Pressure vessels of nuclear facilities

Commissioning inspection

This Guide is valid as of 15 January 1992 until further notice. This Guide replaces Guide YVL 3.7 issued on 16 March 1976.

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Authorization

By virtue of section 55, second paragraph, point 3 of the Nuclear Energy Act (990/87) and section 29 of the Council of State Decision on the General Regulations for the Safety of Nuclear Power Plants (395/91), the Finnish Centre for Radiation and Nuclear Safety issues detailed regulations concerning the safety of nuclear power plants.

The YVL Guides are rules an individual licencee or any other organization concerned shall comply with, unless the Finnish Centre for Radiation and Nuclear Safety has been presented with some other acceptable procedure or solution by which the safety level laid down in YVL Guides is achieved.

Translation. Original text in Finnish.

1 General

The safety of pressure vessels is part of the safety of nuclear facilities. The control of pressure vessels ensures that pressure vessels in all Safety Classes and in Class EYT and their auxiliary equipment satisfy the requirements set for them. Safety classification requirements are given in Guide YVL 2.1.

Prior to their commissioning, pressure vessels are subject to control as follows:

- inspection of construction plans
- control of manufacture
- construction inspections
- commissioning inspections.

This Guide presents general requirements for the commissioning inspections and for the contents of the inspections. Detailed requirements are presented in other YVL Guides and in standards referred to in this Guide, e.g. Standard SFS 3334 /1/.

Prior to the commissioning of a nuclear facility, pressure vessels are subject to commissioning inspections in accordance with this Guide. In operational repairs and modifications, requirements concerning the commissioning inspection are applicable to inspections conducted according to Guide YVL 1.8. If the repairs and modifications are very extensive and include e.g. construction and installation of new pressure vessels or other extensive entities, the commissioning inspections shall be conducted according to Guide YVL 3.7.

I.a. pressure tanks and piping are pressure vessels. Detailed definitions are presented in Guide YVL 3.0.

The commissioning inspections required by Finnish pressure vessel regulations and pressure vessel safety in general of all pressure vessels and their auxiliary equipment controlled by the Centre, their safety classification notwithstanding, are carried out by an inspector of the Finnish Centre for Radiation and Nuclear Safety; with the exception of Class EYT/B piping and auxiliary equipment. The utility shall attend to the safety of Class EYT/B piping and auxiliary equipment in a way corresponding to that of Class EYT/A piping.

In the commissioning inspection it is ascertained that a pressure vessel which has been installed in its place plus its auxiliary equipment and their performance conform to approved designs; it is also ascertained that adequate testing and inspections have been conducted to ensure the above. It is further ascertained that any defects and shortcomings detected during testing and inspections have been corrected. A pressure vessel may be placed into service only after an inspector has approved it in a commissioning inspection and has determined the allowable operating parameters. Approved commissioning inspections are one prerequisite for the commissioning of a nuclear facility.

The utility may submit a request for a commissioning inspection to the Finnish Centre for Radiation and Nuclear Safety after the pressure vessel and its auxiliary equipment have been installed in their place and have been approved in the construction inspection. To facilitate the procedure of obtaining an operating licence for a nuclear facility, commissioning inspections are conducted to entities as large as possible, such as a system's all piping and its auxiliary equipment. Pressure vessels are inspected individually, however.

For practical reasons, the commissioning inspection will be in two phases, namely:

- the verification inspection which is conducted on a pressure vessel and its auxiliary equipment which have been installed in their place and
- auxiliary equipment performance tests conducted on a pressure vessel which has been approved in a verification inspection.

In the verification inspection, the pressure vessel is granted a test operating licence which is a prerequisite for the starting of auxiliary equipment performance tests. Approved auxiliary equipment performance tests, for their part, are a prerequisite for the granting of a pressure vessel operating licence by an inspector.

When issuing the operating licence, the inspector determines the dates of forthcoming inservice inspections.

2 Verification inspection

A verification inspection is commenced only after the Finnish Centre for Radiation and Nuclear Safety has approved the plans for the location, auxiliary equipment and construction of the pressure vessel; and, after any potential further requirements which may have been made and all deviations which have appeared have been dealt with to the Centre's satisfaction. The pressure vessel's auxiliary equipment shall be structurally and functionally appropriate and reliable, as required by safety considerations. The pressure vessel and its auxiliary equipment shall have been installed in their place and approved in a construction inspection.

