defined by the licensee so that the manufacturing date and other information of each component and material batch are traceable.

333. The approved manufacture-related plans, procedures and standards shall be available at the place of manufacture.

334. The licensee shall ensure the properties and conformity of the product in accordance with the inspection plan in various phases of manufacture and ensure that the product quality and other properties of the product are preserved during storage.

3.6 Installation

335. The approved installation-related plans, procedures and standards shall be available at the place of installation.

336. The licensee shall ensure that the release barriers and their structures and components are compliant with the requirements after storage, transfer and transport.

337. The licensee shall supervise the installation and affirm the conformity to requirements of the installation.

3.7 Construction

338. The approved construction-related plans, procedures and standards shall be available at the place of construction.

3.8 Machinery and equipment

339. Testing, calibration and maintenance plans shall be available for the machinery and equipment used in manufacture, installation, construction, tests and inspections in order to ensure their operability.

3.9 Inspections by the licensee

3.9.1 General requirements for inspections and supervision by the licensee

340. The licensee shall supervise and ensure by means of inspections that the quality management standards on which the approval is based, approved plans, procedures and related inspection plans are complied with in manufacture, installation and construction.

341. The licensee shall have in place systematic methods for performing the inspections, affirming the conformity to requirements and documentation.

342. If inspection becomes more difficult as manufacturing, installation or construction proceeds, or after assembly, the inspections to be carried out on the structure or target shall be divided into intermediate inspections to be carried out during manufacture, installation or construction, if necessary.

3.9.2 Readiness inspections

343. Through readiness inspections, the licensee shall ensure the conditions for starting the planned work. Before starting work, the licensee shall perform a readiness inspection:

- a. on safety-classified release barriers in accordance with the manufacture or installation phase, for example, on the first structure or component of the series;
- b. on each safety-classified concrete barrier before concrete casting; and
- c. on underground facilities.

344. The licensee shall ensure that in order to start the work, the supplier has access to approved, up-to-date plans and procedures and other relevant documents, requirements and regulations.

3.9.3 Acceptance inspections

345. Through receiving inspections, the licensee shall ensure that the material acquired for manufacture or construction, the finished product, the release barrier or its construction or component meets the requirements. The acceptance inspection shall be performed

- a. on materials entering the manufacturing or construction site before the deployment of the material in manufacture or construction; and
- b. on manufactured barriers or their components or structures when they are delivered to the construction or installation site.

346. It shall also be inspected that the structure or its component has not been transported, stored or handled in a way that would be detrimental to its durability and operation.

3.9.4 Construction inspections

347. Through construction inspections and the intermediate inspections preceding them, the licensee shall ensure that

- a. the engineered barrier, its structure or its component has been manufactured according to the design documents and meets the requirements; and
- b. the rock tunnel has been constructed according to the design documents, it meets the requirements, and the rock surfaces have been properly documented.

3.9.5 Installation inspections

348. Through installation inspections, the licensee shall ensure that the release barrier and its parts have been installed according to the requirements.

3.10 Conditions for oversight and inspections by the Radiation and Nuclear Safety Authority

349. The licensee shall ensure that in STUK's inspection, all plans concerning manufacture, installation, construction and inspections and the approvals, decisions and terms regarding them are known and available.

350. When planning the time of the inspection, the approval processes and necessary intermediate inspections relating to different phases shall be taken into account.

351. The licensee and the different suppliers shall ensure beforehand, by conducting inspections themselves, that the object to be inspected has the prerequisites for being inspected and approved in STUK's inspection.

352. The licensee shall request an inspection from STUK at least two weeks before the planned inspection date.

353. The licensee shall present the results of its own inspection to STUK during the inspection at the latest.

354. The licensee shall afford STUK the opportunity to

- a. pay inspection visits to ensure that the licensee maintains and complies with its quality management system and follows the other terms and conditions on which the approval is based; and

b. conduct on-site oversight and inspections at the premises of the suppliers and their subcontractors used for the activity in question.

355. The licensee, the manufacturer, the installer and the supplier shall, upon request, submit to the inspector any other documents related to the plan or presented in its references.

356. The material for the inspection shall be processed and presented in accordance with the approved construction plan.

357. The necessary tools, equipment and auxiliary personnel shall be arranged for the inspection.

358. In connection with the construction inspection, STUK shall be provided with the opportunity to participate in the dimensional inspection or, if necessary, perform its own dimensional inspections.

3.11 Deviations

359. In addition to requirements concerning deviations in Guides YVL A.3 and YVL A.5, deviation reports concerning engineered barriers and the natural barrier shall also present and discuss the long-term safety significance of the deviation with related justifications.

4 General requirements for design documents and records

4.1 General

401. The plans shall be submitted for inspection as a logical entity and primarily as one application prior to the commencement of construction or the manufacture of the engineered barrier.

402. Detailed and clear references to the source literature, standards and points in standards shall be presented. References to design documents relating to the subject area shall be presented unambiguously.

4.2 Summary of justifications

403. The licensee shall draw up and enclose with the official document a summary of justifications presenting how the safety-classified structure meets the requirements set for it, and how the licensee has established its conformity to requirements. The summary of justifications shall also present the changes made to the approved documents, any occurred deviations, and their impact on the suitability and acceptability of the structure.

4.3 Construction plan and rock construction plans

404. A construction plan shall be prepared for the manufacture or construction of a release barrier. For rock construction, excavation, reinforcement and sealing plans corresponding to the construction plan shall be prepared. The requirements for their content are presented in Chapter 4.3 and in release barrier-specific Chapters 5–8.

405. The construction plans or rock construction plans shall demonstrate the acceptability of the structural solution and the compliance with design requirements and standards. The plans shall include the information to ensure the safety and compliance of the product.

406. The construction plan shall include the descriptions of

- a. the implementation and results of the method, model or full-scale tests performed to demonstrate the acceptability of structural solutions; and
- b. the properties and acceptability of the materials and their applicability for the intended purpose.

4.3.1 Drawings

407. Drawings shall describe the assembly and details of a release barrier or structure in such a way that the size, geometry, manufacture, construction and installation of its components, with allowable tolerances, are accounted for in adequate detail and unambiguously.

408. If necessary, the drawings shall present further instructions concerning work performance (such as manufacturing method, installation method and phase), quality control and the requirements set for structures during construction.

4.3.2 Dimensioning calculations

409. The dimensioning calculation shall describe how the dimensioning presented has been derived from the structural system, structures, boundary conditions, load situations and combinations and material properties. The loads derived or selected from the design bases shall be justified.

410. The dimensioning calculation or analysis shall be described in enough detail that the reliability of the analysis method used and the fulfilment of the dimensioning requirements can be assessed based on it. The document shall allow for the replication of the essential parts of the calculation.

411. Dimensioning calculations shall demonstrate that the requirements for the release barrier are met under design basis situations and conditions and that the dimensioning and geometry of the structure meet the requirements of the applicable standard.

412. The calculations and analyses shall present at least the following information:

- a. input data;
- b. structural drawings;
- c. calculation methods;
- d. acceptance criteria;
- e. calculation and analysis results;
- f. if necessary, results illustrated with plots and figures;
- g. acceptability of results; and
- h. conclusions.

