FINNISH CENTRE FOR RADIATION AND NUCLEAR SAFETY
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Steel structures for nuclear facilities

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1 General

Pursuant to this Guide, The Finnish Centre for Radiation and Nuclear Safety (STUK) controls the design, manufacture and use of steel structures for nuclear facilities. STUK's activities have no effect on the regulatory actions required under the Building Act (370/58) /1/ and the Building Decree (266/56) /2/, unless otherwise agreed by authorities.

In Guide YVL 1.1 /4/ general procedures concerning regulatory control of nuclear facilities performed by the Finnish Centre for Radiation and Nuclear Safety are given. In this guide requirements concerning design and fabrication of steel structures for nuclear facilities and documents to be submitted to STUK are presented. Furthermore, regulations concerning inspection of steel structures during construction of nuclear facilities and during their operation are set forth in this guide.

1.1 Safety classification

Classification of steel structures is determined by a classification document. Principles of safety classification are given in Guide YVL 2.1 /9/.

1.2 Scope

In the below, typical steel structures at nuclear facilities are listed to which this guide applies:

- supporting steel structures of buildings
- supports against piping rupture
- missile barriers
- stockpiling racks for fresh and spent fuel
- tanks loaded by hydrostatic pressure
- steel liners of pools
- doors and hatches.

Also supporting structures of components, crane rails equipment for the handling and storage of nuclear fuel and tools required in the assembly and disassembly of the RPV are controlled according to this guide, unless other YVL guides apply to them.

Guide YVL 3.0 /10/ applies to the pressure-retaining steel structures of the concrete containment building such as personnel and equipment airlocks as well as penetrations. Other steel structures which affect the containment structurally and functionally are controlled according to this guide.

As to fire doors and partitioning structures, the provisions of Guide YVL 4.3 /14/ shall be taken into consideration.

The above-mentioned structures to be controlled according to this guide are hereinafter jointly referred to as steel structures. If these structures are fabricated of metal construction materials other than steel, this guide is complied with where applicable.

1.3 Phases of steel structure control

Regulatory control performed by STUK comprises the following phases:

- inspection of the Preliminary and the Final Safety Analysis Reports (PSAR, FSAR)
- inspection of the classification document
- inspection of the construction plan
- control of fabrication and the construction inspection
- commissioning inspection
- inservice inspections
- inspections of repairs and modifications.

The Preliminary Safety Analysis Report (PSAR) and the topical reports pertinent to it such as the classification document, are reviewed by STUK in connection with the application for a construction permit. The Final Safety Analysis Report (FSAR) is dealt with in connection with the application for an operation permit. More detailed provisions are given in Guide YVL 1.1 /4/. Other control measures are dealt with in more detail later.

2 Construction plan

The construction plan for steel structures in Safety Classes 2 and 3 presents

- a description of designer and manufacturer
- design data
- a description of materials
- dimensioning

- drawings
- a quality control programme
- other necessary reports

The construction plan is submitted to STUK for approval in accordance with Guide YVL 1.2 /5/ before commencement of fabrication and is specified according to this guide. The applicant may, if he so wishes, submit to STUK for approval his own suggestion for an entire construction plan together with delivery schedules.

Concerning products in Safety Class 3 which have a type acceptance certificate effective in Finland, a construction plan approved by STUK is not required provided that the products are used as specified in the type acceptance certificate. Only the type acceptance certificates of the products in question shall be submitted to STUK for information.

Construction plans for Class EYT steel structures are inspected by the applicant.

2.1 Description of designer and manufacturer

The purpose of the description is to give an idea of how the design and implementation of a steel structure is arranged in the activities of the applicant, plant supplier, construction designer, building contractor, manufacturer of the steel structure and any other potential party. The description shall contain organization confirmed by company management, definitions of duties, competences and responsibilites as well as the arrangement of QA. If these data are given in some other connection, a reference to the document in question is sufficient.

A responsible designer and persons responsible for implementation and quality control shall be designated for each structure or building.

In case of technically exacting work, the manufacturer shall report for any previous corresponding work to facilitate assessment of his competence for the assignment in question.

2.2 Design data

Design data contain information relating to loads, operation and operating conditions required in steel structure design.

2.2.1 General design data

Design data shall contain

- Safety Class of a steel structure
- a steel structure's function and operation or a reference to the Preliminary Safety Analysis Report
- loads, temperature, supports, corrosion conditions, design service life
- design basis regulations, guides and standards and an explanation of their application
- location drawings with explanations
- geometry of steel structure, load combinations and load factors with explanations
- inservice inspection requirements potentially arising from choice of material, construction method and operating conditions.

