INSTITUTE OF RADIATION PROTECTION

GUIDE YVL 4.2

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In the event of any differences in interpretation of this guide, the Finnish version shall take precedence over this translation

NUCLEAR POWER PLANT STEEL STRUCTURES

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1. GENERAL

This guide deals with licensing procedures and inspections relative to the design, manufacture and use of nuclear power plant steel structures. The provisions of this guide are based on Guide YVL 1.1 and they shall also be applied to other nuclear facilities.

1.1. Regulatory body

The Institute of Radiation Protection (IRP) is the body responsible for the control of safety-related steel structures at nuclear power plants. The function of the IRP does not affect the control measures that are stipulated in Building Act (370/58) and Decree (266/59), unless agreed upon separately by the authorities.

1.2. Scope

This guide bears upon the following nuclear power plant steel structures:

- supporting steel structures of buildings, including steel thin plate structures
- metal liner of the reactor containment
- supports against piping rupture
- non-pressure tanks
- steel lining of pools and tank rooms
- supporting structures of components and pressure tanks
- shielding doors and hatches and pressure doors and hatches
- ice condenser structures

The supporting structures of pressure tanks are dealt with in accordance with this guide as far as they are outside the scopes of Guides YVL 3.1 and 3.2.

As for shielding and pressure doors and hatches, the requirements set forth in Guide YVL 4.3 shall also be given consideration.

The above-mentioned structures are hereinafter jointly referred to as steel structures. If materials other than steel are used in the manufacture of these structures this guide will be followed where applicable.

In addition, nuclear power plants contain other structures than can be classified as steel structures. They are dealt with in the following YVL Guides (the list also includes guides still in preparation):

- fuel stockpiling racks, Guide YVL 2.6
- steel containment and accompanying penetrations, Guide YVL 3.0 and other guides concerning pressure vessels
- internals of the reactor pressure vessel and control rod drives, Guide YVL 3.0 and other guides concerning pressure vessel
- lifting and transfer apparatus, guide will be prepared
- non-pressure piping, Guide YVL 3.3
- piping supports (excluding supports against rupture), Guide YVL 3.3
- control of nuclear power plant ventilation equipment, Guide YVL 5.6.

Instructions and regulations for the surface treatment of steel structures are given in Guide YVL 5.12 (in preparation).

This guide replaces the following SFL Guides:

- SFL Guide 10.00.74, 1974-05-04, Preinspection of Steel Structures
- SFL Guide 16.00.74, 1974-09-25, Construction Inspection (for steel structures).

1.3. Safety classification

Nuclear power plant steel structures are classified into safety classes as specified in Guide YVL 2.1. The division of structures or constructions into the safety classes (1, 2, 3 and EYT) is based on the classification proposed by the applicant and accepted by the IRP.

Maintenance planes, ladders and steel stairs are regarded as supporting steel structures. They are usually placed in Class EYT. However, if components belonging to Safety Classes 1, 2 or 3 are attached to maintenance planes thus causing considerable loads on these planes or sections of these planes, the maintenance planes are for

these parts placed in a safety class that is one class below the classification of the components, but not less than Safety Class 3.

1.4
Inspections

The regulatory work carried out by the IRP comprises the following stages:

- examination of the Preliminary Safety Analysis Report
- preinspection
- supervision of manufacture and construction inspection
- commissioning inspection
- inservice inspections
- inspections of repairs and modifications

The Preliminary Safety Analysis Report (PSAR), which is dealt with in greater detail in Guide YVL 1.1, is examined by the IRP before issuance of the construction permit pronouncement. Instructions for the other inspections are given below.

2.
PREINSPECTION

The preinspection documents for steel structures in safety classes 1, 2 and 3 comprise the following items:

1. Description of the manufacturer
2. Design data
3. Dimensioning
4. Drawings
5. Construction material report
6. Quality control programme
7. Other necessary reports

The preinspection documents are submitted to the IRP in accordance with Guide YVL 1.2 not later than one month before commencement of manufacture. The division of items is based on the principle utilized in this guide. However, the applicant can put forward his own proposal for the timetable and combination of preinspection documents and have it accepted by the IRP.

