STUK

GUIDE **YVL 1.15** / 28 APRIL 2008

MECHANICAL EQUIPMENT AND STRUCTURES OF NUCLEAR FACILITIES

Construction inspection

As regards new nuclear facilities, this guide is valid as of 1 November 2008 until further notice. At operating nuclear facilities, and those under construction, this guide is enforced by a separate STUK decision. This guide replaces Guide YVL 1.15, issued on 19 December 1995.

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Authorisation

By virtue of the below acts and regulations, the Finnish Radiation and Nuclear Safety Authority (STUK) issues detailed regulations that apply to the safe use of nuclear energy and to physical protection, emergency preparedness and safeguards:

- section 55 of the Nuclear Energy Act (990/1987)
- section 29 of the Government Decision (395/1991) on the safety of nuclear power plants
- section 13 of the Government Decision (396/1991) on the physical protection of nuclear power plants
- section 11 of the Government Decision (397/1991) on the emergency preparedness of nuclear power plants
- section 8 of the Government Decision (398/1991) on the safety of a disposal facility for reactor waste
- section 30 of the Government Decision (478/1999) on the safety of disposal of spent nuclear fuel.

Rules for application

The publication of a YVL guide does not, as such, alter any previous decisions made by STUK. It is only after having heard those concerned that STUK makes a separate decision on how a new or revised YVL guide applies to operating nuclear power plants, or those under construction, and to licensees' operational activities. The guides apply as such to new nuclear facilities.

When considering how new safety requirements presented in YVL guides apply to operating nuclear power plants, or those under construction, STUK takes into consideration section 27 of the Government Decision (395/1991), which prescribes that *for further safety enhancement, action shall be taken which can be regarded as justified considering operating experience and the results of safety research, as well as the advancement of science and technology.*

If deviations are made from the requirements of the YVL guides, STUK shall be presented with some other acceptable procedure or solution by which the safety level set forth in the YVL guides is achieved.

Translation. Original text in Finnish.

1 General

This guide presents the principles to be followed in performing the construction inspections of mechanical equipment and structures of nuclear facilities.

Construction inspection means inspections and tests to ascertain that equipment or structures have been manufactured, modified or repaired and quality control implemented in accordance with an approved construction plan and procedures. In addition, it is verified that the equipment or structures have not been treated in a way that would negatively affect their endurance and functioning during service.

Based on their safety significance, mechanical equipment and structures are divided into five construction inspection areas:

1. equipment and structures inspected by the Finnish Radiation and Nuclear Safety Authority (STUK)
2. equipment and structures inspected by a STUK-approved inspection organisation
3. equipment and structures inspected by the licensee
4. equipment and structures whose construction inspection (conformity assessment) is conducted by a notified body or a user inspectorate
5. equipment and structures not subject to construction inspection.

2 Definitions

For the purposes of this guide

- mechanical equipment and structures mean i.a. pressure equipment, reactor pressure vessel internals, control rod drives, motors, filters, valve actuators, cranes, auxiliary hoisting equipment, fuel handling equipment, final disposal canisters, pool linings, fans, air ducts and steel structures as well as materials and test pieces used in their manufacturing
- a licensee is a licensee as referred to in section 9 of the Nuclear Energy Act (990/1987)
- a notified body is an inspection organisation that has been reported under Pressure Equipment Directive 97/23/EY of the European Parliament and the Council of the European Union
- a user inspectorate is an inspection organisation designated by the Ministry for Employment and the Economy
- a STUK-approved inspection organisation is an inspection organisation approved in accordance with Guide YVL 1.3
- an inspector is an inspector employed by STUK or a STUK-approved inspection organisation
- pressure equipment is defined as vessels, pipings, pumps and other technical assemblies in which overpressure exists, or within which it may develop, as well as technical assemblies intended to protect pressure equipment.

3 Construction inspection areas and rights

3.1 Inspection areas

A construction inspection is carried out by STUK, a STUK-approved inspection organisation or the licensee in accordance with STUK's plant-specific decisions about inspection sharing. The general principles of pressure equipment inspection sharing are given in Guide YVL 3.0. The same principles apply to other mechanical equipment and structures. The details of inspection sharing are defined in separate decisions about each inspection area. The conformity of conventional pressure equipment is assessed by an appointed notified body or a user inspectorate under regulations based on the Pressure Equipment Act.

To define the construction inspection areas, the licensee shall maintain a document defining the general principles of inspection sharing and detailed inspection areas as per inspection organisation. STUK's decisions on construction inspection sharing and YVL guides that apply to the equipment or structures in question shall be followed when defining the limits of inspection areas.