2.2.2 Coatings

Under accident conditions, coatings of steel structures and components inside the containment will be subjected to loads which deviate essentially from loads encountered during normal operation. The coatings used shall be such that they will not have an unfavourable effect on accident management. It shall be demonstrated, therefore, i.a. that coatings will not come off to an extent which would endanger core coolability or removal of residual heat. Furthermore, it shall be demonstrated that under accident conditions potential chemical changes in coating material will not create new risk factors.

In the design data the requirements placed on the coatings of steel structures and components inside the containment shall be presented. They are as follows:

- radiation resistance
- decontaminability
- chemical resistance
- durability under operating conditions
- durability under postulated accident conditions
- fire technical properties.

In the design data also the methods are presented by which the meeting of requirements placed on coating materials and accomplished coatings is ascertained.

Only coatings which have passed tests demonstrating the meeting of requirements are allowable in structures and components inside the containment. Individual components the coated surface of which is negligible may be an exception to this rule.

2.3 Construction material data

Construction material data describe suitability of materials for their intended use and present unambiguous acceptance criteria for construction materials and their characteristics.

In the construction material report or drawings the following shall be presented as concerns the different parts of supporting structures

- standard marking and type of base material and welding filler material
- method of fabrication, condition and type of material certificate of base material
- explanation of the choice of construction material where necessary.

2.4 Dimensioning

The document shall be an entity in which it can be seen how dimensioning was derived from load combinations and construction material properties. The document shall be sufficiently detailed to facilitate assessment of accuracy of the calculation method and the meeting of design requirements on its basis.

For demonstrating structural resistance and reliability, estimates of stability, fatigue or other phenomena shall also be presented in addition to design calculations, where necessary.

A description of the computer codes used shall be given if they are not widely known. Also the results of test runs shall be presented in order to assess code suitability and the reliability of the results it yields. The initial values given, the element net chosen, the assumptions made and an interpretation of the results shall be presented in a report summary.

In the dimensioning document, sufficient reference shall be made to source literature, drawings and other documents. When using foreign regulations or standards in dimensioning, the applicability of the dimensioning with reference to Finnish regulations shall be presented.

2.5 Drawings

Drawings describe a steel structure's composition and details in such a way that the structure's size, shape, fabrication and installation with allowable tolerances are accounted for in sufficient detail. Drawings shall be unambiguous and clear. Drawings shall present

- a steel structure's location and how it is connected to other structures
- composition with lists of components, materials and welding filler materials
- sizes and shapes determined by dimensioning with their allowable tolerances
- types of joint with measurements
- surface finishings of a steel structure.

In the drawings, instructions shall be given, where necessary, for the fabrication, installation and quality control of a structure.

2.6 Quality control programme

In a quality control programme the scope of quality control measures applied to a steel structure and the inspection instructions applied in their implementation are presented systematically.

A quality control programme shall contain

- *inspection plans* for base materials, welding filler materials, welded joints and the completed structure as well as the

procedure and work tests to be performed during fabrication
- *inspection instructions* and a list of them or references to standards or instructions issued earlier.

2.6.1 Inspection plans

In the inspection plan the following facts of base material, work tests, welding, coatings and quality control of the completed structure shall be presented:

- type specific numbering of welded joints and components according to drawings
- name and quantity of component
- standard marking of construction materials and welding filler materials as well as type of material certificate
- division of quality control by the headings of the inspection instructions
- programme of procedure tests, where required.

An inspection plan shall be drawn up separately for fabrication at the factory and for installation on site. Also, it shall be stated which parties (manufacturer, approved inspection agency, applicant, the Regulatory Authority) will conduct the inspection or supervise it.

2.6.2 Inspection instructions

Inspection instructions shall be presented for inspection and control measures related to design, fabrication, installation and performance tests of steel structures. In the inspection instructions the method, scope, requirements and report of an inspection shall be presented. As to details, a reference to standards can be made.

The most common quality control measures presented in the inspection instruction can be grouped as follows:

- inspection of construction plans
- marking of and certificates for construction materials
- taking samples for material testing
- destructive testing
- non-destructive testing
- monitoring of procedure tests
- competence of welders according to Standard SFS 2218/15/ or in a corresponding manner
- control of welding
- control of heat treatment
- inspections of structure measurements
- control of coatings
- leaktightness tests
- test loading and performance tests
- reception.

