

Guide YVL E.6, Buildings and structures of a nuclear facility

1 Introduction

The YVL Guide update has been most influenced by the changes in the Land Use and Building Act and the guidelines and decrees of the Ministry of the Environment issued by virtue of them. The National Building Code of Finland has been updated since the previous YVL Guide update carried out in 2013. However, the update of the National Building Code of Finland has not influenced most of the requirements of Guide YVL E.6.

This Guide does not give further instructions on complying with Regulation STUK Y/1/2018, Sections 17 and 20 a and Regulation STUK Y/4/2018, Sections 20 and 24 a related to the decommissioning of nuclear facilities. If necessary, separate plant unit-specific instructions on complying with these regulatory requirements are given in accordance with the scope of Guide YVL E.6. As a rule, the dismantling of a nuclear facility's buildings and structures shall take place at a significantly later stage than the removal of the corresponding protected plant components and significant fire loads.

1.1 Legislation concerning construction products

The European Union regulations are directly applicable in the EU member states. An essential piece of legislation in the EU related to construction products is the Construction Products Regulation (EU) No 305/2011, which came fully into effect on 1 July 2013. The Construction Products Regulation has superseded the Construction Product Directive (89/106/EEC). Due to the regulation, CE marking has become obligatory when a construction product with a valid harmonised EN product standard or European Technical Approval is placed on the EU market.

For construction products with no defined European level harmonised product standard or European Technical Approval, a national approval procedure may be used. The new national approval procedures are based on the Act on the Type Approval of Certain Construction Products (954/2012), which the Ministry of the Environment has specified with decrees (e.g. 555/2013). There are three options for the national approval of construction products: type approval, verification certificate and verification of manufacture quality control.

The Ministry of the Environment has laid down the essential technical requirements for reinforcement bars and welded meshes in a decree (125/2016), and similar decrees are also being prepared for prestressing tendons. Decrees have been issued on the type approval of reinforcement steels and spiral reinforcements.

The Ministry of the Environment has issued assessment criteria of the verification certificate for certain product groups. Issued assessment criteria of the verification certificate that affect Guide YVL E.6 at the time of writing are the following (in Finnish):

- [Mechanical couplers of reinforcement bars](#)
- [Pile rock shoes and pile splices](#)

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- [Ready-mixed concrete](#)
- [Liquid vessel elements, mass concrete slab elements and other mass concrete elements](#) (pdf)
- [Lightweight concrete elements](#) (pdf)
- [Stair product systems](#) (pdf)
- [Fire protection products and accessories](#)
- [Roof bollards, fire ladders, snow barriers and horizontal roof safety rails](#) (pdf)

The list is supplemented as the work of the Ministry of the Environment progresses.

1.2 The Land Use and Building Act and the National Building Code of Finland

Several changes have been made to the Land Use and Building Act (132/1999) concerning construction plans, designers, design task competence classes, designer acceptability requirements and building supervision requirements. The Government and the Ministry of the Environment have specified the Act with several decrees:

- Government Decree on the Determination of Difficulty Classes of Building Design Tasks (214/2015)
- Land Use and Building Decree (895/1999)
- Decree of the Ministry of the Environment on Plans and Reports Concerning Construction (216/2015)
- Ministry of the Environment guidelines on the difficulty classes of design tasks (YM1/601/2015)
- Ministry of the Environment guidelines on the qualification of building designers (YM2/601/2015)
- Ministry of the Environment guideline on plans and studies concerning building (YM3/601/2015)
- Ministry of the Environment guideline on the difficulty categories of building management tasks and qualifications of building managers (YM4/601/2015)
- Ministry of the Environment guideline on the performance and supervision of construction work (YM5/601/2015)
- Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)
- Decree of the Ministry of the Environment on Foundation Structures (465/2014).

The Ministry of the Environment has renewed the National Building Code. The following guidelines of the National Building Code of Finland have been taken into account in the update of Guide YVL E.6:

- Strength and stability of structures, Basis of structural design for load-bearing structures, regulations and instructions, 2016
- Strength and stability of structures, Actions on structures, regulations and instructions, 2016
- Strength and stability of structures, Concrete structures, instructions, 2016
- Strength and stability of structures, Steel structures, instructions, 2016
- Strength and stability of structures, Composite steel and concrete structures, instructions, 2016

The essential standards referred to in the National Building Code of Finland are SFS-EN 1990, 1991, 1992, 1993 and 1994.

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2 Scope of application

In accordance with Guide YVL E.6, STUK supervises the design, manufacture and use of steel, concrete and composite structures of nuclear facilities that are important in terms of nuclear and radiation safety. STUK's regulation has no bearing on any regulatory measures required under the Land Use and Building Act and Decree, unless authorities agree otherwise. The Guide presents the requirements concerning the design and execution of safety-classified concrete, steel and composite structures of nuclear facilities and the inspections performed during operation of the plant.

3 Justifications of the requirements

3.1 Chapter 1 Introduction

The introduction presents the legal basis of the Guide. The requirements of Chapter 1 are based on the legislation concerning nuclear energy and construction.

In addition to the Act on the Approval of Certain Construction Products (954/2012), requirement 112 now includes a reference to the decrees and guidelines issued under it, several of which the Ministry of the Environment has issued after the previous update of the YVL Guides.

3.2 Chapter 2 Scope of application

The scope of application describes the activities of STUK regarding the regulation and inspections of the construction and use of structures of nuclear facilities in relation to the supervision measures and supervisors required by the Land Use and Building Act (132/1999) and the Land Use and Building Decree (895/1999), i.e. municipal building supervision authorities, the licensee's developer supervision and construction product market surveillance (TUKES).

Requirement 201 has been updated to only cover safety-classified steel, concrete and composite structures.