In the verification inspection it will be ascertained that the plans for the location, auxiliary equipment and structure of the pressure vessel, and the construction inspections have been approved, and that the plans have been complied with; also the prerequisites for safely starting the performance tests of the pressure vessel's auxiliary equipment will be assessed. If, according to the YVL Guides, there is no need to subject the plans to the Finnish Centre for Radiation and Nuclear Safety for approval, and, if an inspector of the Centre does not conduct a construction inspection of the items, the items shall, however, meet the design and inspection requirements of relevant standards and of utility instructions.

The location, auxiliary equipment and other prerequisites for operation of the pressure vessel shall meet the requirements of Standards SFS 3323 /2/ and SFS 3333 /3/ and of the boiler and boiler plant standards, where appropriate.

As early as during the construction inspection, some attention shall be paid to the requirements of the verification inspection since extensive changes in the installation of the pressure vessel and its auxiliary equipment may be difficult to implement later.

2.1 Verification document

The verification document is an entity of documents which has been written and arranged, and shall be stored, as agreed upon with the Finnish Centre for Radiation and Nuclear Safety; it contains documents relating to the design, approval and inspection of the pressure vessel, and inspection protocols, quality control result documentation and other records relating to the pressure vessel.

It is ascertained during the inspection of the verification document that the pressure vessel and its location and auxiliary equipment have been approved in all necessary previous inspections, and that all documents have been duly written and arranged for final storage and for the vessel's operation.

In a verification inspection, an inspector shall be presented with the following documents in particular:

- plans for location and auxiliary equipment approved by the Finnish Centre for Radiation and Nuclear Safety

- decisions granting approval
- construction inspection protocols for the pressure vessel and its auxiliary equipment
- a statement of the utility's approval of such auxiliary equipment for which a construction plan inspection or a construction inspection is not required in the YVL Guides
- reports and approvals relating to any additional requirements and remarks made by the Finnish Centre for Radiation and Nuclear Safety or by an inspector of the Centre and
- deviations from design with approvals.

2.2 Location

The Finnish Centre for Radiation and Nuclear Safety reviews the location plans for the pressure vessel and its auxiliary equipment as part of a review of the preliminary and final safety analysis reports referred to in Guide YVL 1.1. The plans shall be so detailed that the meeting of the below requirements may be assessed already when processing the plans.

In the verification inspection it is inspected that the pressure vessel and its auxiliary equipment have been located and that the surrounding spaces and structures have been built according to design; which ensures that

- potential pressure discharges in the event of failures or operational transients do not cause damage to individuals, property or the environment
- the pressure vessel and all its auxiliary equipment may be properly operated, maintained, repaired, tested and inspected; special attention has been paid to accessibility during inservice inspections conducted in accordance with Guides YVL 3.0 and YVL 3.8.
- the requirements of Standards SFS 3323 /2/ and SFS 3333 /3/ concerning location and
- the requirements of Guide YVL 7.18 concerning radiation safety, will be met.

2.3 Auxiliary equipment

The pressure vessel shall be fitted with reliable auxiliary equipment which are required during operation and which ensure operational safety; they shall be marked in the system's flow sheet and list of auxiliary equipment. When reviewing the plans for systems and components, the Finnish Centre for Radiation and Nuclear Safety considers the flow sheet also in terms of pressure vessel safety. It is checked that both the design and operating pressures and operating temperatures have been correctly chosen, and that the pressure vessel has been fitted with the below auxiliary equipment which are required in Standards SFS 3323 /2/ and SFS 3333 /3/ and which affect pressure vessel safety:

- safety devices
- shut-off and drainage valves
- equipment for the measurement of pressure and temperature
- equipment for the control and limitation of pressure and temperature and
- equipment for the control and measurement of liquid level.