3.2 Inspection rights

Upon application by the licensee, STUK may grant construction inspection rights to an inspection organisation in accordance with Guide YVL 1.3. The application shall be submitted to STUK in accordance with Guide YVL 1.2. It shall identify the groups of assemblies and structures

subject to inspection and the types of inspection covered.

Guide YVL 1.3 describes the qualification, approval, obligations and oversight of operation of the inspection organisations and inspectors.

4 Content and performance of construction inspection

4.1 Content of construction inspection

Construction inspection contains

- review of manufacturing and quality control result material
- inspection of equipment or structures and their dimensional check or its verification
- pressure test, if necessary
- inspections after pressure test
- loading and leaktightness tests, if necessary
- functional tests, if necessary.

The prerequisite for a construction inspection is that the item of inspection's construction plan has been approved by STUK or a STUK-approved inspection organisation in accordance with decisions about construction inspection sharing; and that the manufacturer, licensee and, in connection with a plant delivery, the plant supplier, have verified the item of equipment or structure as being in compliance with the construction plan. Construction inspection is usually made on completed equipment or structures at the manufacturer's premises before delivery or installation.

If inspection becomes more difficult as manufacturing proceeds, or after assembly, an adequate number of parts of construction inspection shall be carried out during the various manufacturing phases. The manufacturer is responsible for the timely performance of the inspections. The timing of construction inspection parts in relation to manufacturing phases shall be specified in the construction plan. The parts of multi-compartment pressure equipment shall be inspected both internally and externally during every manufacturing phase. The equipment or structures to be coated shall be inspected before and after coating when considered necessary.

The installation of an item of equipment or structure shall be checked in a construction inspection that is in accordance with this guide. Spare parts are subject to inspection in the extent specified in Guide YVL 1.8.

The approved construction plan, related decisions by STUK or a STUK-approved inspection organisation and potential approved modification documents shall be presented to the inspector early in the construction inspection at the latest. In addition, the manufacturer and licensee shall upon request make available to the inspector other documents relating to the construction plan or presented in its references.

Item-of-equipment specific requirements pertaining to construction inspection are given in YVL guides dealing with mechanical equipment and structures.

4.2 Review of manufacturing and quality control result material

The result material shall be systematically gathered. The result material and the structure shall be approved by both the manufacturer and licensee and, in connection with a plant delivery, the plant supplier. In addition, the result material for nuclear pressure equipment shall be approved by a person in charge of manufacturing in accordance with Chapter 3 of Guide YVL 3.4.

The result material shall contain the test reports required in the quality control plan and procedures as well as in any additional requirements. The qualification of manufacturing methods and the qualifications of persons making permanent joints and performing NDT tests shall be described as well.

Based on the result material, it is verified that

- manufacturers of nuclear pressure equipment have approval in accordance with Guide YVL 3.4
- testing organisations performing testing of structures have approval in accordance with Guide YVL 1.3
- testing organisations performing destructive and non-destructive testing of the materials of the main components of pressure equipment in Safety Classes 1 and 2 have approval in accordance with Guide YVL 1.3; in other respects, qualification requirements in accordance with the product standard in ques-

tion apply to testing done during the material manufacturing process
- a STUK-approved third party is the organisation witnessing and verifying sampling and testing for material certificates 3.2 and witnessing welding filler material tests and their testing
- equipment or structures have been manufactured in accordance with the construction plan and the prerequisites for manufacturing
- the materials and welding filler materials used have been selected and tested as required in the construction plan; the results have been validated by conforming material certificates; and the results of materials testing fulfil the requirements of the material standard and the construction plan
- persons making permanent joints have valid qualifications in accordance with Guide YVL 3.4 as regards nuclear pressure equipment, and joints have been made according to a procedure stated in the approved construction plan
- testers carrying out testing during manufacturing have valid qualifications in accordance with the requirements
- the construction plan and the procedures stated in applicable standards have been followed in a potential heat treatment and its witnessing; and persons performing the heat treatment of nuclear pressure equipment have approval in accordance with Guide YVL 3.4
- supervision of manufacturing by the manufacturer, licensee and possibly a third party has been conducted as required in the approved quality control programme and Guide YVL 1.14.

Any remarks arising from this inspection, which could jeopardise the safety or acceptability of a pressure test, shall be clarified before the test.

4.3 Inspection and dimensional check of structure before pressure test

Inspection and dimensional check of structure shall be performed on completed equipment or structures after potential heat treatment but before any kind of coating of surfaces. In preparation for the inspection, the manufacturer shall ensure safe access to all pressure vessel surfaces for example. The inspectors shall be provided with adequate lighting, calibrated measuring instruments and auxiliary devices as well as the necessary assisting personnel.