Requirement 208 presents the necessary references to other YVL Guides and their application to civil structures. Item n) of the list presented in the requirement has been modified to include that the licensee may, with justification, also apply Guide YVL E.3 to the manufacture and qualification of steel containers that only withstand hydrostatic pressure. The traditional difference between structural containers and pressure vessels is that, in addition to hydrostatic pressure and heat loads, pressure vessels also contain overpressure, which makes the requirement level of Guide YVL E.3 naturally more demanding than the corresponding requirements of Guide YVL E.6. On the other hand, licensees may in this case alternatively follow the established practices when complying with Guide YVL E.3 and use approved suppliers of pressure vessels. In this case, the standard SFS-EN 1090-2, which pressure equipment manufacturers normally do not use, does not have to be complied with.

Change proposals received from licensees also include proposals to add rock construction to the scope of this Guide. However, such expansion will not be added to the requirements of this Guide. This Guide may be applied to rock construction as a supplement to the D series YVL Guides while complying with the National Building

Code maintained by the Ministry of the Environment. Guide YVL E.6 also contains general requirements for the design, execution and quality control of rock structures and anchoring that support safety-classified buildings and structures. For example, rock anchors are post installations, for which instructions are given in Annex A to this Guide.

3.3 Chapter 3 Structural requirement specification

The requirements for structural requirement specifications along with design procedures are based on experience from the OL3 project. The requirements are similar in all E series YVL Guides. Component-specific requirement specifications in accordance with Guide YVL E.3 are required for steel sealing plates and liners and containment manholes and material hatches, among other things. A separate requirement specification may also be presented for the containment tendon system.

Requirements 301 and 302 have been clarified to give more freedom of choice in deciding in which documents certain subjects are presented.

3.4 Chapter 4 Requirements concerning the contractors and the supervision of construction work and of the execution of structures

The qualification requirements have been changed to correspond to the personal qualification requirements updated by the Ministry of the Environment. FISE has updated its qualification register to correspond to the new decrees of the Ministry of the Environment, which are listed at the beginning of this explanatory memorandum. The FISE qualification register may therefore be used in verifying the competences of the persons in charge of design and execution of civil structures. In the same spirit, FISE has also added qualifications for construction work supervision and renovation construction, which correspond to STUK's understanding that supervision and renovation construction also maintain sufficient qualifications for handling the corresponding tasks related to construction.

3.4.1 Chapter 4.1 Construction supervision by the licensee

The requirements concern the licensee's obligations in the supervision of construction and are based on the Nuclear Energy Act (990/1987) and the Land Use and Building Act (132/1999).

Requirements 404–408 have been updated to correspond to the qualification requirements updated by the Ministry of the Environment and reduce the qualification requirement level regarding repair and modification work, which does not affect the stability, leak-tightness or fire compartmentation of the building frame, or the durability of the equipment assemblies. Connected to this topic, the requirement 406a has also been added.

As a result of the updating the previous requirements, requirement 407 has become unnecessary and been removed.

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3.4.2 Chapter 4.2 Construction work execution organisation

The requirements concerning the management system in Chapter 4.2 are similar to those in E series equipment Guides (e.g. YVL E.3). The responsibilities of the construction work execution organisation are presented in the laws and decrees concerning construction, which is stated in requirements 107, 108 and 409.

Requirements 412–419 concerning work supervision are based on the Land Use and Building Act and the decrees and guidelines of the Ministry of the Environment (e.g. YM4/601/2015).

Regarding requirement 417, it should be noted that according to standard SFS-EN 13670, welds performed at the construction site on reinforcement steels shall adhere to standards SFS-EN ISO 17660-1 (load-bearing welded joints) and SFS-EN ISO 17660-2 (non-load-bearing welded joints).

The requirements for the construction work execution organisation refer to the requirements for licensees in Chapter 4.1. This also reduces the qualification requirement level for the construction work execution organisation regarding repair and modification work, which does not affect the stability, leak-tightness or fire compartmentation of the building frame or the durability of equipment assemblies.

3.4.3 Chapter 4.3 Execution organisation of steel and composite structures

The requirements in the chapter are consistent with the general requirements for the manufacturer in other E series YVL Guides (e.g. YVL E.3) and the decrees and guidelines of the Ministry of the Environment.

Requirement 421 is consistent with the technical requirements for structural steel constructions (SFS-EN 1090). Standard SFS-EN 1090-1 recommends a quality plan in accordance with standard SFS-EN 9001, and standard SFS-EN 1090-2 demands quality requirements in accordance with standard SFS-EN ISO 3834-2 in execution classes EXC3 and EXC4. The heat treatment requirements of standard SFS-EN 1090-2 refer to standard SFS-EN ISO 17663.

Requirement 424 is based on the Ministry of the Environment guideline on the difficulty categories of building management tasks and qualifications of building managers (YM4/601/2015). Requirement 425 concerns welding coordinators and is consistent with the E series YVL Guides and standard SFS-EN 1090-2. The qualification requirements of welding coordinators are presented in standard SFS-EN 1090-2, table 14. Requirement 431 requires the presentation of qualifications in manufacturer reports.

Requirements 429–430 concerning testing organisations and non-destructive and destructive testing refer to the requirements of Guide YVL E.12.

The change in requirement 427 is based on the need-based qualification requirement in the field of steel structures, which has been established to improve quality in industrial manufacture of CE-marked steel structure products in accordance with the Construction Products Regulation (FISE Oy and the Finnish Constructional Steelwork Association).

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Requirement 428 requires qualification in accordance with the applicable standard from welders. Standard EN 1090-2 also requires welders to be qualified. The qualification standard has been updated to the current standard EN-ISO 9606-1.

3.5 Chapter 5 Materials and products to be used in concrete and steel structures

The qualification requirements of construction materials and products are based on the EU Construction Products Regulation (EU No 305/2011) or the Act on the Approval of Certain Construction Products (954/2012) and the decrees and guidelines of the Ministry of the Environment.