4.3.3 Information on the manufacture of engineered barriers

413. For the manufacture of engineered barriers, at least the following must be presented:

- a. a description of the manufacturer of the engineered barrier;
- b. manufacturing methods;
- c. a technical description of the manufacture and the necessary drawings;
- d. manufacturing procedures and procedure test results;
- e. planned production tests; and
- f. any demanding monitoring and inspection phases for structures and components requiring supervision by an independent third party.

4.3.4 Inspection and testing plan for the manufacture of engineered barriers

414. The inspection and testing plan concerning the monitoring of the manufacture of engineered barriers shall present at least

- a. the procedures, phases and parties involved in the supervision of manufacture;
- b. demanding manufacture and inspection phases for structures and components requiring supervision by any independent third party;
- c. inspections and tests of materials, structures, components and permanent joints;
- d. the performer and supervisor of inspections and tests;
- e. reporting requirements for inspections and tests;
- f. references to specifications, inspection and testing procedures and standards;
- g. component-specific identification information and references to drawings;
- h. material-specific markings and the necessary reference to material specifications; and
- i. procedures and phases of receiving inspections.

415. The procedures shall cover the destructive and non-destructive testing of materials, with the applicable requirements for material certificate and supervision of testing. Testing and inspections performed during manufacture and on completed products shall be covered as well.

416. The inspection and testing procedures shall include at least the necessary procedures, extent of inspection and testing, reporting requirements, testers' qualification requirements, and acceptance criteria.

417. The inspection plan shall present the hold points and witness points of STUK, a third party, the licensee and other parties.

418. The minimum scope of supervision by STUK, a third party and the licensee for engineered barriers is presented in Annexes A and B.

4.3.5 Information on the installation of an engineered barrier

419. For the installation of an engineered barrier, at least the following must be presented:

- a. a report of installation tests performed;
- b. information on the installation and a description of and procedures for installation methods;
- c. a description of and procedures for installation quality assurance and control;
- d. procedures for the inspections and tests of installation work; and
- e. a report and information on the organisation installing the barrier.

4.3.6 Inspection plan for the installation of an engineered barrier

420. In the inspection plan for the installation of an engineered barrier, at least the following must be presented:

- a. the procedures, phases and parties involved in the supervision of installation;
- b. inspections and tests of structures and components;
- c. the performer and supervisor of inspections and tests;
- d. reporting requirements for inspections and tests;
- e. references to inspection and testing procedures; and
- f. references to drawings.

421. The inspection and testing procedures shall include at least the necessary procedures, extent of inspection and testing, reporting requirements, qualification requirements and acceptance criteria.

422. The inspection plan shall present the hold points and witness points of STUK, the licensee and other parties.

423. The minimum scope of supervision by STUK, the licensee and other parties for engineered barriers is presented in Annexes A and B.

4.4 General inspection plan for concrete and rock construction

424. General inspection plans shall be prepared for concrete and rock construction. The general inspection plans shall be prepared for safety-classified systems and structures, and facilities and parts of rock tunnels in class EYT/STUK, when they can have long-term safety significance for actual emplacement rooms.

425. The general inspection plan shall present the hold points and witness points of STUK, the licensee and other parties.

426. The minimum scope of supervision by STUK and the licensee for rock construction is presented in Annex C.

4.5 Result and realisation documentation

427. The supervision, inspection and testing measures required by the design documents and the quality, inspection and testing plans shall be verifiable.

428. The licensee shall ensure that the realisations of manufacture, installation and construction and the prepared testing, inspection and monitoring documents are compiled into result documentation.

429. Within the scope of the design documents and quality plans, the certificates for construction materials and welding consumables, the staff qualification certificates, the non-conformity reports processed and other records created during manufacture, installation, construction, control and testing shall be appended to the result documentation.

430. The result documentation shall contain the documentation on any deviations and repairs.

431. The result and realisation documentation shall be systematically compiled, and the documentation shall be clearly presented.

432. The licensee shall assess, inspect and approve the result and realisation documentation before presenting them to STUK.

433. The result and realisation documentation shall be saved and archived until the duty of care of the licensee ends. The information shall be sufficient for any post-analyses and comparisons.

5 Disposal canister

5.1 Materials

501. The approval of testing organisations that test materials is addressed in Guide YVL E.12.

5.2 Organisation

502. The manufacturer shall maintain a list of the persons who are authorised to transfer material identification markings.

503. The quality management system used by a manufacturer performing the welding of disposal canisters in safety classes 2 and 3 shall take into account the requirements of standard SFS-EN ISO 3834-2. A manufacturer performing heat treatment in connection with welding and related processes shall observe the requirements of standard SFS-EN ISO 17663.

504. Persons performing the closure (permanent joints) of disposal canisters (welding operators) shall be qualified under the supervision of a authorised third-party supervisor.

505. Personnel engaged in the heat treatment of a structure shall have the proper training and instructions for the task. In heat treatment, the requirements of the quality management standard that serves as the basis of the manufacturer's approval shall apply.

5.3 Design and design documents

506. Structural design of the disposal canister shall be performed on the basis of the calculation formulae presented in the standards and/or strength analyses.

507. Strength analyses shall be required whenever the standards do not provide dimensioning instructions due to unusual materials, loadings or structural configuration.

508. The design of the disposal canister and the location and shaping of welds shall ensure that manufacture inspections are technically feasible.

509. The disposal canister shall be so designed that the criticality safety of the spent nuclear fuel deposited in the canister is ensured in accordance with Section 32(3) of Regulation STUK Y/4/2016 and Guides YVL D.5 and YVL B.4.

510. The identification markings of the disposal canister required under Guide YVL D.1 shall not endanger the long-term performance of the disposal canister.

511. The construction plan of the disposal canister shall present at least

a. the YVL Guides and standards applied, and justification for any deviations;

- b. the safety classification and identification markings of system;
- c. a summary by the design organisation of how the design bases are met;
- d. the design of the release barrier (including necessary calculations);
- e. the materials used and the procedures for the related inspections and tests;
- f. the construction and manufacturing drawings and other data describing the plan for manufacture;
- g. information on the organisations related to manufacture according to the requirements of Guides YVL A.3 and YVL E.3;
- h. information on manufacture and installation and their supervision and inspections;
- i. manufacturing procedures and procedure test results; and
- j. information on the third party that supervises the manufacture, testing and qualification.

512. The construction drawings of the disposal canister shall present at least

- a. main dimensions;
- b. safety classes and their boundaries;
- c. parts lists;
- d. dimensions of parts; and
- e. locations, sizes, groove and joint types of welds.

513. In construction drawings, the welding symbols shall be presented in accordance with standard SFS-EN ISO 2553.

514. The disposal canister manufacturing drawings and their parts lists shall present at least the following:

- a. main dimensions;
- b. safety classes and their boundaries;
- c. assembly and subassembly information with references to drawings;
- d. dimensions, tolerances, surface quality requirements and material information required for the manufacture of non-standardised components, separately for each part;
- e. locations, sizes, and groove types of welds and weld-specific references to welding procedures;
- f. nominal sizes of standardised components;
- g. reference to the inspection plan and/or inspection and testing standards and procedures;
- h. tolerances required by the installation.