Products in Safety Class 3 that have been granted a type acceptance certificate effective in Finland require no preinspection certificate given by the IRP, if the products are used as specified in the type acceptance certificate. It is only required that the IRP be submitted the type acceptance certificates of the products for information.

The IRP does not consider it necessary to conduct a preinspection for steel structures belonging to Class EYT. The applicant is responsible for the inspection of the construction plans.

2.1. Description of the manufacturer

The main purpose of the description is to answer the question how the quality assurance of the design and implementation of the steel structure is arranged in the organizations of the applicant, supplier, contractor, manufacturer of the steel structure, construction designer, and any other concerned parties. If this information is given somewhere else, a reference to the document in question is sufficient.

The management of the company shall confirm the organization presented in the description. The organization includes the following items:

- definitions of duties
- competences and responsibilities
- quality assurance arrangements.

A responsible designer and persons answerable for quality assurance and supervision of the work shall be designated for each structure or construction.

In addition, the manufacturer should display corresponding products made earlier so that his competence in the work could be estimated.

2.2. Design data

The purpose of the design data is to define the design basis of the steel structure.

Depending on the structure, the design data shall

include:

- safety class of the steel structure
- definition of the purpose of the steel structure and description of its functions or reference to PSAR
- design bases describing temperature, pressure, external loads, supports, corrosion conditions, etc.
- regulations, standards and guides used as a basis for design and the extent of the scope
- location drawings with additional comments
- geometry of the steel structure, load combinations and load factors with explanations
- inservice inspection requirements that may be caused by the choice of material, construction or operating conditions.

Each load shall be justified, for instance, by referring to regulations, standards, supplementing guides or to accident analyses.

2.3.
Dimensioning

The document shall form a coherent entity explaining how the dimensioning is derived from load combinations and material properties. The document shall be explicit enough so that it is possible to form a judgement about the accuracy of the calculation method employed and the fulfilment of the dimensioning requirements.

When necessary, the estimate of the strength of the steel structure shall be complemented with estimates of stability, fatigue or some other phenomenon, depending on structure and operating conditions.

The dimensioning shall as a rule be performed by means of the theory of elasticity. However, the dimensioning against accident loads can also be performed by means of an acceptable limit analysis method.

If the dimensioning of the structure is performed

using a computer code, the suitability of the code to the task shall be justified. The document shall also include operating instructions for the code. The suitability and adequacy of the element model that is used shall be shown. The document shall also give examples of the utilization of the output lists.

In preparing the dimensioning document, extra attention shall be paid to unambiguous presentation and arrangement of topics. The document shall contain necessary references to other documents, source literature and drawings. If foreign regulations or standards are used in dimensioning, an estimate of the applicability of the dimensioning with reference to Finnish regulations shall be presented.

2.4. Drawings

The purpose of the drawings is to describe the prefabrication, assembly and details of the steel structure in such a way that the dimensioning, shape and manufacture of the structure become apparent in adequate detail.

The drawings shall be unambiguous and clear. The following information is essential:

- connections with other documents (references and bibliographical data)
- measures and shapes with tolerances used in or obtained from strength calculations
- types, locations and measures of joints
- assembly data, including lists of parts and constructions materials.

The drawings shall give necessary instructions for the manufacture, installation and quality control of the structure.

2.5. Construction material report

The purpose of the construction material report is to give an account of the applicability of the construction materials to their intended use, and to give such information about the construction materials and their properties that the unambiguous definition of acceptance bases and limits is possible.

The construction material report includes material data for each part of the supporting structures. The data shall manifest

- standard symbols and types of base material and welding filler material
- fabrication method and state of delivery of the base material and type of material certificate
- design data essential to choice of material and supervision or an explicit reference to a document where these data can be found.

The construction materials shall meet the requirements presented in applicable standards.