Requirements 504 and 506–507 concerning reinforcement steels have been updated to correspond to the new decrees of the Ministry of the Environment (125/2016 and 126/2016). Type approval has been added as an option to requirement 504. Requirements 506–507 require reinforcement steels to have the characteristics in accordance with Decree 125/2016 and the type approval in accordance with Decree 126/2016.

Chapter 5.3 Materials and products for steel structures and composite structures

The requirements of Chapter 5.3 are based on building codes and guidelines valid in Finland.

Requirements 508–509 are based on the requirements presented in guideline B3 “Steel structures” (2017) of the National Building Code of Finland.

Requirement 510 is based on the principle that material requirements from the standard that was used in design should also be used when choosing a material.

Requirements 512–513 are requirements for composite structures based on the requirements presented in guideline B4 “Composite steel and concrete structures” (2017). Requirement 513 is based on the practices adopted and experience gained in the OL3 project.

Requirement 514d concerning the repeating of the coating tests has been eased with the sentence “Individual components with a negligible coated surface may be an exception from this rule.” This applies particularly to renovation and modification where small areas are coated in a way that it does not cause a conflict with the essential parts of requirement 514. The coatings shall not flake off to an extent which would block water flow paths at e.g. sumps and endanger cooling of the reactor core or the removal of residual heat from the reactor core. Furthermore, it shall be demonstrated that under accident conditions possible chemical changes, if any, in the coating material do not create new risks.

Requirement 515 concerning the quality control of painting and coating work has been divided into three parts in order to facilitate the management of the requirements. The body of the requirement and the supporting item c have been left in the current requirement 515. Item b of the original requirement has been moved to requirement 515a, and a reference to the guideline “Steel structures” of the National Building Code of Finland has been added to it. Item a of the original requirement has

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changed into description 515b, which refers to the updated report STUK-YTO-TR 210 (2017) on the demonstration of the durability of coatings and corresponding quality control between the licensee, coating manufacturer and independent testing organisation.

3.5.1 Chapter 5.4 Coatings and fire protection products for concrete structures, steel structures and composite structures

The following new changes have been made to requirements 514–515:

- Report STUK-YTO-TR-210, “Requirements for Coatings of Nuclear Power Plant Controlled Area” is no longer referred to. Instead, references to corresponding ASTM and ISO standards have been added and the corresponding minimum requirements for test arrangements and tolerance of radiation, chemical and mechanical stress have been presented for the coatings.
- Requirement 514d on repeating the tests has been relaxed.
- Requirements for flame proof paints are presented in guideline B3 “Steel structures” (2017) of the National Building Code of Finland. Requirement 515h requires the compliance of guideline B3 of the National Building Code of Finland.
- In regard to flame proof paints, it has been clarified that they are meant particularly for fire protection and not to replace corrosion protection.

3.6 Chapter 6 Design

The design requirements are based on the Nuclear Energy Act (990/1987), Regulation STUK Y/1/2018, the Land Use and Building Act and the decrees and guidelines of the Ministry of the Environment issued under it.

3.6.1 Chapter 6.2 Qualifications of the structural designer

Requirements 606 and 608–609 concerning the qualifications of designers are based on the Land Use and Building Act.

Requirements 606–610 have been modified to consider the changes to the Land Use and Building Act (132/1999). Safety class 2 structures and buildings have been elevated to the exceptionally demanding class, as have the qualification requirements of their designers. The qualification of a designer of demanding structures has been considered sufficient for a designer of safety class 3 structures.

The new requirement 608a reduces the qualification requirements of a structural designer in charge and a structural designer insofar as the situation involves building- or structure-specific repair and modification design at the nuclear facility with no effect on the stability, leak-tightness or fire compartmentation of the building frame or the durability of equipment assemblies.

3.6.2 Chapter 6.3 Plan review and reviewer qualifications

The foundation of requirements 613–614 is the Land Use and Building Act.

The qualification requirements of plan reviewers refer to the qualification requirements of designers presented in Chapter 6.2. This also reduces the

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qualification requirement level regarding small repair and modification work with no effect on the stability or fire compartmentation of the building frame or the durability of the equipment assemblies.

3.6.3 Chapter 6.4 Design methods

The requirements are based on the Decree of the Ministry of the Environment on Load-bearing Structures, requirements of SFS-EN standards concerning design parameters and experiences gained in the OL3 project.

3.6.4 Chapter 6.5 General design requirements

The design requirements are based on Section 4(2) of Regulation STUK Y/1/2018, which requires the actions taken to ascertain the compliance with the requirements of the structures related to safety functions to be commensurate with the safety class.

Requirements 619–621 concerning service life are based on Section 5 of Regulation STUK Y/1/2018.

Requirement 621 presents the exposure classes required in service life design and the composition and durability requirements of concrete. To reach the planned service life, the materials to be used (such as the quality of steel and concrete) and any requirements concerning concrete and the execution shall be defined in accordance with the requirements and guidelines of the National Building Code of Finland.

Requirement 622 concerning the safety margin against failure is based on the general requirements for the load-bearing structures of buildings (e.g. guideline B1 "Load-bearing structures" (2010) of the National Building Code of Finland).

Requirement 624 is based on Section 15 of Regulation STUK Y/1/2018 (e.g. consideration of fires), the Land Use and Building Act and the Decree of the Ministry of the Environment on the Fire Safety of Buildings issued under it.

Requirement 625 explains the use of consequence classes in design based on SFS-EN standards and refers to the new decrees and instructions of the Ministry of the Environment.

Requirements 625–627 tie the dimensioning of safety-classified structures to the requirements of SFS-EN standards and the National Building Code of Finland by defining the consequence classes (SFS-EN 1990, Annex B) and the competence classes of design tasks in the Land Use and Building Act (132/1999, Section 120 d). In requirement 626, structures and buildings in safety class 2 have been elevated to the new exceptionally demanding class.

