STUK

GUIDE **YVL 3.3** / 26 JUNE 2006

NUCLEAR FACILITY PIPING

continues

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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 to 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 to 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 preseented 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

The reliable operation and integrity of nuclear pressure equipment are of great importance for the safety of nuclear facilities. The level of safety required of nuclear pressure equipment is based on the Nuclear Energy Act (990/1987) and the regulations issued by virtue of it. The Government Decision (395/1991) presents requirements for ensuring the safety of the primary circuit.

The Finnish Radiation and Nuclear Authority (STUK) regulates nuclear pressure equipment on the basis of section 60 of the Nuclear Energy Act (990/1987) and section 117 of the Nuclear Energy Decree (161/1988). Guide YVL 3.0 sets forth requirements for nuclear pressure equipment and their regulation, which apply to piping together with the requirements of this guide.

Guide YVL 2.1 classifies piping in nuclear facilities into Safety Classes 1, 2, 3 and 4, in which case they are nuclear pressure equipment as referred to in section 60 of the Nuclear Energy Act, or into Class EYT (non-nuclear), in which case they are conventional pressure equipment as referred to in the same section of law.

The requirements of this guide apply to the design, manufacturing, inspection, testing and installation of nuclear piping as well as piping supports. In Class EYT (non-nuclear) the requirements apply to installation, repairs and modifications. The design and manufacturing requirements of Class EYT piping components are determined by the Decision of the Ministry of Trade and Industry (KTMp 938/1999).

The Decree of the Ministry of the Interior (SM-1999-967/Tu33) applies to the design and manufacturing of the piping of automatic extinguishing equipment. Piping inspections are made according to the principles described in Guide YVL 3.0.

If piping pressure is less than or equal to 0.5 bar overpressure, it is taken into account in applying this guide that pressure is not a piping dimensioning factor.

Guides YVL 1.0 and YVL 3.0 set forth the general safety principles and requirements to be followed in pressure equipment design. Guide YVL 3.5 deals with assurance of the strength of piping most important for safety. Guide YVL 2.6 concerns requirements pertaining to seismic events. Guide YVL 5.3 deals with valves connected to piping, Guide YVL 5.4 with safety valves and Guide YVL 5.7 with pumps.

According to Section 60a of the Nuclear Energy Act (990/1987), *the Radiation and Nuclear Safety Authority (STUK) approves manufacturers of nuclear pressure equipment for their duties and inspection organisations or testing organisations for duties pertaining to the control of pressure equipment at nuclear facilities.* According to Section 113, subsection 1, of the Nuclear Energy Decree (161/1988), *non-destructive testing of a nuclear power plant's structures and components may only be carried out by a testing company or a tester approved by the Radition and Nuclear Safety Authority (STUK).* Guides YVL 1.3 and YVL 3.4 describe the approval procedure.

Guide YVL 1.14 deals with control of the manufacturing of mechanical equipment and structures for nuclear facilities. Guide YVL 3.0 presents the general principles governing the control of pressure equipment in nuclear facilities and the division of inspection areas between STUK, inspection organisations approved by STUK and licensees.

According to section 60 of the Nuclear Energy Act (990/1987), *the provisions of the Pressure Equipment Act (869/1999) shall apply to the technical requirements for conventional pressure equipment at nuclear facilities, demonstration of safety and other preconditions for their placing on the market.*

2 Definitions

For the purposes of this Guide

1. *pressure accessories* means devices with an operational function and having a pressure shell, such as valves, pressure regulators, measuring chambers, pressure gauges, glass gauges, filters and expansion joints.
2. *pressure equipment* means vessels, piping and other technical assemblies in which overpressure exists, or within which it may develop, as well as technical assemblies intended to protect pressure equipment; including elements such as flanges, nozzles, couplings, supports, lifting lugs, etc., attached to pressurised parts.