515. The manufacturing drawings of the disposal canister shall be based on dimensioning calculations and/or strength analysis.

5.4 Manufacture

516. The structures and components of the disposal canister shall be marked with identifiers. Using identifiers, the material batch and manufacturing date and method of each structure and component shall be traceable. The manufacture of the disposal canister shall take into account para. 357 of Guide YVL D.1 and the fact that identification markings shall not endanger the long-term safety functions (of the canister).

517. The manufacturer-specific welding procedures, heat treatment procedures and hot forming procedures for the manufacture of the disposal canister in safety classes 2 and 3 shall be qualified by procedure tests carried out prior to manufacture.

518. In safety classes 2 and 3, the procedure test shall be conducted under the supervision of a authorised third-party supervisor.

519. To supplement the welding procedure test and to verify the mechanical properties, the manufacturer shall, if necessary, conduct production welding tests using parameters corresponding to the welding work. The requirement level for the procedure tests and production tests shall be one which complies with the applicable design standard.

520. If the metal structure of the disposal canister in safety classes 2 and 3 is heat treated, a report on heat treatment shall be drawn up showing at least the identification data relating to the structure heat treated, parameters used in heat treatment and the procedure concerning heat treatment.

521. Whenever special processes are used in the manufacture of the disposal canister, the licensee shall apply for STUK's approval for the manufacturer and subcontractors separately for each location. Requirements for special processes are presented in Chapters 4.2.1–4.2.6 of Guide YVL E.3.

5.5 Inspections performed by the licensee

522. The conformity to requirements of the manufacture of the disposal canister shall be affirmed separately for each component and disposal canister in accordance with the inspection plan.

523. The construction inspection of the manufacture of the disposal canister shall demonstrate that the disposal canister meets the requirements and that

- a. the main dimensions of the product conform to the manufacturing drawings;
- b. the material can be identified and verified as conforming to the approved construction plan;

- c. the product has not been damaged during manufacture;
- d. the traceability of weld joints and non-destructive testing can be verified;
- e. the weld joints meet the requirements laid down in the construction plan; and
- f. there are no shape deviations in the structure.

524. The construction inspection of the installation of the disposal canister shall demonstrate that the disposal canister has been installed into the deposition hole according to the requirements. The conformity to requirements shall be affirmed separately for each disposal canister.

5.6 Result documentation of manufacture and installation

525. The result documentation of the manufacture and quality control of the disposal canister shall demonstrate that

- a. the manufacturer has been approved;
- b. the testing organisations conducting destructive and non-destructive testing have been approved;
- c. the NDT testers have the required qualifications;
- d. a third party meeting the requirements has acted as the organisation witnessing and verifying material certificate type 3.2 sampling and testing, and supervising the welding filler material tests and their testing as well as qualifications;
- e. the manufacturing procedures have been qualified under the supervision of a authorised third party;
- f. the structure or component has been manufactured, tested and inspected in accordance with the construction plan and the conditions relating to manufacture;
- g. the materials and welding consumables used have been selected and tested as required in the construction plan, the results have been validated by means of conforming material certificates, and the results of materials testing fulfil the requirements of the material standard and the construction plan;
- h. personnel engaged in making permanent joints have a valid qualification meeting the requirements, and the joints have been made following the instructions given in the approved construction plan;
- i. the construction plan and instructions in the relevant standards have been complied with in any heat treatment process and in its monitoring;
- j. the supervision of the manufacturing or installation process by the manufacturer, licensee and any third party has been conducted as required under the approved inspection plan and this

Guide;

- k. deviations have been processed and approved; and
- l. according to visual inspection, the canister meets the requirements.

526. The result documentation of the installation and quality control of the disposal canister shall demonstrate that

- a. the canister has been installed according to the plan and the requirements for installation;
- b. the supervision of the installation process has been conducted as required under the approved inspection programme and this Guide; and
- c. deviations have been processed and approved.

5.7 Testing organisation in the supervision of the disposal canister

527. When required, the licensee shall ensure that testing organisations have been approved under Guide YVL E.12.

528. When a testing organisation is approved by STUK, the construction plan shall make a reference to STUK's decisions concerning the approval of the testing organisation, with its period of validity.

529. If the testing organisation has been approved based on accreditation, and without a separate application, the construction plan shall refer to the certificate of accreditation submitted to STUK for information and its covering letter.

5.8 Third party in the supervision of the disposal canister

530. A notified body pursuant to the Pressure Equipment Directive or an authorised third party within the scope of its area of qualification may act as a third party.

531. Within the scope of the inspection plan, an independent third party shall oversee manufacturing, including welding, working, non-destructive testing and heat treatment. A report on the competence of such a third party shall be presented in the construction plan of the canister.

532. Within the scope of the inspection plan, a third party shall:

- a. witness the sampling, stamp transfer and destructive testing of materials and confirm the results with a certificate of type 3.2 under standard SFS-EN 10204;
- b. oversee and confirm procedure and personnel qualifications;
- c. oversee and confirm the manufacturing of the canister, including welding, working and non-destructive testing.

When performing supervision, the third party shall see the material before the removal of the samples to be tested and ensure the traceability of the samples to the product either by stamping or by other applicable methods. The supervisor shall be present in the testing event that he/she supervises.

533. The same third party organisation shall oversee the inspection and testing complex relating to the testing of a certain material or the qualification of a method or person, and confirm this complex with a certificate.

534. A third party shall be independent of the other parties involved in the activities in question. A third party may not be the designer, manufacturer, supplier, orderer or owner of the equipment it supervises or a representative or someone in the employ of such a party. A third party may not participate in other activity that compromises the independence or impartiality of its inspection operations or decisions.

535. The organisational role of someone representing a third party shall be such that any other functions of the organisation cannot influence his or her decisions.

6 Clay-based release barriers

6.1 Materials

601. The licensee shall have systematic procedures in place for marking clay-based material batches and components or component batches made of them with traceable identifiers, and for material monitoring and usage location documenting taking place at the disposal facility. The identification may be component-specific or component batch-specific depending on the safety significance of the structure or components and the number and size of supply batches and components.

6.2 Design and design documents

602. For the structural plan of a clay-based engineered barrier, at least the following must be presented:

- a. the YVL Guides and standards applied, and justification for any deviations;
- b. safety classification;
- c. a general summary by the design organisation of how the design bases are met;
- d. the design of the barrier (including necessary calculations);
- e. the materials used and the procedures for the related inspections and tests;
- f. construction drawings and manufacturing drawings;
- g. information on the organisations related to manufacture according to the requirements of Guide YVL A.3;
- h. information and procedures concerning manufacture and installation and their supervision and inspections; and
- i. manufacturing procedures and procedure test results.

603. The construction drawings shall describe at least the following:

- a. main dimensions;
- b. safety classes and their limits;
- c. part lists and materials; and
- d. part dimension information.