According to requirement 627, safety class 3 structures shall be designed and built at least as demanding structures. Structures with no effect on the stability, leak-tightness or fire compartmentation of the building frame or the durability of the equipment assembly may be designed and built as conventional structures, which also reduces the administrative burden.

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3.6.5 Chapter 6.6 Dynamic analysis of structures

The requirements for the dynamic analysis of structures are based on Section 14 of Regulation STUK Y/1/2018, item 2 of which requires the consideration of seismic phenomena and aircraft crashes in the design.

Requirements 631–632 require dynamic analyses for the vibration analyses of structures. Applicable dynamic structural analysis methods are presented in the standard ASCE 4-16 “Seismic Analysis of Safety-Related Nuclear Structures”. The use of standard SFS-EN 1998 has also been accepted in some cases for the seismic design of steel structures, mainly for the determination of load combinations.

According to requirement 633, it shall be considered in the selection of damping parameters that the earthquake resistance of nuclear facilities in Finland is designed against relatively small earthquake magnitudes compared to countries that are seismically more active than Finland. In Finland, the criterion for a safe shutdown earthquake (SSE) of a nuclear power plant corresponds to earthquakes in seismically more active countries that may recur a few times during the operation of the nuclear facility (OBE). Guide YVL B.7 and its explanatory memorandum provide instructions for the selection of damping values used in the analyses. When searching for suitable design parameters in literature and test results, the corresponding analysis and design items and objectives presented in them shall also be considered. For example, long service life objectives may easily lead to structural damping lower than normal and thereby to higher design accelerations. According to “US NRC Regulatory Guide 1.61”, the damping of concrete structures is 4% for an earthquake occurring a few times during the operation of a nuclear power plant (OBE) and 7% for a larger earthquake against which the safe shutdown of the nuclear power plant (SSE) is designed. The recommendations for new damping values in Reg. Guide 1.61 (NUREG/CR 6919) present that if the stresses of the structure remain below 80% of the allowed values, damping corresponding to an OBE earthquake shall be used.

3.6.6 Chapter 6.7 Containment

The requirements concerning the containment are based on Section 10 of Regulation STUK Y/1/2018.

The dimensioning of the containment refers to the National Building Code of Finland, SFS-EN standards and ASME III Div 1 and Div 2 standards. The design margins of the containment shall be ensured using the ASME III standard as a benchmark/reference. ASME III Div 1 discusses part that penetrate the containment, and ASME III Div 2 discusses the containment liner and reinforced concrete structures. Applying the ASME III standard, the design margin is assessed against the acceptance criteria of deformations of the tightness-ensuring liner and penetrations and by ensuring the load-bearing capacity of concrete structures conservatively in accordance with the method of allowed stresses specified for the containment.

Requirement 634 repeats the requirement of Guide YVL B.6 concerning containment design for the concrete containment liner and provides a recommended standard to be applied. In dimensioning the penetrations of the containment, both standards ASME III Div 1 and ASME III Div.2 are used.

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Requirement 635 provides instructions on the design of a steel containment. The requirements are the same as for the hatches of a concrete containment. The applicable standard is ASME III Div. 1 Subsection NE. The requirement also refers to the pressure vessel requirements of Guide YVL E.3 and requirements for strength analyses in Guide YVL E.4.

Requirement 636 provides the option for alternative design standards, e.g. standard KTA3401, which was used for the dimensioning of material hatches and manholes of the OL3 project.

Requirement 637 provides options for the design of airlocks in a concrete containment. These options include standard SFS-EN 1992 with the national choices given in guideline "Concrete structures" in the National Building Code of Finland and standard ASME III Div. 2. Requirement 637 is based on OL3 experiences. The use of standard SFS-EN 1992 requires certain changes so that it is applicable to the calculation of the shell structure. These shall be presented in the design plan.

3.6.7 Chapter 6.8 Leak-tightness and leak monitoring of pools containing radioactive substances

The requirements concerning the tightness and leak monitoring of pools are based on Section 10 of Regulation STUK/1/2018.

Requirement 639 refers to requirement 424 of Guide YVL B.1, according to which the severe damage of spent fuel shall be prevented through design. A mention of pool cooling has been added to the requirement.

Other requirements of Chapter 6.8 are consequential requirements of this principle. These include requirement 640 regarding water-tightness of concrete structures of pools and tunnels significant to nuclear safety and requirements 641 and 642 regarding the liner. Regarding the dimensioning of the reinforcements of water-tight concrete structures, the National Building Code of Finland or the SFE-EN standards do not set special requirements. In addition to the material requirements in the National Building Code of Finland and the SFS-EN standards, the reinforcement steel shall be dimensioned so that the largest allowed characteristic fractures are well controlled. The traditional criterion is to limit the width of cracks that penetrate the material to 0.1 mm maximum and bending cracks to 0.2 mm. If deviations are to be made, their justifications shall be presented in the requirement specification/design plan submitted for approval.

3.6.8 Chapter 6.9 Verification of the design solution

Requirements 643–644 are based on OL3 experiences of the verification of the design of the containment. Non-linear analyses may be used to evaluate the values of tensile stresses in edge-disturbance areas, the structure's safety against fracture/failure and the deformations and tightness of penetrations and hatches. Local, non-linear analyses may be used to check, for example, the stress state of the containment liner, taking into account the initial interference of the liner (tolerance deviations).

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3.7 Chapter 7 Construction plan

The requirements for a construction plan are based on the Nuclear Energy Act (990/1987), Regulation STUK Y/1/2018, the Land Use and Building Act and the decrees and guidelines of the Ministry of the Environment issued under it.

Additions from other E series YVL Guides and SFS-EN standards have been included in the requirements of Chapters 7.2–7.7.

Requirement 714 now includes the addition that structural calculations and analyses shall also consider the situation of unfinished construction during construction.

The requirements of Chapter 7.6 for the implementation breakdown are based on new standards SFS-EN 13670 and SFS-EN 1090-2 concerning the execution of concrete work and steel structures.