In the inspection of the structure, it shall be verified that the main dimensions essential for the structure and its strength conform to the manufacturing drawings. Materials shall be identified and their conformity with the approved construction plan verified. To be verified is also that their markings correspond to the test reports of manufacture and testing. The traceability of materials, permanent joints and non-destructive testing shall be verifiable. The inspector must verify that the material was not damaged during manufacture and that welded joints fulfil the requirements of the construction plan. Special attention shall be paid to weld soundness and height, potential undercuts and root concavity as well as arc strike. Possible nonconformances in the structure's shape shall be established. In addition, it shall be verified that potential temporary supports and brackets used during manufacturing and installation have been properly removed.

All repairs arising from this inspection shall be carried out and inspected before the pressure test.

4.4 Additional inspections

If the inspector detects shortcomings, errors or discrepancies in materials testing, manufacturing result material or inspection of the structure, he may, instead of rejection, extend the inspections or, upon his discretion, call for additional testing to supplement original materials testing to become convinced of the acceptability of the item of equipment.

4.5 Pressure test

Pressure equipment are subject to a pressure test to demonstrate the integrity and strength of the completed product.

The pressure test, which belongs to construction inspection, is conducted after test reports have been reviewed and the structure inspected when an inspector has verified testing readiness.

The pressure test shall be carried out using liquid. If not practical, it may, for justified reasons, be substituted by a pneumatic test or a

combined hydrostatic/pneumatic test. The testing method shall be taken into account during pressure equipment design already. During the pneumatic test, special attention shall be paid to work safety. The pressure test type and test pressure are specified in the construction plan.

The pressure test shall be carried out under controlled conditions with appropriate safety precautions and equipment and in such a way that it is possible for those responsible for the test to inspect all pressure retaining parts. Operations influencing the inspectability of pressure retaining parts, such as painting, insulation, brickwork, lining, galvanising, enamelling, etc. shall only be carried out following an approved pressure test.

If it is not practicable, due to size or mode of manufacture, to pressure test a complete structure, approval for the test procedure to be followed shall be applied for in the construction plan.

No pressure equipment shall be subject to any form of shock loading such as hammer testing when undergoing pressure testing.

Detailed requirements for pressure testing, e.g. water quality, increasing of pressure and the time the system is held at test pressure are given in the manufacturing and inspection standards (e.g. EN 13445-5 and EN 13480-5).

An item of pressure equipment shall be leaktight and is not to suffer permanent deformation.

4.6 Inspection of structure after pressure test

The inspection shall be conducted after completion of the pressure test and after the structure has been drained and cleaned. The inspection verifies that the pressure test has not caused deformation or other damage to the pressure retaining structure. All blind flanges fitted to isolate components not subject to pressure testing shall have been removed. Every gauge fitted to the vessel for the purpose of pressure testing shall have been removed. Coating inspection shall be a separate inspection. The extent of the inspections and non-conformances shall be reported.

4.7 Load and leaktightness tests

Load and leaktightness tests, which belong to the construction inspection, may be conducted after a review of test reports and inspection of the structure when an inspector has verified testing readiness.

Load and leak tightness tests shall be performed in accordance with the construction plan requirements. The requirements are determined by YVL guides pertaining to individual structures or components and applicable standards.

4.8 Functional tests

The extent of functional tests shall be specified in an approved construction plan or in a separately approved test programme.

Functional tests shall be performed as separate tests or in connection with systems testing in which case they shall fulfil the requirements of Guide YVL 2.5 and component specific YVL guides.

If electrical and I & C equipment essential from the testing point of view are connected to the tested component, the manufacturer shall demonstrate its readiness before functional tests. Guides YVL 5.2 ja YVL 5.5 present requirements for the electrical and I & C systems of nuclear facilities.

5 Approval requirements

A component or structure passes the construction inspection if it is verified to be in accordance with the approved construction plan and fulfils all its requirements and when all inspections and tests required in the construction plan have been performed. Remarks documented during construction inspections shall have been clarified.

6 Actions in case of non-conformances

If it is found in an inspection that a component or structure does not fulfil the requirements of the construction plan or it has shortcomings and drawbacks affecting safety, these shall be reported to the manufacturer, licensee and, where necessary, to STUK.

If the component or structure is put into service with the shortcoming or drawback uncorrected, the manufacturer shall obtain approval for the non-conformance. A non-conformance report shall describe the non-conformance, ex-

plain its cause, give justification for its approval and, where necessary, present an action plan to prevent its recurrence. The non-conformance report shall be approved by the manufacturer, licensee and, in connection with a plant delivery, the plant supplier. An approval for the non-conformance shall be obtained from STUK or a STUK-approved inspection organisation following the same procedure used for construction plan approval. STUK's approval shall always be obtained for deviations from the requirements of YVL guides and STUK-approved specifications.