604. The manufacturing drawings and their parts lists shall present at least the following:

- a. main dimensions;
- b. safety classes and their limits;
- c. assembly and subassembly information with references to drawings;
- d. dimensions, tolerances, surface quality requirements and material information required for

the manufacture of non-standardised parts, separately for each part;

e. nominal sizes of clay-based components (blocks);

f. reference to the inspection plan and/or inspection and testing standards and procedures;

g. tolerances required by the installation.

605. The theoretical calculated estimate for the use of clay-based materials or components required to ensure performance of each release barrier shall be presented as part of the design documents. The estimate may be expressed as a quantity of pieces, mass or volume.

6.3 Inspections by the licensee

606. The inspections and supervision of manufacture shall be carried out according to the approved plan.

607. The licensee shall supervise the installation of components of clay-based release barriers and after all phases, affirm the conformity to requirements of the barrier complex manufactured by installation.

608. For the buffer, the conformity to requirements of the installation shall be affirmed separately for each disposal hole and, if necessary, for each phase or component.

609. The conformity to requirements of the backfill shall be affirmed in accordance with the inspection plan.

6.4 Result documentation of manufacture and installation

610. The result documentation of the manufacture of clay-based release barriers shall demonstrate that

a. the manufacturer has been approved as part of approving the construction plan;

b. the testing organisations conducting destructive and non-destructive testing have been approved in the way and with the requirements presented by the licensee in the construction plan;

c. the structure or component has been manufactured, tested and inspected in accordance with the requirements of the construction plan;

d. the materials used have been selected and tested as required in the construction plan, the results have been validated by means of conforming material certificates, and the results of materials testing fulfil the requirements of the construction plan; and

e. the control of manufacturing performed by the manufacturer and the licensee has been conducted as required by the approved inspection programme and this Guide.

611. The result documentation of the installation of clay-based release barriers shall demonstrate that

- a. the structure or component has been installed and inspected in accordance with the requirements;
- b. the installed quantity of pieces, mass or volume corresponds to the calculated quantity of pieces, mass or volume.

7 Concrete barriers or parts of barriers

701. With the specifications or exceptions mentioned in Chapters 7, 9 and 10 of this Guide (YVL D.7), Guide YVL E.6 is applied to concrete or reinforced concrete barriers or their structures remaining permanently in the disposal facility.

7.1 Requirement specification

702. For requirement specification, paras. 301 and 303 of Guide YVL E.6 are applied with the following additions:

- a. If the operation of the structure requires watertightness and integrity of the structure, requirements shall be presented for these properties.
- b. The requirement specification shall present special requirements for materials.
- c. The requirement specification shall present criteria for the placement of concrete barriers.
- d. Deviations from standards shall be processed in accordance with para. 338 of Guide YVL B.1.

7.2 Materials

703. In concrete materials and in the design of the composition and properties of concrete, the following requirements resulting from ensuring the long-term safety of disposal shall be taken into account:

- a. preservability for the service life set by the licensee under prevailing and anticipated conditions and stresses;
- b. the chemical composition of water in contact with concrete and its effect on environmental conditions; and
- c. compatibility with other engineered barriers.

704. If the acceptability of concrete, cement or admixtures for construction cannot be demonstrated with a CE marking based on the European harmonised product standard or no European Technical Approval (ETA) has been granted to the product, acceptability can be demonstrated by using a national approval procedure, for example, a verification certificate, monitoring of manufacture or other national approval procedure.

705. The conformity to requirements of special concrete shall be demonstrated through standard and, if necessary, otherwise sufficient laboratory studies and test pieces.

7.3 Design and design documents

706. The design and placing of concrete barriers shall take into account their estimated interactions with other release barriers so that the operability targets set for long-term safety functions (of release barriers) are met.

707. The procedures for the inspections and tests performed on the materials of the structure shall be enclosed with the design documents of concrete barriers.

708. A monitoring plan shall be prepared for concrete barriers in order to verify the meeting of set objectives or requirements during the time that they are accessible.

7.4 Verification of the design solutions

709. Before production of safety-classified concrete barriers, the conformity to requirements and properties of the design shall be ensured with procedure tests and test structures.

8 Natural barrier and rock tunnels

8.1 Requirement specification

801. The requirements set for the positioning and construction of rock tunnels shall take into account the disturbance caused by the construction and use to the surrounding bedrock and groundwater.

8.2 Bedrock selected for disposal use

8.2.1 Rock surface mapping

802. The licensee shall have methods for geological and hydrogeological assessment of the excavated rock surfaces and the surrounding bedrock.

803. The data collected from rock surfaces and the surrounding bedrock and the assessments of the data shall produce material for the design of rock engineering structures and the suitability analysis to be performed on the disposal facilities.

804. Materials shall be collected from the rock surfaces of excavated facilities before covering the surfaces. Rock surfaces that need to be covered immediately for occupational safety reasons may be documented in accordance with a procedure separately defined by the licensee.

8.2.2 Suitability assessment of bedrock

805. When designing and constructing rock tunnels for a disposal facility, the licensee shall define and classify the fractures, zones and properties of the surrounding bedrock that may have significance for long-term safety.

806. In the assessment of the suitability of the bedrock, at least the following possibly significant factors for long-term safety shall be taken into account:

- a. geological discontinuity zones and fractures and sufficient distances to these;
- b. water-conducting zones and fractures in the rock and the estimated hydrogeological disturbance during construction;
- c. properties of bedrock groundwater and disturbance to planned and implemented emplacement rooms caused by construction;
- d. rock mechanical and thermal properties and any changes to them caused by the construction of rock tunnels; and
- e. other special requirements set for installing engineered barriers and achieving long-term

performance targets.

807. The assessment of the applicability of the rock shall be based on different mutually complementary investigations.

808. The applicability of the bedrock to disposal use shall be assessed in phases, taking into account the safety significance. The assessment of applicability shall be started before the excavation of the facilities, and the assessment shall be specified as the construction progresses.

809. The assessment methods and procedures for the applicability of bedrock shall be developed based on the safety case and gained experiences.

810. Rock suitability analyses with input data shall be available for design and construction in a timely manner.

811. The licensee shall inspect and approve the bedrock models prepared for the assessment of applicability before they are used as input data for the design and construction of rock tunnels.

8.3 Rock engineering design

812. The design of the construction and use of rock tunnels for the disposal facility shall aim at maintaining rock characteristics favourable to long-term safety. For this purpose, rock construction methods and materials that restrict disturbance or changes caused by construction in the bedrock surrounding the disposal facility shall be used in tunneling as well as practically possible.

813. The rock tunnels in the disposal facility shall be positioned in rock volumes that meet the suitability criteria of bedrock. Changing the positioning of the facilities shall be prepared for if the quality of the bedrock proves unfavourable based on research, models or suitability analysis.

814. Disposal operations at the disposal facility and the transport of excavated rock, backfilling materials and heavy machinery shall be appropriately separated. Rock collapses, deformations or displacements shall be prevented by appropriate rock construction methods and by keeping excavation work sufficiently far away from facilities in disposal use.