The requirements for quality control plans in Chapter 7.7 supplement the requirements for the management system and quality management presented in Guide YVL A.3. The supplementations provided by requirements 718–725 are based on the Decree of the Ministry of the Environment on Load-bearing Structures (477/2014), which stipulates that when the potential consequences of a defect or damage in a building or structure are severe or medium, a quality control plan shall be prepared for the building as part of the work plan for the execution of the structure. This plan shall contain an assessment of the executing party's competence and resources in terms of the requirements that have been set, a description of the executing party's project organisation and its responsible persons, the principles of the inspection and responsibilities, and a plan for the quality control measures and records.

In Chapter 7.8, requirements 726–727 concerning the installation construction plan are applied versions of requirements in Guide YVL E.3. Requirements 728–729 refer to execution standards applied in construction. The reference in requirement 729 to standard SFS-EN 1090 has been replaced by a reference to the guidelines on steel and composite structures in the National Building Code of Finland.

Requirement 730 in Chapter 7.9 takes into account requirement 4.44 in Guide IAEA NS-G-1.10.

The requirements for a summary of justification in Chapter 7.11 comply with the new practices of the E series YVL Guides.

3.8 Chapter 8 Execution

The requirements on the execution of structures are based on the Nuclear Energy Act (990/1987), Regulation STUK Y/1/2018 and the Land Use and Building Act.

3.8.1 Chapter 8.1 Execution of concrete structures

The requirements for concrete and precast concrete products refer to standard SFS-EN 13670 "Execution of concrete structures" and its national application standards.

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The requirements are based on guideline "Concrete structures" (2016) in the National Building Code of Finland.

Regarding concrete characteristics, requirement 804 requires compliance with standard SFS-EN 206-1 and its national application standard. New versions (SFS-EN 206 and SFS 7022) of these standards have been issued, so the requirement has been updated in this regard.

Requirement 805 assigns safety-classified structures, structures made of high strength concrete and prestressed structures to execution class 3, which is the highest class. During the YVL Guide update, the requirement has been supplemented with the definition of high strength concrete in accordance with the SFS-EN standards.

The reference in requirement 806 concerning exposure classes has been changed to the updated standard SFS-EN 206. During the YVL Guide update, an additional requirement has been added regarding the effects of the exposure class on the design requirements. This requirement is in accordance with guideline "Concrete structures" (2016) of the National Building Code of Finland.

3.8.2 Chapter 8.2 Precast concrete products and concrete elements

The vocabulary and definitions of SFS-EN standards concerning precast concrete structures have been used in the requirements.

In addition to the execution standards, guideline "Concrete structures" (2016) of the National Building Code of Finland has been added to requirement 808 as a guideline to be followed.

3.8.3 Chapter 8.3 Execution of steel structures and composite structures

Requirement 813 in Chapter 8.3 corresponds to the requirements for the qualification of manufacturing procedures in E series YVL Guides.

Requirements 814, 816 and 817 tie the safety classes of nuclear facilities to the execution classes in accordance with standard SFS-EN 1090-2.

The following changes have been made in the update of Guide YVL E.6:

- The new guidelines of the Ministry of the Environment for steel and composite structures in the National Building Code of Finland have been added to requirement 814.
- In requirement 816, the execution class of safety class 2 structures has been dropped from EXC3 to EXC4. Welding requirements in class 4 have been proven too demanding. In addition, SC3 structures with no effect on the stability or fire compartmentation of the building frame or the durability of equipment assemblies can be manufactured in class EXC2.
- The execution classes of composite structures have been added to requirement 817.

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3.9 Chapter 9 Inspections of civil structures

Requirements 905–907 and 909 have been specified to only apply to safety class 2 structures. Similarly, requirements 910 and 911 only apply to safety class 3 structures.

Requirement 915 has been specified to only apply to structures in safety classes 2 and 3.

Requirement 922 specifies the construction inspection obligation for a standard structure that is CE marked or has been approved according to the different options in the Act on the Type Approval of Certain Construction Products. It should be noted that the construction inspection shall be performed even in the case of a CE marked or ETA approved steel structure if it is a safety-classified structure.

The monitoring of the test results of safety class 3 structures has been added to requirements 931 and 932 because of the general quality management problems observed in concrete construction in Finland in the late 2010's.

The licensee as sole party to draw up the concrete work report has been removed from requirement 934. In this form, the requirement allows the concrete work report to be drawn up by other parties besides the licensee. This does not, however, remove the licensee's responsibility.

The requirements of Chapter 9.5 "Commissioning inspections and test programmes" have been supplemented with experiences from commissioning inspections from the OL3 project.

The detailed periodic inspection procedures required in requirement 944 may be submitted for information instead of submitting them for approval.

Composite structures, which had been left out of the original wording, have been added to the building inspection targets in requirement 946 concerning repairs, modifications and complementary building.

3.10 Chapter 10 Documents to be submitted to STUK

The delivery time of the in-service structural supervision plan in requirement 1011 is important because the first results of pressure and tightness tests may cause changes in the plans. It has been specified in the requirement that periodic inspections are a part of the plant's in-service inspections, which also corresponds to current practices.

Requirement 1016 for the submission of documents related to modifications to the structural systems of an operating nuclear facility refers to the requirements in this Guide for the submission of documents related to the structural systems in earlier licence phases. The requirement has been modified to be followed where applicable so that more focus can be put on the safety significance of changes at the nuclear facility.

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3.11 Chapter 11 Regulatory oversight by the Radiation and Nuclear Safety Authority

The requirements of Chapter 11 have been modified from the requirements of other equipment Guides in the E series of YVL Guides (mostly Guide YVL E.3) to be applicable to the monitoring of concrete and steel structures.

The text *or the corresponding information in connection with other material* has been added to requirement 1104 so that the requirement specifications of structures do not have to be presented in one document.