In the verification inspection it is ensured that the final installation of the pressure vessel and its auxiliary equipment is in accordance with the flow sheet approved by the Finnish Centre for Radiation and Nuclear Safety and with a list of auxiliary equipment based on the flow sheet. The auxiliary equipment shall bear markings facilitating their identification and the establishment of construction materials, allowable operating parameters and manufacturer. In the inspection it will be ensured that all inspections related to the auxiliary equipment have been conducted.

The pressure vessel's auxiliary equipment shall be listed based on an up-to-date flow sheet approved for the purpose of inspecting the quality of the installation work; this list of auxiliary equipment can also be utilized when carrying out auxiliary equipment performance tests prior to and after the commissioning of the nuclear facility. The list shall be approved by the utility and shall be updated also during operation. It shall carry the following information on auxiliary equipment

- component designations
- names
- type markings
- serial numbers
- nominal sizes
- nominal pressures
- nominal temperatures
- construction materials
- references to standards and
- manufacturers.

The requirements of YVL Guides concerned with auxiliary equipment are dependent on the Safety Class and nominal size of the equipment. If a pressure vessel has been fitted with auxiliary equipment for which a construction plan inspection or a construction inspection by the Finnish Centre for Radiation and Nuclear Safety is not required in the below YVL Guides, the equipment shall conform to the utility's instructions and a description of the utility's approval is required:

- Guide YVL 5.3 Regulatory control of nuclear facility valves and their actuators
- Guide YVL 5.4 Supervision of safety relief valves in nuclear facilities
- Guide YVL 5.5 Supervision of electric and instrumentation systems and components at nuclear facilities
- Guide YVL 5.7 Pumps at nuclear facilities.

The utility shall see to it that all auxiliary equipment meet the basic requirements of Standards SFS 3323 /2/ and SFS 3333 /3/.

3 Auxiliary equipment performance tests

An approved verification inspection is the prerequisite for the granting of a trial run licence for a pressure vessel by an inspector. Approved performance tests of auxiliary equipment for their part, are the prerequisite for the granting of an operating licence for the pressure vessel by an inspector.

As part of a nuclear power plant's trial run, performance tests shall be conducted on all safety-related auxiliary equipment of the pressure vessel. These tests serve to prove that

- safety devices function reliably and have an adequate blowing-off capacity
- equipment for the measurement, control and limitation of pressure and temperature, and for the control and measurement of liquid level, function correctly
- valves perform according to design
- the limiting positions of actuators of shut-off valves have been correctly set
- thermal expansion joints and supports of piping function according to design
- other auxiliary equipment affecting pressure vessel safety are operational and
- auxiliary equipment are leaktight.

Their safety classification notwithstanding, the trial run programme of all auxiliary equipment which affect pressure vessel safety shall be approved by the Finnish Centre for Radiation and Nuclear Safety; in the programme the equipment are tested employing the pressure vessel's normal operating parameters. The auxiliary equipment trial run programme can be contained in a system's trial run programme.

The results of auxiliary equipment performance tests shall be so recorded that they can be utilized as basic values later when conducting periodic performance tests.

Valves and other controllers which shall be locked open or closed during operation, and which affect pressure vessel safety, shall be listed.

3.1 Safety devices

It shall be demonstrated by safety relief valve performance tests that all safety relief valves function reliably under operating conditions and that their blowing-off capacity is adequate. Performance testing is addressed in detail in Guide YVL 5.4.

The type testing certificate, identification tag and installation of a bursting disc are inspected.

The right to supervise safety relief valve tests and to seal the valves may be granted on the same grounds as corresponding construction inspection rights. The supervision and results protocols of the tests shall be submitted to the commissioning inspector.

After the performance test, the safety relief valve shall be sealed in such a way that it will be impossible to alter the opening pressure and time, and the closing pressure and blowing capacity, without opening the seal.

In case a safety relief valve's performance has had to be tested in a test stand for reasons well justified, final approval of the valve may only be granted in a commissioning inspection which will be conducted after the valve has been installed in its place.

3.2 Valves

Their safety classification notwithstanding, all valves affecting pressure vessel safety, such as shut-off valves, shall undergo performance tests in which a test programme approved by the Finnish Centre for Radiation and Nuclear Safety shall be complied with. The commissioning inspector reviews the trial run result reports which shall have been approved by the utility. A detailed description of the commissioning inspection of valves is given in Guide YVL 5.3.