815. Reinforcement and grouting of rock shall be done so that the amounts of substances detrimental to the performance of release barriers that enter the waste emplacement rooms are as small as practically possible.

816. The serviceability, repairability and replaceability of structures or components susceptible to wear, aging or damage shall be taken into account in the design phase.

817. For structures intended to be disassembled (for example, waterproofing or reinforcement structures), the disassembly and removal shall be demonstrated to be possible before implementation of the structure. Plans shall be prepared for the disassembly and removal of these structures.

818. The suitability analysis of a rock tunnels to be constructed shall be made before the approval of implementation design documents and the start of the implementation of the facility in question.

8.4 Materials

819. The licensee shall have procedures in place to approve and manage the substances and materials used in constructing and using rock tunnels and the amounts of these substances and materials.

820. The use of organic, oxidising and other potentially harmful substances in construction shall be restricted to be as low as practically possible. For harmful substances or materials, the use of a less harmful option for the performance of release barriers shall be preferred whenever practically possible.

821. Substances or materials used in construction or operation that are harmful for the performance of release barriers shall be removed before the closure of the facilities, taking into account occupational safety aspects. If such substance or material cannot be removed to a sufficient degree before the closure of the facilities, the effects of its use to the operation of release barriers shall be assessed before the use of the substance or material.

822. The acceptability of construction materials used in rock construction shall be demonstrated with a CE marking based on the European harmonised product standard or by using another national approval procedure approved by the Ministry of Environment.

8.5 Design documents for rock tunnels and rock engineering structures

823. The design documents of rock tunnels and rock engineering structures shall include at least the following reports or documents to be prepared divided mainly by rock tunnels.

- a. regulations, codes and standards applied;
- b. requirement specification;
- c. design service lives;
- d. input data;
- e. work instructions;
- f. dimensioning calculations (reinforcement and grouting);
- g. drawings, plans and work procedures supplementing these;
- h. quality assurance; and
- i. summary of justifications for safety class 3 rock caverns.

824. At least the following input data employed in the design of rock tunnels and rock engineering structures shall be given: up-to-date state and location drawings and geo-interpretation (geological and engineering geological mapping, rock quality mapping, mapping of the water-conductivity properties of bedrock and rock stress state interpretation), loads for reinforcement, groundwater pressure, stress categories according to groundwater chemical properties and materials.

825. For quality assurance, the control points and the control measures, inspections and tests to be performed for them shall be presented. For quality assurance measures and inspections, there shall be procedures presenting, among other things, the inspection item, method, scope and requirements as well as the performer and documentation of the measure.

8.6 Rock engineering implementation and realisation documentation

826. In safety-classified rock tunnels, rock construction shall be implemented using rock construction methods that are known or sufficiently pre-tested with procedure tests and that have been demonstrated to be able to reliably and repeatedly produce rock tunnels in accordance with the requirements.

827. It is not allowed to proceed to the work phase in which the rock surfaces and rock engineering structures are covered before the necessary inspections by the licensee and STUK in the previous phase, or the related intermediate inspections, have been performed.

828. Rock construction and its quality assurance shall be documented as as-built documentation. The documentation of the as-built shall be done in enough detail to unambiguously clarify the locations of completed excavations, rock reinforcements and groutings, the materials and quantities used and the quality assurance measures taken. The realisation documentation may include references to data such as other realisation records, taking into account the requirement that the whole realisation documentation shall be traceable.

8.7 Monitoring, managing and reporting disturbances and changes caused by construction

829. For the duration of construction and operation, the licensee shall have in place a monitoring programme (investigation and monitoring programme) under Guide YVL D.5 intended to ensure the suitability of the location and the rock to disposal and to collect information significant to safety concerning the bedrock and the performance of the release barriers. To implement this:

- a. The licensee shall have methods in place to implement the investigation and monitoring programme during construction and operation and to assess and manage the quality of its measurements.
- b. Limiting values shall be defined for the parameters to be monitored in order to estimate the magnitude, development speed and significance of the disturbance and change and the necessary actions. These limiting values and the actions linked to them shall have justified connections to the restriction of disturbance in the rock surrounding the rock tunnels and the groundwater contained in it.
- c. The monitoring results and the necessary actions shall be available for design and construction in a timely manner. The exceeding of limiting values requiring measures (action limits) shall be processed, and their significance to operation or long-term safety shall be assessed.
- d. Measurement data, observations and the exceeding of limiting values shall be documented.

830. The bedrock monitoring observations shall be collected at least every three months. The results shall be available within two months of the date of the last measurement observation to be included in the report.

831. The licensee shall prepare a plan of how to connect the monitoring of facilities to be excavated or constructed to the investigation and monitoring programme of the disposal site.

832. For the exceeding of limiting values that lasts for a long time (over a year) or develop quickly, indicating disturbance, the licensee shall prepare a plan of actions to bring the disturbance under control.

8.8 Inspections by the licensee

833. The licensee shall perform readiness inspections for all rock tunnel. The readiness inspections of rock tunnels shall be performed for entities no larger than those in the implementation design scope. A readiness inspection of rock caverns shall also be performed in demanding or exceptional local circumstances and for work operations for which STUK has, on the basis of the design documents or a readiness inspection of a rock tunnel, required the licensee to perform a separate target- or work operation-specific readiness inspection.

834. The construction of a rock tunnel in safety class 3 shall not be started before STUK has verified the prerequisites for starting construction. In rock tunnel of class EYT/STUK, the readiness inspection by the licensee is a prerequisite for starting construction. STUK may verify the prerequisites for starting construction of separately defined parts of EYT/STUK rock tunnels that are significant to long-term safety.

835. Inspections of the documentation of rock surfaces shall be performed for all rock tunnels in the disposal facility, and the inspections shall ensure that the rock surfaces and the surrounding bedrock have been characterised geologically and hydrogeologically according to the requirements and that the documentation corresponds to visual observations.

836. The conformity to requirements of the rock engineering structures in the rock tunnels shall be affirmed visually and with document inspections by comparing the constructed rock tunnel and rock engineering structures to the approved plans, as-built documentation and other requirements set for the rock cavern concerning, for example, the exceeding of limiting values of monitoring. The licensee shall define and implement the necessary inspections of components.

837. The licensee shall perform construction inspections of rock tunnels. In construction inspections of rock tunnels, it shall be affirmed that

- a. the documentation inspections of rock surfaces in the rock tunnel and the rock suitability classification have been performed in the planned extent;
- b. rock engineering structures in the rock tunnel have been inspected;
- c. deviations have been handled in an acceptable manner;
- d. the exceeding of action limits have been handled in an acceptable manner; and

e. quality assurance records have been inspected and approved.

838. If there is a significant delay between the construction inspection and the start of operation, during which the circumstances or the condition of the rock tunnel or its part might have changed, the conformity to requirements of the rock tunnel and its parts shall be inspected again before the start of nuclear operation.

9 Documents to be submitted to STUK

901. The delivery plan for the construction design documents shall be submitted to STUK for information. In the delivery plan, the licensee shall present a proposal for the documents to be delivered and their delivery times. STUK's processing times shall be taken into account in the delivery plan and in the deliveries.