Tendon system components, including tendon system anchors, steel and spiral-weld pipes and their supports have been added to the readiness inspections presented in requirement 1119.

Requirement 1132 concerning STUK's regulatory control measures related to maintenance and repair work has been specified in such a way that it follows the same process as this Guide presents for the approval of the original work.

Plans for composite structures and their inspections have been added to requirement 1134 concerning the inspections of modifications.

3.12 ANNEX A Detailed instructions for the execution of concrete structures

Detailed instructions for the execution of concrete structures have been compiled into Annex A guiding the application of the National Building Code of Finland and corresponding SFS-EN standards in the construction of a nuclear facility.

Requirements A101, A105, A107, A110, A111, A113, A114, A117, A206 and A301 have been clarified and their references have been updated to correspond to the current National Building Code of Finland and the applicable SFS-EN standards.

The requirement concerning manufacture under non-certified quality control, which was included in Guide YVL 4.1 issued in 1999 but was missing from Guide YVL E.6 issued in 2013 and has proven to be necessary even at large building sites at nuclear power plants, has been returned as requirement A103. The requirement specifies the approval practice in which a body approved by the Ministry of the Environment grants a product that meets the requirements of product group special rules "Valmisbetoni" (Ready-mixed concrete) a verification certificate based on the initial inspection of the production plant and internal quality control during production and continuous supervision.

Requirement A111 has been updated to correspond to the type approval related Ministry of Environment Decree (126/2016) on the essential technical requirements for weldable concrete reinforcing steel and mesh reinforcements, Section 7 of which concerns quality control and its verification.

The requirements presented in Concrete Code BY65 and the European Technical Approval Guideline ETAG013 have been added to requirement A115 to be followed in the quality control plan.

A reference to standard EN 1992-4, which was confirmed on 3 August 2018, has been added to requirement A116. If necessary, previously approved practices may be referred to if they can be used to demonstrate the technical sufficiency of corresponding construction products. In seismic classes S1 and S2A, class C2 in accordance with Annex C of standard SFS-EN 1992-4 is required of the post installed anchorages of structures and equipment. ETAG001 Annex E/EOTA TR 045 requires this for important buildings if the design basis peak ground acceleration (PGA) of the earthquake is greater than 0.1 g and for all buildings if PGA is greater than 0.2 g. The corresponding EAD 330250-00-0601 is still pending approval of the European Union, but the recent development of the post installation products meeting the requirements of the above standards enables their use at nuclear power plants. In that case, requirement A116.c.ii.1 may be removed and the fixing of safety class 1 steel structures, equipment and piping may be focused on.

In item c/ii of requirement A116, the sentence *Post-installed anchors must not be used without a justified reason to fasten steel structures, equipment and piping in safety class 1* is kept in this format because it is part of good design practice that at least SC1 systems, equipment and structures are designed in an early enough phase to enable the use of embedded anchor parts.

Acceptability demonstration has been added to item d of requirement A116 to ensure that tested products are used as intended.

The required content of the concrete work plan has been added as requirement A204 by combining the requirement list in Annex 2, Chapter 1.3 of Guide YVL 4.1 issued in 1999 and the requirement list presented in the guideline "BY65 Concrete Code" because a sufficient requirement list is not included in the guideline "Concrete structures" (2016) of the Ministry of the Environment.

3.13 ANNEX B Detailed instructions for the execution of steel structures and steel components of composite structures

Detailed instructions for the execution of steel structures and steel parts of composite structures have been compiled into Annex B presenting the application of the National Building Code of Finland and corresponding SFS-EN standards in the construction of a nuclear facility.

Requirements B103, B104, B204, B205, B304 and B309 have been clarified and their references have been updated to correspond to the current National Building Code of Finland and the applicable SFS-EN standards.

The inspection plan in Annex B, Chapter 13.3 "Quality control of steel assemblies" has been divided into two parts: 13.3.1 "Inspection plan" and 13.3.2 "Material certificates".

3.14 ANNEX C Division of inspection responsibilities

A detailed division of inspection responsibilities comparable to Annex A of Guide YVL E.1 has been collected into Annex C. No content changes have been made during the Guide update; only IO has been changed into AIO, which is generally used in YVL Guides as an acronym of "authorised inspection organisation".

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3.15 **ANNEX D Material certificate requirements for materials and welding filler materials, SFS-EN 10204**

Material certificate requirements for materials and welding filler materials (SFS-EN 10204) have been compiled into Annex D.

4 **International provisions concerning the scope of the Guide**

In Guide YVL E.6, the Eurocode and EN standards valid in Finland with their national annexes and application standards have been set as primary design standards for safety classes 2 and 3. The national annexes have now been issued as guidelines in the "Strength and stability of structures" series of the National Building Code of Finland.

Because the Eurocode standards are not directly applicable to the dimensioning of the containment, "ASME Boiler and Pressure Vessel Code, Section III", which is particularly intended for nuclear power plant components, has been set as the primary standard for safety class 2 containment design. The application of Eurocode standards is also allowed as long as the licensee submits a sufficient design plan describing how the Eurocode standards (EN 1992-1-1) are applied to different loads in the containment. Acceptable German KTA standards have also been mentioned in the instructions concerning the containment.

The significance of the entry into force of the EU Construction Products Regulation (No 305/2011) has been discussed in the introduction. Based on the Construction Product Directive, EOTA issues ETAG and EAD guidelines and technical reports (EOTA TR) for European Technical Approval, setting the acceptance principles for construction products approved with European Technical Approval (ETA).

The requirements set in Guide YVL E.6 have been compared with the following IAEA and WENRA requirement documents:

- IAEA safety instructions
 - Safety of Nuclear Power Plants: Design Safety Requirements, Safety Standards Series No. NS-R-1
 - Design of Reactor Containment Systems for Nuclear Power Plants, Safety Guide, Series No. NS-G-1.10, September 2004
- WENRA Reactor Safety Reference Levels, January 2007
 - Issue K, Maintenance, In-service Inspection and Functional Testing
 - Issue LM, Emergency Operating Procedures and Severe Accident Management Guidelines.