2.6.3 Inspection rights

Companies and their inspectors inspecting Safety Class 2 steel structures shall be approved by STUK. Approval is applied for according to Guide YVL 1.3 /6/. As an exception to the requirements of Guide YVL 1.3, Safety Class 3 steel structures may also be inspected on the basis of inspection rights granted by the Technical Inspection Centre (TTK).

2.7 Other potential reports

In the report, other matters relating to the construction plan are presented such as e.g. a description of fabrication and installation, structure-related special issues, a start-up testing programme.

3 Control of fabrication and construction inspection

3.1 Control of fabrication

The Finnish Centre for Radiation and Nuclear Safety controls fabrication of Safety Class 2 and 3 steel structures at its own discretion by conducting audits at the manufacturing plant and the installation site. STUK's representatives shall be given an opportunity of acquainting themselves with the organization, fabrication methods and quality control of the factory and the installation site. STUK employed inspectors take special interest in the procedure tests of Safety Class 2 steel structures. A steel structure's fabrication schedule is submitted to the Finnish Centre for

Radiation and Nuclear Safety for the purpose of conducting audits.

The Finnish Centre for Radiation and Nuclear Safety does not control fabrication of Class EYT steel structures.

3.2 Construction inspection

A construction inspection of all Safety Class 2 and 3 steel structures is conducted according to Guide YVL 1.15 /8/. Welded joints are inspected before coating is applied.

An inspector employed by STUK performs the construction inspection of Safety Class 2 and 3 steel structures. STUK can also approve a person employed by an inspection agency authorized by STUK or by the power company as a construction inspector of Safety Class 3 steel structures. A proposal concerning this can be submitted either in connection with a construction plan or by a separate application.

A construction inspection is not performed for type accepted products. In so far as a type acceptance is not valid, e.g. concerning a product's installation a construction inspection is conducted in accordance with the above.

The STUK does not perform construction inspections of Class EYT steel structures. The power company shall ensure that a steel structure has been fabricated in conformity with the regulations and designs applicable to it.

4 Commissioning inspection

A steel structure may be brought into use after it has passed the commissioning inspection. The commissioning inspection can be performed upon the approval of a steel structure's construction plan, its installation in the final location and the passing of the construction inspection.

A STUK employed inspector carries out the commissioning inspection of Safety Class 2 and 3 steel structures. An applicant for a licence shall ensure the completion of Class EYT steel structures before plant commissioning.

In the commissioning inspection the following shall be presented

- an approved construction and installation plan and a description of compliance with the conditions in STUK's decisions
- original records of construction inspections with appendices
- deviation reports
- records of test loading and performance tests.

5 Inservice inspection

Inservice inspections of Safety Class 2 and 3 steel structures are conducted according to a specifically prepared programme. The inservice inspection requirements stated in the design data shall be taken into account in the programme.

The applicant shall have STUK's approval for the inservice inspection programmes of steel structures before the commissioning of the nuclear facility. In the inservice inspection programme, the following will be presented

- items subject to inspection and the scopes of the inspections
- inspection intervals
- inspection instructions
- applicable regulations, guides and standards
- inspecting personnel and its competence requirements
- preparation of the items of inspection for inspection
- inspection reports.

When deciding on inservice inspection intervals and their scope, the requirements concerning the use and reliability of a steel structure will be taken into account.

The applicant shall notify STUK of the inservice inspections of Safety Class 2 and 3 steel structures well in advance of their implementation. STUK supervises inservice inspections to the extent it deems necessary.

6 Repairs and modifications

Requirements concerning repairs and modifications implemented at nuclear facilities during operation are presented in Guide YVL 1.8 /7/.

7 Literature

1 370/58 Building Act
2 266/59 Building Decree
3 867/75 Ministry of the Interior: the Finnish Construction Code SFS 3200 Standard
4 YVL 1.1 The Institute of Radiation Protection as the supervising authority of nuclear power plants, 10 May 1976
5 YVL 1.2 Formal requirements for the documents to be submitted to the Institute of Radiation Protection, 1 Dec. 1976
6 YVL 1.3 Mechanical components and structures of nuclear power plants. Inspection licenses, 25 March 1983
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10 YVL 3.0 Pressure vessels in nuclear facilities. General guidelines on regulation, 21 Jan. 1986
11 YVL 3.1 Nuclear power plant pressure vessels. Construction plan. Safety classes 1 and 2, 11 May 1981
12 YVL 3.2 Nuclear power plant pressure vessels. Construction plan. Safety class 3 and class EYT, 21 June 1982
13 YVL 3.3 Supervision of the piping of nuclear facilities, 21 May 1984
14 YVL 4.3 Fire protection at nuclear facilities, 2 Feb. 1987
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