902. The design documents of structures in class EYT shall be presented to STUK for information when they are closely related to the documents supplied for approval or information or they explain the documents supplied for approval or information. The deliveries are defined in more detail in the delivery plan for the construction design documents.

903. For changes significant to safety, the delivery method of the document is the same as that of the original document. Minor changes, such as editorial updates or changes of documents that do not affect safety, may be submitted for information.

9.1 Documents regarding the disposal canister

904. The design documents of the disposal canister and its structures in safety classes 2 and 3 that are in accordance with Chapters 4 and 5 of this Guide shall be submitted to STUK for approval.

905. The plans and criteria of procedure tests and the documents concerning the assessment of their results shall be submitted to STUK for approval.

906. The application concerning an organisation using a special process in the manufacture of the disposal canister shall be submitted for approval in accordance with Guide YVL E.3.

9.2 Documents concerning clay-based release barriers

907. The design documents of the clay-based engineered barriers and their structures and components in safety class 3 that are in accordance with Chapters 4 and 6 of this Guide shall be submitted to STUK for approval.

908. The plans and criteria of procedure tests and the documents concerning the assessment of their results shall be submitted to STUK for approval.

9.3 Documents concerning concrete barriers and concrete barrier parts

909. The construction technology plans for concrete barriers shall be supplied to STUK under Guide YVL E.6, in accordance with their safety classification and the related paras. 1007–1010, 1012 and 1013.

910. The plans and criteria of procedure tests and the documents concerning the assessment of their results shall be submitted to STUK for approval.

911. For special concrete,

a. the results of laboratory development work shall be submitted to STUK for information with the construction plan at the latest; and

b. the results of the concrete mixture approved and used for production shall be submitted to STUK for information during the readiness inspection of concrete work at the latest.

912. The as-built drawings or 3D realisation models regarding concrete barriers shall be submitted to STUK for information. STUK shall have the opportunity to check other as-built documentation electronically or at the site.

913. The general inspection plan of concrete structures shall be submitted to STUK for information.

914. The monitoring plan of concrete barriers for separately selected concrete barriers shall be submitted to STUK for information.

9.4 Documents regarding the rock tunnels

915. The main drawings of architectural design shall be submitted to STUK for approval, and the updated main drawings shall be submitted for approval when changes are made that

a. affect the positioning of rock tunnels in the disposal facility; or

b. affect operational or long-term safety.

916. The as-built documentation of architectural design shall be submitted to STUK for information.

917. For rock tunnels in safety class 3, design documents shall be submitted to STUK for approval, indicating what rock engineering work the licensee is planning to do in the rock tunnel to be constructed and demonstrating that the licensee has met the requirements of Guides YVL D.5 and YVL D.7. These requirements include at least

a. a work description and type designs of excavation, reinforcement and grouting with location drawings;

- b. excavation, reinforcement and grouting plans in places demanding for operational or long-term safety; and
- c. a summary of justifications.

918. For rock tunnels in safety class 3, at least the following shall be submitted to STUK for information:

- a. geo-interpretations affecting rock engineering design as illustrative 2D and 3D presentations;
- b. rock suitability assessments;
- c. dimensioning calculations for reinforcement and grouting; and
- d. design documents for excavation, reinforcement and grouting that are closely related to the type and special plans for rock tunnel systems in order to assess the entirety of the plan.

919. For rock tunnels in class EYT/STUK, design documents shall be submitted to STUK for information, indicating what rock engineering work the licensee is planning to do in the rock tunnel to be constructed and demonstrating that the licensee has met the requirements of Guides YVL D.5 and YVL D.7. These requirements include at least

- a. a work description and type and special designs of excavation, reinforcement and sealing with location drawings;
- b. design documents for excavation, reinforcement and grouting that are closely related to the type and special plans for rock tunnel systems in order to assess the entirety of the plan and that the licensee uses to demonstrate the compliance with safety requirements in accordance with the YVL Guides and the design requirements of the licensee; and
- c. geo-interpretations affecting rock engineering design as illustrative 2D and 3D presentations.

920. For rock engineering design documents, changes due to positioning changes or affecting long-term safety shall be submitted to STUK in the way required by the delivery method of the original document.

921. The plans and criteria of procedure tests and the documents concerning the assessment of their results shall be submitted to STUK for information.

922. Rock engineering as-built documentation (excavation, reinforcement and grouting realisation drawings or 3D realisation models) for all rock tunnels shall be submitted to STUK for information. Other realisation documentation shall be available for viewing electronically or alternatively at the site.

923. The general inspection plan of rock tunnels shall be submitted to STUK for information.

924. The monitoring plan of bedrock shall be submitted to STUK for information.

925. The annual reports of bedrock monitoring with observations processed and analysed shall be submitted to STUK for information by the end of July of the year following the year of observation.

9.5 Monthly construction report

926. In the monthly construction report under Guide YVL A.5, the licensee shall also report

- a. the situation in the development work of release barriers and a summary of the main results;
- b. the exceeding of action limits for bedrock monitoring; and
- c. deviations of safety-classified systems, structures and components.

9.6 Deviations

927. According to para. 371 of Guide YVL A.5, reports concerning significant deviations for nuclear or radiation safety (in this context, operational and long-term safety) shall be submitted to STUK for approval.

9.7 Exceeding of action limits for monitoring

928. The report of a long-term (lasting over a year) or quickly developing exceeding of an action limit and the plan for managing the exceeding shall be submitted to STUK for information.

10 Regulatory oversight by the Radiation and Nuclear Safety Authority

10.1 Processing the requirement specification

1001. STUK shall process the requirements set by the licensee for release barriers by assessing the requirement specifications.

1002. The meeting of the set requirements shall be verified in connection with document reviews and inspections, and as part of the Construction Inspection Programme and Operation Inspection Programme.

10.2 Approval of organisations

1003. STUK shall approve the manufacturers that use special processes in the manufacturing of the disposal canister by a separate decision upon the issuance of an application.

1004. STUK shall evaluate the acceptability of manufacturers that do not employ special processes on the basis of a manufacturer information included in the construction plan.

1005. STUK shall evaluate the acceptability of installation organisations on the basis of an information included in the construction plan.

1006. STUK shall evaluate the expertise of a third party performing manufacturing control on the basis of an information appended to the construction plan.

1007. The approval procedure for inspection organisations is presented in Guide YVL E.1 and the approval procedure for testing organisations in Guide YVL E.12.

10.3 Design document review

1008. STUK shall review the design documents. In safety class 2, the approval of the plan is a prerequisite for the commencement of manufacture or installation as per the plan. In safety class 3, the approval of the plan is a prerequisite for the commencement of manufacture, installation or construction if the work is not reversible.

1009. If a release barrier, structure or component is designed to be constructed in the same form several times, STUK may process the construction plan as a type plan. Changes to the type plan shall be assessed according to procedures for plan changes.

1010. Changes affecting safety shall be processed at STUK as required by the original delivery method. Minor updates to plans approved by STUK may be processed as received for information.