3.3 Pumps

The performance tests of pumps may be conducted in connection with the trial run of the system in question. A detailed description of the commissioning inspection of pumps is given in Guide YVL 5.7.

3.4 Measurement and control equipment

As part of a trial run, it shall be inspected that all equipment which ensure pressure vessel operational safety and which are required in the measurement, control and limitation of pressure, temperature and liquid level are operational, their safety classification notwithstanding. The commissioning inspector reviews all trial run result reports of the measurement and control equipment. The result reports shall be approved by the utility. Functional requirements for all equipment are presented in Standards SFS 3323 /2/ and SFS 3333 /3/. Safety Class 1, 2 and 3 measurement and control equipment shall also meet the functional requirements set for the electrical and instrumentation systems of nuclear facilities, presented in Guide YVL 5.5.

3.5 Pipe supports, thermal expansion and vibrations

In connection with the trial run it is inspected that piping supports perform according to design. Thermal expansion and vibrations are monitored by measurement programmes. The submitting of the programmes and their results to the Finnish Centre for Radiation and Nuclear Safety for approval is described in detail in Guide YVL 3.3.

In certain cases, inspections concerning the mechanical performance of piping may have to be continued even after nuclear facility startup to ascertain performance of the piping with normal operating parameters.

4 References

1 Finnish Standards Association (SFS), Standard SFS 3334:E, Inspection of pressure vessels. Inspection of pressure vessel other than steam boiler or piping.

2 Finnish Standards Association (SFS), Standard SFS 3323:E, Arrangements, equipment and operation of pressure vessels. Pipings.

3 Finnish Standards Association (SFS), Standard SFS 3333:E, Pressure containers. Location, equipment and operation.

YVL guides

General guides

YVL 1.0 Safety criteria for design of nuclear power plants, 1 Dec. 1982

YVL 1.1 The Finnish Centre for Radiation and Nuclear Safety as the regulatory authority in control of the use of nuclear energy, 27 Jan. 1992

YVL 1.2 Documents to be submitted to the Finnish Centre for Radiation and Nuclear Safety concerning the regulation of nuclear facilities, 22 May 1991 (in Finnish)

YVL 1.3 Mechanical components and structures of nuclear power plants. Inspection licenses, 25 March 1983

YVL 1.4 Quality assurance of nuclear power plants, 20 Sep. 1991

YVL 1.5 Reporting nuclear power plant operation to the Finnish Centre for Radiation and Nuclear Safety, 18 Aug. 1989

YVL 1.6 Nuclear power plant operator licensing, 3 March 1989

YVL 1.7 Duties important to nuclear power plant safety, personnel qualifications and training, 28 Dec. 1992 (in Finnish)

YVL 1.8 Repairs, modifications and preventive maintenance at nuclear facilities, 2 Oct. 1986

YVL 1.9 Quality assurance of nuclear power plant operation, 13 Nov. 1991 (in Finnish)

YVL 1.13 Regulatory inspections related to shut-downs at nuclear power plants, 9 May 1985

YVL 1.15 Mechanical components and structures in nuclear installations, Construction inspection, 16 April 1984

Systems

YVL 2.1 Safety classification of nuclear power plant systems, structures and components, 22 May 1992

YVL 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants, 7 Oct. 1987

YVL 2.3 Preinspection of nuclear power plant systems, 14 Aug. 1975

YVL 2.4 Over-pressure protection and pressure control during disturbances in the primary circuit and steam generators of a PWR plant, 19 Sept. 1984

YVL 2.5 Preoperational and start-up testing of nuclear power plants, 8 Jan. 1991 (in Finnish)

YVL 2.6 Provision against earthquakes affecting nuclear facilities, 19 Dec. 1988

YVL 2.7 Failure criteria for the design of a light-water reactor, 6 April 1983

YVL 2.8 Probabilistic safety analyses (PSA) in the licensing and regulation of nuclear power plants, 18 Nov. 1987

Pressure vessels

YVL 3.0 Pressure vessels in nuclear facilities. General guidelines on regulation, 21 Jan. 1986