Requirements related to containment monitoring have been added from the IAEA containment guide.

5 **Impacts of the Tepco Fukushima Dai-ichi accident**

The impact of the Fukushima accident on the Guides include stricter tightness requirements for pools that contain radioactive substances. More detailed instructions for earthquake dimensioning have also been given.

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6 Needs for changes taken into account in the revision

The needs for changes due to changes made to international and national laws/regulations and the change proposals made in connection with the preparation of the YVL Guide implementation decisions (SYLVI) together with others recorded in STUK's change proposal database have been considered when updating the requirements. In addition, the possibilities to reduce the so-called administrative burden have been considered.

6.1 New requirements

A requirement concerning the fire protection plan and product approval options of fire protection products (ETA or verification certificate) and product requirements (ETAG or the assessment criteria of the verification certificates) has been added as requirement 516. The requirement complies with the requirements of guideline B3 "Steel structures" of the National Building Code of Finland, the Construction Products Regulation of the Commission and the Act on the Approval of Certain Construction Products (954/2012).

A reference to fire protection products has been added to requirement 713.

The requirement for a report on the batching plant along with its content list has been added to requirement A103.

Requirement A104 has been supplemented with items concerning alloy materials and fibres, and the use of recovered or recycled aggregate and recycled water has been prohibited.

The assessment criteria of the verification certificates of the Ministry of the Environment and requirements of standards ISO 15835-1 and ISO 15835-2 have been added to requirement A112 concerning mechanical splices of reinforcement steel bars. The fatigue characteristics of mechanical splices shall be demonstrated, and seismic qualification in accordance with Chapter 5.5.1 of standard ISO 15835-1 (class S1 moderate scale earthquake) is required for special splices in S1 class buildings and aircraft crash structures.

Requirement A116 has been supplemented for post-installed anchors used in fixing S1 and S2 structures so that the seismic qualification shall be ensured in accordance with guideline ETAG 001 Annex E/EOTA TR045 in performance class C2.

The required content of the concrete work plan is entirely rewritten in requirement A204 based on guideline "BY65 Concrete Code".

6.2 Significant changes

The change of the Land Use and Building Act affected the competence classes of designers and design tasks and caused changes in the qualification requirements for designers and the requirements for building supervision and supervisors. For example, the old competence classification has been replaced by a new one, according to which design tasks are classified as "exceptionally difficult", "difficult", "conventional" or "minor" (Land Use and Building Act, Section 120 d). The

“exceptionally difficult” class is the new class with the strictest requirements. In Guide YVL E.6, the renewal of the Land Use and Building Act affected the following requirements:

Construction work management and supervisors

- Requirements 404–408 have been revised to correspond to the Land Use and Building Act (132/1999) and the qualification requirements in the decrees and guidelines of the Ministry of the Environment issued under it.
- Requirements 412 and 413 have been specified so that the qualification requirements apply to the work supervision of the executing party in addition to the supervisors of construction work.
- Requirement 414 requires the person responsible for the production of concrete to have the qualifications of a ready-mixed concrete foreperson. The requirement has been made stricter to comply with Concrete Code BY65: the process controller shall be at the site of production.
- The qualification requirement of an installation foreperson has been added to requirement 415 for the person responsible for concrete work.
- In requirement 416, the qualification requirement of the person leading the manufacture of concrete structures has been changed to conform to the terminology of the Land Use and Building Act.
- In requirement 425, the terminology has been changed and the requirement concerning the qualification of an installation foreperson for demanding class steel structures for the person in charge of the installation of steel structures has been added.
- In requirement 427, forepersons heading the manufacture of steel structures shall have the qualifications of a foreperson of a steel element producing plant of manufacturing class 1 or 2. The requirement level has not increased, but the terminology has been updated to conform to the decrees of the Ministry of Education.
- Requirement 431 states that the report concerning the manufacturer of steel structures including the subcontractors shall also present the qualifications of the manufacturing foreperson according to requirement 427.

Structural designer and construction plan inspector

- A reference to the decrees and guidelines of the Ministry of the Environment has been added to requirement 606, and the competence classes of the Land Use and Building Act have been provided in the requirement.
- A responsible structural designer (requirement 607) is required to have the qualifications of a structural designer of exceptionally demanding structures. The requirement was previously an AA class qualification. In requirement 607, the person in charge of inspecting the plans is required to have the same qualification.
- Requirement 608 requires the structural designer of SC2 structures to have the qualifications of a structural designer of exceptionally demanding structures and the designer of SC3 structures to have at least the qualifications of a designer of demanding structures. The requirement level has increased slightly: the required qualification was previously AA class (demanding, partly exceptionally demanding) or A class (conventional).

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- A designer of prestressed structures is required to have the qualification of a designer of exceptionally demanding concrete structures. The requirement level has remained the same.
- The old competence classes have been removed from requirement 610.
- Requirement 614 requires the inspectors of the plans to have the same qualifications as the designers.

Design requirements

- Requirement 626 requires the design of safety class 2 structures to be performed as an exceptionally demanding design task (Land Use and Building Act, Section 120 d). The requirement level has increased slightly: the previous requirement was AA.
- Requirement 627 requires the design of safety class 3 structures to be performed as at least a demanding design task (Land Use and Building Act, Section 120 d). Secondary structures may be designed as a design task of a conventional structure.