10.4 Monitoring and inspections of engineered barriers

10.4.1 Readiness inspection for the serial production of structures and components of clay-based release barriers

1011. STUK shall perform a readiness inspection for the serial production of structures and components of safety-classified clay-based release barriers before the commencement of manufacture. The inspection ensures the prerequisites for starting serial production according to the requirements of Guide YVL D.7.

1012. STUK shall perform the readiness inspection for the serial production of structures and components of safety-classified clay-based release barriers again if

- a. manufacturing is performed with a new construction plan or manufacturing plan;
- b. serial production begins again after a long break;
- c. the manufacturer changes;
- d. the manufacturing place changes; or
- e. the manufacturing process changes.

10.4.2 Control of manufacturing, and construction inspection

1013. STUK monitors the manufacture of safety-classified engineered barriers with construction inspection, intermediate inspections or separate visits.

1014. STUK performs the construction inspections of the manufacture of the canister and the related intermediate inspections for each structure and component.

1015. STUK performs the construction inspections for the components of clay-based release barriers and the related intermediate inspections at its discretion in accordance with Annex B.

1016. In the manufacture construction inspection or intermediate inspection, STUK shall affirm that

- a. the licensee has established the conformity to requirements of the release barrier or its structure or component;
- b. the result documentation has been compiled and inspected acceptably;
- c. deviations have been processed acceptably;
- d. identification markings are compliant with the requirements;
- e. the main dimensions of the product conform to the construction drawings;
- f. the material can be identified and verified as conforming to the approved construction plan;
- g. the product has not been damaged;

- h. there are no abnormalities in the structure's geometry;
- i. for the disposal canister, the traceability of weld joints and non-destructive testing can be verified; and
- j. for the disposal canister, the weld joints meet the requirements laid down in the construction plan.

1017. The prerequisite for the approval of the construction inspection is the approval of all required intermediate inspections.

1018. If necessary, STUK may perform a dimensional inspection. STUK may take samples of materials and components and have reference tests made of them.

10.4.3 Installation construction inspection

1019. STUK will conduct installation construction inspections and related intermediate inspections for safety-classified engineered barriers.

1020. In the construction inspection of the installation, STUK will affirm that

- a. the licensee has established that the release barrier conforms to the requirements and the structure has been installed in accordance with the plan;
- b. the organisation performing the installation work has been approved in accordance with this Guide;
- c. the result documentation has been compiled and inspected acceptably;
- d. deviations have been processed acceptably;
- e. based on visual assessment and measurements, the release barrier, its structure or the barrier complex has been installed according to the requirements.

1021. For disposal canisters and the buffer, the conformity to requirements shall be affirmed separately for each disposal hole.

1022. The conformity to requirements of the backfill shall at least be affirmed separately for each deposition tunnel and separately for each deposition hole distance at the most. The inspection interval shall be specified separately for each disposal tunnel based on the circumstances.

10.4.4 Readiness inspection of the concreting of concrete barriers

1023. STUK will perform readiness inspections of the concreting for each safety-classified concrete barrier or part of a concrete barrier.

10.4.5 Construction inspection of concrete barriers

1024. Intermediate construction inspections of concrete barriers are performed separately for each component or work stage, and a construction inspection is performed for each concrete barrier.

1025. In the construction inspection of a concrete barrier, STUK will inspect that

- a. the licensee has performed its own construction inspection;
- b. all inspection requirements of STUK's previous inspections have been processed in an acceptable manner;
- c. deviations have been handled in an acceptable manner;
- d. result and realisation documentation has been inspected and approved.

10.5 Monitoring and inspections of rock tunnels and rock engineering structures

10.5.1 Readiness inspection of a rock tunnel

1026. STUK will perform technical readiness inspections for all rock tunnels in safety class 3 and at its discretion for the parts of EYT/STUK rock tunnels whose implementation may affect the long-term safety of the disposal. The technical readiness inspection may be targeted at entities no larger than those in the implementation design entity scope. In the specification of the scope, the requirement specification of the facility to be excavated and the situation of the suitability analysis of the rock are taken into account.

1027. In the readiness inspection of the rock tunnel, STUK will inspect that

- a. the licensee has performed its own readiness inspection;
- b. all requirements of STUK's previous inspections and decisions related to the target have been processed in an acceptable manner; and
- c. the latest approved rock engineering design documents are used at the site.

1028. In connection with the inspection of design documents or the readiness inspection, STUK may specify the work stages during the implementation phase for which the licensee will be required to make separate readiness inspection requests to STUK. These work stages or targets may be parts of the rock tunnel that are estimated to be exceptionally demanding for long-term safety.

10.5.2 Structural inspection of the rock tunnel

1029. The construction inspection of rock tunnel collects STUK's intermediate inspections (rock surface documentation inspections and work- and technology-specific intermediate inspections of rock engineering structures) and establishes the conformity to requirements of the rock tunnel.

1030. The entity under construction inspection may correspond to the implementation planning scope in question at most, and it will be divided into a necessary number of intermediate inspections to be performed before proceeding to the covering work stage.

1031. STUK will perform inspections of the documentation of rock surfaces in safety class 3 by affirming the sufficiency and appropriateness of the inspection performed by the licensee in accordance with para. 835. The inspection will be performed as a document inspection and as a visual inspection at the target location.

1032. In technology- or work type-specific rock engineering intermediate inspections of rock tunnels in safety class 3, STUK will inspect using document inspections and as visual inspections of the target that:

- a. all inspections by the licensee have been performed in an acceptable manner;
- b. rock engineering structures in the area under inspection have been implemented in accordance with the design documents; and
- c. the as-built documentation corresponds to the visual observations.

1033. In the construction inspection of a rock tunnel in safety class 3, STUK inspects that

- a. the inspections of the documentations of rock engineering structures and rock surfaces included in the rock tunnel system have been acceptably performed;
- b. the suitability classification of the rock has been performed, and the rock volumes suitable for disposal have been defined;
- c. the exceeding of limiting values giving rise to action has been processed and approved;
- d. deviations have been handled in an acceptable manner;
- e. quality assurance records have been inspected and approved.

1034. In rock tunnels in class EYT/STUK, STUK may perform inspections in accordance with paras. 1031–1033 at its discretion in exceptional circumstances or special areas.

10.5.3 Monitoring

1035. As part of the Construction Inspection Programme and Operation Inspection Programme, STUK oversees that monitoring and its different areas are implemented in accordance with the monitoring programme.

10.6 Condition monitoring and maintenance

1036. With regard to the disposal facility, STUK oversees in particular that the condition of structures affecting operational and long-term safety are monitored and maintained as planned.

10.7 Modification work

1037. STUK oversees the modification work on the disposal facility and its systems and structures. The inspections and monitoring are performed similarly to the monitoring of the original system or structure.

10.8 Other oversight by the Radiation and Nuclear Safety Authority

1038. In addition to the inspections mentioned in Chapter 10 of this Guide, STUK oversees the construction and operation of the facility in accordance with Guide YVL A.1 by means of separate inspection programmes and unannounced inspections.