3. *small diameter piping* means piping with DN ≤ 50.
4. *piping* means an assembly intended for the transport of gas, liquid, steam and their mixtures when connected together for integration into a pressure system; piping components include a pipe or a system of pipes, tubing, fittings, expansion joints, hoses and other pressure-bearing components.
5. *safety accessories* means devices designed to protect pressure equipment against the allowable limits being exceeded; such devices include devices for direct pressure limitation, such as safety valves, bursting disc safety devices, controlled safety pressure relief systems as well as limiting devices such as pressure switches, temperature switches or fluid level switches and safety-related measurement, control and regulation devices.
6. *a nuclear facility's pressure equipment* means nuclear and non-nuclear pressure equipment at a nuclear facility.
7. *nuclear piping* means piping classified into Safety Classes 1, 2, 3 or 4.

3 Piping classification

According to section 21 of the Government Decision (395/1991), *the functions of systems, structures and componenets important to the safety of a nuclear power plant shall be defined and the systems, structures and components classified according to their safety significance.*

Based on their significance for nuclear safety, piping shall be classified into Safety Classes 1, 2, 3, 4 and Class EYT in accordance with Guide YVL 2.1. Piping parts, valves, pumps, safety accessories and other pressurised accessories primarily belong to the same safety class as the piping.

When determining the safety class of small-diameter piping (DN ≤ 50) directly connected to safety classified process piping or equipment, Guide YVL 2.1 shall be applied as follows:

1. Small-diameter piping (DN ≤ 20) connected to Safety Class 1 piping or equipment belongs to Safety Class 2. The leakage control pipes (DN ≤ 20) of the sealings of primary circuit equipment belong to Safety Class 3.
2. Small-diameter piping connected to Safety Class 2 piping or equipment belongs to Safety Class 3.
3. Small-diameter piping connected to Safety Class 3 or 4 piping or equipment belongs to Class EYT (non-nuclear).

The classification of small diameter piping is not lowered if a leak in the pipe would result in the loss of the safety function on which the classification is based. Small diameter piping of this kind includes, for instance, impulse lines controlling the main system, fuel pipes of diesel generators and coolant pipes of pumps.

Piping supports and brackets shall be primarily placed in a safety class one step lower than the class of piping they support. The supports of Safety Class 3 and 4 as well as Class EYT piping belong to Class EYT.

4 General inspection plan and inspection procedures for piping

4.1 Requirements

As part of the quality assurance description in accordance with Guide YVL 1.4, for which approval is obtained in connection with the construction licence application, a nuclear facility specific piping general inspection plan including division into safety classes, as well as the general piping inspection procedures, shall be submitted.

In drawing up the general inspection plan and inspection procedures the licensee shall take into account alternative acceptable piping dimensioning standards in accordance with subsection 5.4.2.

In connection with the construction plan both the general inspection plan and the general inspection procedures shall be complemented with piping specific information in accordance with subsection 5.8.

4.2 General inspection plan

The general inspection plan for piping defines the procedures and parties involved in the conformity assessment and supervision of piping manufacturing.

The general inspection plan for the nuclear facility's piping shall define the principles applied in the inspection and testing of construction and welding materials, prefabricated components, procedure qualification and pre-production tests, manufacturing processes and completed structures in various manufacturing phases. The plan shall state

- the procedures and phases of, and the parties to, manufacturing supervision in accordance with Guide YVL 1.14.
- demanding manufacturing and inspection phases of Safety Class 1 and 2 piping requiring independent third party supervision
- inspection and testing of piping, its materials, components, permanent joints and supports as well as a reference to the general inspection and testing procedures.
- piping construction inspection in accordance with Guide YVL 1.15
- organization performing inspections and tests, controlling party, and place of execution (e.g. manufacturer or subcontractor's premises)
- reporting requirements for inspection and testing.

4.3 General inspection procedures

The licensee shall draw up procedures for commissioning of the construction inspections of the nuclear facility's piping in accordance with Guide YVL 3.0.