2.6.
Quality control programme

The purpose of the quality control programme is to give a systematic presentation of the quality control measures and inspection procedures that the steel structure is subjected to.

The quality control programme includes

- definitions
- instructions for inspections
- inspection plans for base materials, joints, surface materials and completed structure

2.6.1
Instructions for inspections

Instructions shall be given for all inspection measures that are related to the fabrication and installation of steel structures and to representative procedure or work tests. The instructions shall describe the method, extent, requirements and reporting of the inspection. As regards details, reference can be made to standards.

The most common quality control measures presented in the instructions for inspections can be grouped as follows:

- identification, marking and certificates of construction materials
- taking of test specimens
- destructive material testing
- nondestructive material testing
- supervision of welding and competence of welders
- supervision of heat treatments
- inspections of the structure measurements
- integrity tests
- other inspections performed for the steel structure.

2.6.2.
Inspection plans

The inspection plans shall indicate what quality control measures are taken for the base material, work tests, welding, installation and completed structure of each part and welded joint.

The following information shall be presented in the plan:

- numbering for each part and welded joint in accordance with the drawings
- name and quantity of the part
- standard symbol of base material and welding filler material
- which procedure test qualifies each welded joint
- division of quality control measures according to instructions for inspections.

It must be stated for each inspection included in the plan whether it is carried out at the fabrication mill, machine shop or at the installation site and which parties (e.g. manufacturer, inspecting body, supplier, applicant, regulatory body) perform the inspection or supervise it.

The inspecting companies and inspectors employed by them for the quality control of steel structures in Safety Classes 1 and 2 shall be approved by the IRP. The approval is applied for in accordance with Guide YVL 1.3.

2.7.
Other necessary reports

The report discusses other matters relative to the preinspection of structure. These may include, for instance, description of manufacture and installation, special issues concerning the structure, and start-up testing programme.

3.
SUPERVISION OF MANUFACTURE AND CONSTRUCTION INSPECTION

3.1.
Supervision of manufacture

The IRP supervises the manufacture of steel structures of Safety Classes 1, 2 and 3 by conducting audits at the fabrication mill and the installation site. The IRP must be given an opportunity to become acquainted with the organization, fabrication methods and quality contro at the mill and at the installation site. Prior to the audits, the IRP shall be submitted a fabrication schedule of the steel structure, which also determines times for the inspections required by the quality control programme. When necessary, the IRP follows these inspections, however, procedure tests for steel structures of Safety Classes 1 and 2 are always supervised by an IRP inspector. The manufacture of steel structures in Class EYT is not supervised by the IRP.

3.2.
Construction inspection

The construction inspection is conducted for all steel structures that lie within the scope of preinspection. It includes the inspection of results obtained in quality contro, visual inspection of supporting structures, possibly supplemented by nondestructive testing and in some cases an integrity test.

Products that have been granted a type acceptance require no construction inspection. A normal construction inspection is carried out for those parts, for instance as concerns the installation, that are not included within the scope of the type acceptance.

The inspection request shall be submitted to the IRP in accordance with Guide YVL 1.2. If the accessibility of a supporting part in the steel structure is worsened in the course of the manufacture, part of the construction inspection shall be performed before continuation of the work.

The construction inspection of steel structures in Safety Classes 1, 2 and 3 is performed by an inspector employed by the IRP; the IRP can also accept the owner of the nuclear power plant or a person working for a separate inspecting body accepted by the IRP as the executor of the construction inspection of steel structures in Safety Class 3.

Records of all the construction inspections of the steel structure are presented to the inspector in connection with the commissioning inspection. The records of construction inspection are prepared in such a way that they explicitly express the structural unit that has been inspected.

The applicant is responsible for the construction inspections of steel structures in Class EYT.

4. COMMISSIONING INSPECTION

The steel structure can be placed in service after it has been accepted in the commissioning inspection. An inspector employed by IRP performs the commissioning inspectors for steel structures in Safety Classes 1, 2 and 3. In the commissioning inspection phase of steel structures in Class EYT the applicant shall give an account of their commissioning inspection procedures and have these accepted at the IRP.