YVL 3.1 Nuclear power plant pressure vessels. Construction plan. Safety classes 1 and 2, 11 May 1981

YVL 3.2 Nuclear power plant pressure vessels. Construction plan. Safety class 3 and class EYT, 21 June 1982

YVL 3.3 Supervision of the piping of nuclear facilities, 21 May 1984

YVL 3.4 Nuclear power plant pressure vessels. Manufacturing license, 15 April 1981

YVL 3.7 Pressure vessels of nuclear facilities. Commissioning inspection, 12 Dec. 1991

YVL 3.8 Nuclear power plant pressure vessels. Inservice inspections, 9 Sept. 1982

YVL 3.9 Nuclear power plant pressure vessels. Construction and welding filler materials, 6 Nov. 1978

Buildings and structures

YVL 4.1 Nuclear power plant concrete structures, 22 May 1992 (in Finnish)

YVL 4.2 Steel structures for nuclear facilities, 19 Jan. 1987

YVL 4.3 Fire protection at nuclear facilities, 2 Feb. 1987

Other structures and components

YVL 5.3 Regulatory control of nuclear facility valves and their actuators, 7 Feb. 1991

YVL 5.4 Supervision of safety relief valves in nuclear facilities, 3 June 1985

YVL 5.5 Supervision of electric and instrumentation systems and components at nuclear facilities, 7 June 1985

YVL 5.7 Pumps at nuclear facilities, 27 May 1986

YVL 5.8 Hoisting appliances and fuel handling equipment at nuclear facilities, 5 Jan. 1987

Nuclear materials

YVL 6.1 Control of nuclear fuel and other nuclear materials required in the operation of nuclear power plants, 19 June 1991

YVL 6.2 Fuel design limits and general design criteria, 15 Feb. 1983

YVL 6.3 Supervision of fuel design and manufacture, 15 Sept. 1993

YVL 6.4 Supervision of nuclear fuel transport packages, 1 March 1984

YVL 6.5 Supervision of nuclear fuel transport, 1 March 1984

YVL 6.6 Surveillance of nuclear fuel performance, 5 Nov. 1990 (in Finnish)

YVL 6.7 Quality assurance of nuclear fuel, 11 Oct. 1983

YVL 6.8 Handling and storage of nuclear fuel, 13 Nov. 1991 (in Finnish)

YVL 6.11 Physical protection of nuclear power plants, 13 July 1992 (in Finnish)

YVL 6.21 Physical protection of nuclear fuel transports, 15 Feb. 1988 (in Finnish)

Radiation protection

YVL 7.1 Limitation of public exposure in the environment of and limitation of radioactive releases from nuclear power plants, 14. Dec. 1992

YVL 7.2 Evaluation of population doses in the environment of nuclear power plants, 12 May 1983

YVL 7.3 Evaluating the dispersion of radioactive releases from nuclear power plants under operating and in accident conditions, 12 May 1983

YVL 7.4 Nuclear power plant emergency plans, 12 May 1983

YVL 7.5 Meteorological measurements of nuclear power plants, 28 Dec. 1990 (in Finnish)

YVL 7.6 Measuring radioactive releases from nuclear power plants, 13 July 1992 (in Finnish)

YVL 7.7 Programmes for monitoring radioactivity in the environment of nuclear power plants, 21 May 1982

YVL 7.8 Reporting radiological control of the environs of nuclear power plants to the Institute on Radiation Protection, 21 May 1982

YVL 7.9 Radiation protection of nuclear power plant workers, 14 Dec. 1992 (in Finnish)

YVL 7.10 Individual monitoring and reporting of radiation doses, 1 March 1984

YVL 7.11 Radiation monitoring systems and equipment in nuclear power plants, 1 Feb. 1983

YVL 7.14 Action levels for protection of the public in nuclear power plant accidents, 26 May 1976

YVL 7.18 Radiation protection in design of nuclear power plants, 14 May 1981

Radioactive waste management

YVL 8.1 Disposal of reactor waste, 20 Sept. 1991

YVL 8.2 Exemption from regulatory control of nuclear wastes, 19 March 1992

YVL 8.3 Treatment and storage of radioactive waste at the nuclear power plants, 1 July 1985