The general inspection procedures shall state the practices and requirements applied in the testing and supervision of the manufacturing, installation and materials of the nuclear facility's piping.

5 Construction plan for nuclear piping and piping components

5.1 Drawing up of the construction plan

For the manufacturing of nuclear piping, a construction plan shall be drawn up whose approval procedures are addressed in Chapter 12.

The piping construction plan shall be drawn up and presented for approval prior to the start of manufacturing. However, for a justified reason, the manufacturing of first piping sections may be started before the entire construction plan is completed in case the piping manufacturing time is exceptionally long or when piping has to be replaced immediately to assure safety. In such a case, the organisation approving the construction plan shall, prior to the start of manufacturing, be presented with those parts of the piping section construction plan on the basis of which the fulfilment of a component's design bases and the acceptability of the piping section's dimensioning, design, manufacturing and inspection can be evaluated. The licensee shall also ensure that it is possible to make the inspections and testing required by the organisation approving the construction plan.

The same set of norms, as a rule, shall be applied in nuclear piping design, manufacturing, testing and installation. Any additional requirements based on the general inspection plan shall be taken into consideration.

If, for justified reasons, the construction plan deviates from the requirements of the YVL guides, the procedure given in Chapter 12 shall be followed.

A licensee assessment of the fulfilment of safety requirements shall be attached to the construction plan.

5.2 Manufacturer and testing organisation

STUK's decisions granting approval for the manufacturer and testing organisation as well as the period of validity of the approvals shall be given in the construction plan. If the testing organisation has been approved based on accreditation, and without a separate application, the construction plan may refer to documents submitted to STUK for information and to the certificate of accreditation. Information on a third party controlling manufacturing and testing shall be submitted as well.

According to Guide YVL 3.4 an approval for the manufacturer to deliver an individual item of pressure equipment may, for justified reasons, be applied for in connection with the construction plan. Guide YVL 1.3 states that in Safety Classes 3 and 4, and for a specific reason, approval may be applied for in connection with a manufacturing construction plan for testing personnel who have certification from a certification body and

carry out manufacturing-related non-destructive testing.

Due to features specific to the manufacturing and installation of piping, the aforementioned information can, prior to the start of manufacturing or installation, be presented in a document that is separate from the construction plan. In such a case there shall be a mention of this in the piping construction plan. The document shall indicate the division between workshop manufacturing and installation work.

5.3 Design bases

The design bases shall be presented extensively enough so that, on their basis, it is possible to evaluate the choice of piping, the prerequisites for the system's operation and its structural requirements, and to review piping overall design, hydrodynamic analysis and strength calculations as well as condition monitoring requirements. The design bases shall be given for all conditions (normal operational conditions, transients and accidents) for which requirements for the operability of piping are given.

The design bases shall include

- safety class of piping
- process and instrumentation charts
- a description of the use of piping with operating and design parameters (pressure, temperature, etc. as well as their range of variation and the number of load cycles)
- information on the contents of piping and ambient conditions
- information on pressure tests and piping accessories.

Guide YVL 2.0 gives requirements for system planning.

Adequate structural measures (primary and secondary supports, venting, inclinations, pressure equalisers, heat shields, etc.) shall be used to prevent harmful dynamic and fatigue inducing loads such as vibrations, pressure shocks, the restriction of thermal expansion, temperature fluctuations in thermal mixing locations and thermal stratification of the medium. Susceptibility to erosion corrosion shall be limited by the choice of materials and by the avoidance of areas of flow discontinuities and exceptionally high flow rates. Planning shall also consider phase transitions of the flowing medium and the accumulation of non-condensable gases in the piping.

Piping shall be placed, routed and provided with accessories in a way that facilitates appropriate operation, maintenance and inspection. Inclinations shall be adequate for all operating conditions. The pressure vessel, its piping accessories and components shall form a safely operating entity.