The owner of the nuclear power plant shall present a written commissioning inspection request to the IRP after the steel structure has been accepted in a preinspection, installed in its permanent place and accepted in a construction inspection.

In the commissioning inspection it is ascertained that the installed steel structure has undergone a preinspection and a construction inspection and that their requirements have been met.

During the inspection, the inspector shall be shown the following documents concerning the steel structure:

- accepted preinspection material and the acceptance certificate and a written account of the fulfilment of the requirements set in a conditional acceptance
- original record of the construction inspection with appendices
- deviation reports

Records are written of all commissioning inspections of steel structures. They shall be prepared in such a way that the general state of the commisioning inspections can be easily demonstrated, when necessary. In the inspection record, the executor of the commissioning inspection permits the use of the steel structure as intended in the design documents. On the basis of the inspection, the inspector can also forbid the use of the structure or modify the conditions for use if the steel structure is not in conformity with regulations.

5. INSERVICE INSPECTION

The owner of the nuclear power plant shall conduct inservice inspections for the steel structures in accordance with a separately prepared programme. The inservice inspection requirements given in the design data shall be taken into account in preparation of this programme.

The applicant shall submit the inservice inspection programmes of steel structures to the IRP for approval not later than three months before the planned loading of the reactor. The inservice inspection programme shall describe

- objects and scope of inspection
- inspection cycles
- applicable standards and other regulations
- competence requirements of the inspecting personel
- preparation of the object of inspection for the inspection
- inspection methods and equipment to be used
- calibration requirements of the inspection equipment

- acceptance criteria of the inspection results
- reporting of the inspections and filing of the results

Any detailed instructions concerning the inservice inspections can be submitted to the IRP for approval at a later stage, but not later than one month before the plannede inspection.

The IRP supervises the above-mentioned inservice inspections and, in accordance with a programme of its own, conducts inspections relative to the supervision of operation.

6. REPAIRS AND MODIFICATIONS

Requirements for repairs and modifications on nuclear power plants during operation are given in Guide YVL 1.8 Separate reports on repairs and modifications and on events leading to these shall be prepared in accordance with Guide YVL 1.5.

7. LITERATURE

357/57	Atomic Energy Act
7/73	Act on Amendments to Atomic Energy Act
74/77	Act on Amendments to Atomic Energy Act
75/58	Atomic Energy Decree
735/70	Decree on Amendments to Atomic Energy Decree
555/73	Decree on Amendments to Atomic Energy Decree
75/77	Decree on Amendments to Atoic Energy Decree
536/74	Act on the Institute of Radiation Protection
103/75	Decree on the Institute of Radiation Protection
124/76	Decree on Fees Charged for Safety Control of Nuclear Power Plants
370/58	Building Act
266/59	Building Decree
867/75	Ministry of the Interior: the Finnish Construction Code SFS 3200 Standard
YVL 1.1	The Institute of Radiation Protection as the Supervising Authority of Nuclear Power Plants
YVL 1.2	Formal Requirements for the Documents to be Submitted to the Institute of Radiation Protection
YVL 1.3	Acceptance of Separate Inspecting Bodies

to Carry Out Inspections of Main Components and Systems of Nuclear Power Plants

YVL 1.4 Quality Assurance Program for Nuclear Power Plants

YVL 1.5 Reporting Nuclear Power Plant Operation to the Institute of Radiation Protection

YVL 1.8 Supervision of Repairs and Modifications on Nuclear Power Plants during Operation

YVL 2.1 Safety Classification of Nuclear Power Plant Systems, Structures and Components

YVL 3.0 Nuclear Power Plant Pressure Vessels. General Guidelines on Inspection

YVL 3.1 Nuclear Power Plant Pressure Vessels. Construction Plan. Safety Classes 1 and 2

YVL 3.2 Preinspection of Special Pressure Vessels (not Including Vessels of Higher Safety Classes) SFL Guide 9

YVL 4.3 Nuclear Power Plant Fire Protection