During the construction inspection, it shall be ensured that documentation relating to potential repairs has been attached to the manufacturing documentation.

Approved non-conformance reports shall be attached to the manufacturing documentation of the item of equipment or structure.

During the construction inspection, the inspector may approve minor, normal non-conformances that do not affect the operability, strength or functioning of the item of equipment or structure provided that the non-conformances have been approved by the manufacturer, licensee or, in connection with a plant delivery, the plant supplier.

7 Construction inspection records

The construction inspector draws up an inspection record or certificate specifying the item of inspection and the inspections made. Detected shortcomings are entered as remarks in an attachment to the inspection protocol.

Construction inspection is completed and the inspection protocol signed when the inspected item of equipment or structure has undergone all inspections and testing required in the construction plan and when remarks documented during the construction inspections have been clarified. An inspection protocol and potential attachments are drawn up for both licensee and inspection organisation. The protocol is signed by the inspector and a representative of the licensee acknowledges its receipt by his signature.

The inspector verifies that the component's main structures and nameplate carry markings in accordance with regulations. On the nameplate and body of the item of pressure equipment to be registered he enters the identification markings required in the relevant YVL guide and applicable standards.

8 Obligations of licensee and manufacturer

The licensee and manufacturer shall ensure that the item of equipment or structure to be inspected can be expected to pass the construction inspection.

The licensee and manufacturer are responsible for the inspection arrangements, the necessary facilities and equipment as well as the assisting personnel.

The licensee is obliged to ensure that all manufacturing plans for the item of equipment or structure as well as the approvals and conditions pertaining to them are taken into account in the construction inspection.

The licensee is obliged to agree with the manufacturer or importer inspection dates essential for the construction inspection. Taken into account then shall be possible approval procedures and parts of construction inspection relating to the various phases of manufacturing. The licensee shall set a condition in their procurement agreement making possible audits in accordance with this guide at the premises of the manufacturer and subcontractors.

For the purpose of pressure and leak tightness tests, the manufacturer shall ensure that the item of pressure equipment has been cleaned and all pressure retaining parts and connections are accessible for inspection; and provide an adequate set-up for the performance of the pressure and leaktightness test; as well as arrange for safety precautions during the pneumatic test in particular.

The licensee shall ensure that adequate readiness exists to perform functional tests and inspect the item of equipment disassembled after the tests.

The licensee shall file the construction inspection records until the removal from service of the item of equipment or structure.

9 Obligations of inspection organisation and inspector

In making a construction inspection, the inspector of a STUK-approved inspection organisation shall follow the requirements of this guide.

General requirements and obligations for inspection organisations and inspectors making construction inspections of pressure equipment are given in Guide YVL 3.0. Similar obligations apply to inspection organisations and inspectors performing construction inspections of the nuclear facility's other mechanical equipment and structures. Detailed obligations for inspection organisations and inspectors are given in Guide YVL 1.3.

In addition, equipment and structure specific inspection requirements and procedures are given in the relevant YVL guides.

Inspection organisations shall witness functional tests pertaining to construction inspections to an extent adequate to verify an item of equipment's functioning.

10 Oversight by STUK

STUK oversees the manufacturing and installation as well as repair and modification of components and structures important to the safety of nuclear facilities by reviewing construction plans, witnessing manufacturing and by making construction and commissioning inspections. The general oversight of repairs, modifications and preventive maintenance at nuclear facilities is described in Guide YVL 1.8. Detailed requirements are set forth in component specific YVL guides.

STUK witnesses functional testing relating to the construction inspection of components in Safety Classes 1 and 2 to an extent adequate to verify a component's operation.

STUK approves inspection organisations performing construction inspection. The approval of a construction inspector is part of the approval of an inspection organisation. During its review and inspection activities, STUK oversees the operation of inspection organisations and inspectors it has approved. The need for separate audits is specifically assessed for every inspection organisation. A separate audit is conducted when it becomes evident that an inspection organisation has deviated from the conditions of the approval decision or when its operations do not otherwise fulfil the requirements set for them. An audit's purpose is to establish the quality and severity of non-conformances relating to the activities of the inspection organisation or inspector and determine the corrective actions required. The oversight procedure ensures the organisation's quality of operations complies with the approval decision for its entire period of validity.

11 References

1. Nuclear Energy Act (990/1987)
2. Nuclear Energy Decree (161/1988)
3. Pressure Equipment Directive 97/23/EY
4. Unfired pressure vessels EN 13445-5
5. Metallic industrial piping EN 13480-5