In piping design and the layout of welds the form and location of welded seams shall be considered in a way to ensure sufficient space for in-service inspections in accordance with Guide YVL 3.8 as well as for condition monitoring. The number of welded seams shall be kept as low as practicable to reduce the need for inspection. Furthermore, the radiation protection requirements of Guide YVL 7.18 shall be taken into account in piping design.

5.4 Design

5.4.1 Hydrodynamic analysis

It shall be verified by hydrodynamic analyses that piping and accessories operate as designed under normal operating conditions. Guides YVL 2.2 and YVL 3.5 deal with hydrodynamic analysis for transients and accidents.

Hydrodynamic analysis shall take into account pressure losses in piping and their accessories, the characteristic parameters of pumps connected to the same system as well as flows entering or exiting piping ends and branchtrees. Cavitation analyses shall consider pipe sections on the suction side as well as pipe sections where heavy pressure reductions occur.

5.4.2 Structural analysis for adequate strength

It shall be verified by strength calculations that the dimensioning and geometry of piping components meet the requirements of applicable standards.

Basic design calculations shall cover piping design conditions (pressure and temperature). The design calculations are based on drawings of the piping and its components. The drawings are to show the necessary dimensions and geometry.

Safety Class 1 (DN > 50) piping components shall be dimensioned according to Standard ASME Boiler and Pressure Vessel Code, Section

III [7], point NB-3600 in the first place. Deviations are allowable if based on an acceptable standard effective in the manufacturing country, or some other acceptable nuclear power plant standard.

Safety Class 1 (DN ≤ 50), 2, 3 and 4 piping components shall be dimensioned according to SFS-EN standards or other acceptable standards.

No specific strength calculations are generally required on the basic dimensioning of parts of Safety Class 2, 3 and Class EYT piping sections (e.g. shape pieces, flanges and couplings) that have been dimensioned to a Finnish or foreign pressure classification standard. In choosing standard piping components it shall be ensured that their pressure class corresponds to the specific temperature determined in the standard.

The flexibility of piping shall be established to determine loads affecting the piping itself or the accessories and pipework connected to it. As regards Safety Class 1 components this can be done in accordance with ASME Code Section III or a corresponding acceptable standard.

In Safety Classes 2, 3 and 4 the need for a flexibility analysis is determined on the basis of nominal diameter, design temperature and piping components. An analysis shall be made when design temperature exceeds +120 °C and the piping includes components that could sustain damage from forces caused by thermal movement. However, this does not apply to DN < 100 piping. It shall be ensured that the design of small-diameter piping (DN< 100) does not have a detrimental effect on stresses arising from the thermal movement of main piping.

A piping stress analysis shall be made to establish stresses and structural fatigue caused by thermal transients and discontinuities. Safety Class 1 piping and other primary circuit piping, as well as parts extending up to the isolation valves outside the containment in the steam and feedwater systems of pressurised water reactor plants shall, in addition to basic dimensioning, be subjected to a detailed stress analysis in accordance with Standard ASME Section III NB-3600 and Guide YVL 3.5.

Specific attention shall be paid to dynamic pipe stresses. Depending on the circumstances, the following shall be taken into account:

- mechanical vibration loads caused by machinery and equipment
- pressure shock loads caused by the opening and closing of valves or process adjustments
- loads caused by a turbulent or uneven flow as well as by the condensation or stratification of liquid or gas in the piping
- loads caused by pipe contents discharging after a pipe rupture and loads caused to the piping by missiles.

Stresses that cannot be calculated accurately enough shall be established by experimental measurement.

5.4.3 Supports

Piping supports (primary and secondary) shall be dimensioned to withstand all loads they are subject to during design basis operational conditions and accident situations. The supporting forces and torques exerted on pumps, valves and other associated components shall be restricted in such a way that they do not impair the leaktightness, integrity and operability of the components. The supports must make piping flexible in a way that suits the operating conditions to prevent harmful vibrations and the restriction of thermal expansion.