1039. STUK also oversees the construction and operation of the disposal facility by means of on-site monitoring visits.

11 ANNEX A Minimum scope of supervision by STUK, a third party and the licensee for the disposal canister in each safety class

Action target	Safety class	STUK	Third party	Licensee
Auditing/assessment of the manufacturer's operations	2	H	-	H
	3	W	-	H
Auditing of material manufacturer's quality management system	2	W	-	H
	3	W	-	H
Conditions for manufacture • approval of manufacturers and subcontractors as well as NDT and DT testing organisations • approval of the construction plan	2	H	-	H
	3	H	-	H
Qualifications of methods • manufacturing methods (closure of the canister, hot forming)	2	W	H	W
	3	-	H	W
Qualifications of personnel • personnel (welding, NDT)	2	-	H	W
	3	-	H	W
Control of material tests and sampling¹⁾ • control of materials research; tensile, bending and impact tests	2	W	H	H
	3	W	-	W
NDT control • materials NDT and structure and component manufacture NDT	2	W	H	W
	3	W	-	W
Control of manufacturing¹⁾ • manufacture of structures and components and closure of the disposal canister	2	W	H	W
	3	W	-	W
Production tests	2	W	H	W
	3	W	-	W
Construction inspection and installation construction inspection • inspection of manufacturing documentation and structure • inspection of installation documentation	2	H	-	H
	3	H	-	H

1) Targets are defined in more detail in the licensee's specifications and plans.

H = Hold point. Hold point shall refer to an inspection for which advance invitations have been sent to the parties defined in the inspection plan and whose supervision is a condition for proceeding with the work unless the parties have given written permission to proceed without their presence.

W = Witness point. Witness point shall refer to an inspection for which advance invitations have been sent to the parties defined in the inspection plan but whose supervision is not a condition for proceeding with the work.

Having received the invitation, the invited parties may, however, separately require that they be present in order for the work to be continued.

12 ANNEX B Minimum scope of supervision by STUK and the licensee for clay-based engineered barriers and their components in safety class SC3

Action target	Safety class	STUK	Licensee
Auditing/assessment of the manufacturer's operations • blocks and pellets	3	W	H
Assessment of the operation of the supplier of buffer and filling material • raw material	3	W	H
Manufacturing requirements (including installation and modifications) • approval of manufacturers and subcontractors as well as testing organisations • approval of the construction plan	3	H	H
Qualifications of methods • manufacturing methods	3	W	H
Control of material tests and sampling¹⁾ • control of material studies • testing of buffer and filling materials	3	W	H
Control of manufacturing¹⁾ • production tests	3	W	H
Readiness inspection • components, manufacture • installation, verification	3	H	H
Construction inspection • random inspection of the serial production of components • inspection of the manufacturing documentation	3	W	H
Installation construction inspection²⁾ • inspection of installation documentation • inspection of complete structure and final documentation	3	H	W/H

1) Targets and the scope are defined in more detail in the licensee's specifications and plans.

2) The scope of the installation construction inspection concerning different systems and parts of structure is defined in more detail in the licensee's specifications and plans (buffer, backfill).

H = Hold point. Hold point shall refer to an inspection for which advance invitations have been sent to the parties defined in the inspection plan and whose supervision is a condition for proceeding with the work unless the parties have given written permission to proceed without their presence.

W = Witness point. Witness point shall refer to an inspection for which advance invitations have been sent to the parties defined in the inspection plan but whose supervision is not a condition for proceeding with the work. Having received the invitation, the invited parties may, however, separately require that they be present in order for the work to be continued.

13 ANNEX C Minimum scope of supervision by STUK and the licensee for rock caverns and rock engineering structures

Action target	Safety class of rock cavern	STUK	Licensee
Reception inspection • materials entering the construction site	3	-	W
Readiness inspection¹⁾	3	H	H
	EYT/STUK	³⁾	H
(Intermediate) inspection of the documentation of rock surfaces			
• wall surfaces	3	H	H
• floor	3	H	H
• wall surfaces	EYT/STUK	W ³⁾	H
• floor	EYT/STUK	W ³⁾	H
Work- and technology-specific (intermediate) inspection of rock engineering structures²⁾			
• excavation	3	H	H
• sealing/grouting	3	H	H
• reinforcement	3	H	H
• excavation	EYT/STUK	³⁾	H
• sealing/grouting	EYT/STUK	³⁾	H
• reinforcement	EYT/STUK	³⁾	H
Construction inspection of a rock tunnel or its part	3	H	H
	EYT/STUK	³⁾	H

1) Aggregates are defined in more detail target-specifically. In class EYT/STUK rock tunnels or spaces, STUK may perform target-specific readiness inspections if a part of the space has a special significance for long-term safety.

2) STUK's inspections cover the structures; the licensee is responsible for component inspections (see definitions).

3) By notification, STUK may focus the inspection to a part of a rock tunnel that is significant to safety.

H = Hold point. Hold point shall refer to an inspection for which advance invitations have been sent to the parties defined in the inspection plan and whose supervision is a condition for proceeding with the work unless the parties have given written permission to proceed without their presence.

W = Witness point. Witness point shall refer to an inspection for which advance invitations have been sent to the parties defined in the inspection plan but whose supervision is not a condition for proceeding with the work. Having received the invitation, the invited parties may, however, separately require that they be present in order for the work to be continued.

14 References

1. Nuclear Energy Act (990/1987).
2. Radiation Act (592/1991).
3. Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2016).
4. SFS-EN 10204 Metallic products. Types of inspection documents.
5. SFS-EN ISO 3834-2, Quality requirements for fusion welding of metallic materials. Part 2: Comprehensive quality requirements.
6. SFS-EN ISO 17663, Welding. Quality requirements for heat treatment in connection with welding and allied processes.
7. SFS-EN ISO 2553, Welding and allied processes. Symbolic representation on drawings.

Definitions

Special process

Special processes shall refer to manufacturing processes, the results of which cannot be directly verified by means of a product inspection or testing after manufacture; instead, any shortcomings in the process may only appear later while the product is in use. Special processes include, for instance welding, forming and heat treatment.

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.

Third party

Third party shall refer to an individual or organisation that is independent of the individuals or organisations responsible for the design, manufacturing, supply, installation, procurement, ownership, operation or servicing of the item analysed.

Disposal system

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

Final disposal canister

Final disposal canister shall refer to a hermetic, corrosion resistant and mechanically strong container where spent nuclear fuel is enclosed.

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)

Natural release barrier

Natural release barrier comprise of bedrock and groundwater around disposal facility.

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.

Design basis

Design bases shall refer to all requirements, definitions and bases for normal operational conditions and accidents that pertain to the design and operation of a plant, system and component. (Nuclear Energy Decree, 161/1988)

Testing organisation

Testing organisation shall refer to an organisation performing testing activities requiring special competence. (Nuclear Energy Act 990/1987)

Barrier

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

Nuclear waste facility

Nuclear waste facility shall refer to a nuclear facility utilised 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; however, nuclear facility shall not refer to permanently closed facilities where nuclear waste has been placed in a manner approved as permanent by the Radiation and Nuclear Safety Authority. (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 locations 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)