The new decrees and guidelines of the Ministry of the Environment concerning design and the approval of construction products, as well as the decrees and guidelines under preparation, have caused several changes:

- Type approval has been added as one approval option in requirement 504, and reinforcement steels, mesh reinforcements and concrete reinforcements have been added to the materials list. The reason is the type approval that is now required of reinforcement steels (an analogous methodology is under preparation for prestressing tendons as well).
- Requirement 506 has been specified so that characteristics according to Decree 125/2016 and type approval according to Decree 126/2016 are required of reinforcement steels. A similar change has been made to requirement A111 in the Annex.
- The type approval option has also been added to requirement 507 for the demonstration of the acceptability of prestressing tendons. A type approval decree for prestressing tendons is being prepared by the Ministry of the Environment.
- Requirement 621 concerning service life design has been updated based on the guidelines "Concrete structures" (2016) and "Steel structures" (2016) of the Ministry of the Environment and guideline BY65 of the Concrete Association of Finland.
- Requirement 625 has been supplemented with references to the Ministry of the Environment Decree 3/16 and guideline "Basis of structural design for load-bearing structures".
- An item concerning the characteristics to be specified on the basis of the exposure class and a reference to guideline "Concrete structures" (2016) have been added to requirement 806.
- Requirement A117 of Annex A has been supplemented with a reference to a verification certificate issued by a body approved by the Ministry of the Environment.

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6.3 Other changes

Changes to acts, decrees, guidelines and standards have necessitated several changes:

- In requirements 104 and 105, Government decrees have been replaced by STUK's regulations.
- A mention of the decrees has been added to requirement 112.
- The national annex of Eurocode 2 (SFS-EN 1992) has been provided in guideline "Concrete structures" (2016) of the National Building Code of Finland, and a change concerning this has been made to requirement 637.
- In requirements 728, A101 and A110, BY50 has been replaced by the new version BY65.
- A reference to the guidelines in the National Building Code of Finland concerning steel and composite structures has been added to requirements 729 and 814.
- In requirements 804, 806 and A101 and the references, standard SFS-EN 206-1 has been replaced by the new version SFS-EN 206.
- A reference to guideline "Concrete structures" (2016) of the National Building Code of Finland has been added to requirement 808.
- References have been corrected and supplemented with new standards, and the references in the annexes have been removed.
- The terminology of requirement A107 has been changed to correspond with the Act on the Approval of Certain Construction Products and the Ministry of the Environment guideline on ready-mixed concrete.
- The requirements concerning prestressing tendons prepare for the Ministry of the Environment type approval decrees under preparation. In requirements A114 and A206, the quality control plans shall comply with the requirements of BY65 and ETAG 013.
- In requirements 428 and B205, the qualification standards of welders and operators have been updated (SFS-EN-ISO 9606-1 and SFS-EN 14732).

Other specifications in the requirements:

- Requirement 635 has been supplemented with requirements YVL E.3 635 and 636, which were removed from Guide YVL E.3.
- Requirement 639 has been revised so that it is clear that successful cooling of pools is essential in preventing severe damage of fuel.
- Requirement 701 has been supplemented with a requirement to submit the construction plan also for structures in seismic categories S1 and S2A that belong to class EYT. The construction plan shall also comply with the requirements presented in different parts of the National Building Code of Finland.
- Requirement 714 has been specified so that
 - the stability and progressive collapse of the structure during construction shall be inspected
 - if necessary, a non-linear analysis shall be presented for the functionality of the components of the containment
 - initial data (loads, load combinations), boundary conditions and essential stresses of the structure have been specified.

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- Requirement 724 has been changed so that it does not refer to the quality control plan of the concrete part but the quality control plan of concrete structures.
- Requirement 726 has been changed to be more clearly a requirement.
- Requirement 805 has been specified with the definition of high-strength concrete in accordance with standard SFS-EN 1992-2.
- Requirement 817 concerning composite structures has been supplemented with safety classes.
- Concrete structures have been added to requirement 901 alongside composite structures.
- Safety classes have been specified in requirement 915.
- The inspection of the result documentation of the parts of tendon systems has been added to the content of the readiness inspection in requirement 1119.
- In requirement 1127, the inspection body has been corrected from accredited to authorised.
- The inspection of composite structure plans has been added to the requirement concerning modifications.
- References of Guide YVL E.6 have been updated because several laws and standards have been changed. The separate reference lists of Annexes A and B have been removed and added to the main reference list of the Guide.

6.4 Reduction of administrative burden

The following reductions of administrative burden have been made to the requirements:

- A moderation allowing the presentation of structural requirement specifications of concrete, steel and composite structures in several documents has been added to requirement 301. Items e), f) and g) of the requirement have been revised to require the design requirements of construction materials, fire design and coatings and not the final material characteristics. The previous requirement was considered unreasonable in the design phase. A similar moderation has been made to requirement 1104.
- Requirement 302 has been changed so that the structural requirement specifications of the liner, equipment hatch and personnel and emergency airlocks may be submitted in several documents containing the required information.
- According to requirement 514d, coating tests do not have to be renewed even if the composition of the coating has changed, if the area of the coated surface is negligible.
- In requirement 816, the execution class of safety class 2 structures has been dropped from EXC3 to EXC4 because the welding requirements in class 4 have proven too demanding. Secondary structures for SC3 structures with minor importance to structural complexes can be manufactured in class EXC2.
- A specification has been added to requirements 906, 907, 909 and 1116 stating that the requirements apply to safety class 2 and not safety class 3.
- Requirement 934 has been revised so that the concrete work report may be prepared by another party besides the licensee. The final responsibility, however, still stays with the licensee.
- According to requirement 944, detailed procedures for periodic inspections may be submitted for information (which has been the established practice).

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- Complementary building has been added to requirement 946 as an item where Guide YVL E.6 may be followed where applicable. Similarly, according to requirement 1061, the Guide shall be followed where applicable in the modifications to structural systems.
- Qualification requirements have been reduced regarding minor repair and modification work with no effect on the stability, leak-tightness or fire compartmentation of the safety-classified frame structures or the durability of the equipment assemblies. This strengthens the use and development of the licensee's own personnel in the ageing management of the plant and the design and monitoring of repairs and modifications.