Loads in accordance with flexibility analysis and mechanical design loads shall be taken into account in basic dimensioning. In addition, the dynamic loads and thermal transients referred to in subsection 5.4.2 shall be included in stress analysis.

Guide YVL 3.5 sets forth requirements for the stress analysis of supports and the provision made against piping rupture by means of pipe whip restraints.

5.5 Drawings

The drawings shall describe the configuration and details of piping in such a way that the size, geometry, manufacture and mounting of parts and their allowable tolerances are given in adequate detail. The drawings shall be unambiguous and explicit. They shall show

- safety classes and their boundaries
- piping parts material standard markings, nominal sizes and pressure classes or, equivalently, dimensions and geometry as well as reference to drawings of non-standardised parts

- location, sizes and types of grooves for welded joints as well as reference to the welding procedure specification (WPS), or an explanation of welding information
- reference to component specific inspection plans and procedures
- isometric drawings for DN > 50 piping to give sufficient information for piping prefabrication as well as the location and type of supports for the purpose of flexibility analyses
- detail drawings of all non-standardised piping parts (which shall show all the information needed for basic dimensioning and a possible stress analysis).

5.6 Construction and welding materials

Only approved materials and welding materials to be specified in the construction plan may be used in the manufacturing of the nuclear facility's piping. In choosing construction and welding materials, piping operating and environmental conditions shall be taken into account i.a. local corrosion mechanisms, general corrosion and activity migration as well as requirements and constraints due to manufacturing and testing. Guide YVL 3.9 gives the approval procedure for materials. The requirements apply to brazing as well.

Parts of piping manufactured of austenitic cast steel shall not be used in Safety Classes 1 and 2 if the items in question are subject to in-service inspection in accordance with Guide YLVL 3.8 and if their in-service inspections cannot be reliably carried out. Plastic piping is only allowed in Safety Classes 3 and 4.

Segmented bends as well as pipes or pipe bends with longitudinal or spiral weld seams are not allowed in Safety Class 1. Their use in Safety Class 2 can be approved with special justification. If pipes having longitudinal or spiral seams are used the welds shall be subjected to 100% volumetric inspection.

The industrial manufacturer of Safety Class 2 seamed piping shall be approved in accordance with Guide YVL 3.4. In Safety Classes 3 and 4, the manufacturing of seamed pipes is considered equal to materials manufacturing in accordance with Guide YVL 3.9.

The base material and the welded joint of the accomplished structure shall meet the requirements for chemical and mechancal properties stated in the construction material specification. Testing methods and scope shall be determined on the basis of safety class, material manufacturing process, operating conditions, dimensions and material type.

5.7 Manufacturing description

The manufacturing description included in the construction plan shall contain the manufacturing processes and equipment used, qualified manufacturing procedures, approved or planned procedure qualification and pre-production tests as well as the scheduling of inspections during the manufacturing phases. Requirements for manufacturing and the related inspection and testing are given in Chapter 6.

5.8 Inspection

The construction plan shall contain part and joint specific inspection requirements for the piping in question. Inspection shall be based on the general inspection plan and inspection procedures that are in accordance with Chapter 4 and were approved in connection with the construction licence application.

The general inspection plan referred to in subsection 4.2 shall be complemented and made piping specific to meet any further requirements made on the piping in question. I.a. the following additional information shall be attached to the construction plan:

- component specific, and of permanent joints, joint specific identification data and reference to piping drawings
- standards compliant markings on construction and welding materials as well as the necessary reference to material specifications
- joint or joint type specific reference to the manufacturing procedures of permanent joints
- reference to heat treatment and forming procedures
- reference to procedure qualification tests and pre-production tests, where necessary.

When the properties of a component's materials or welded joints change during manufacturing in such a way that the data given in the construction material specification apply no more this shall be taken into account

in the testing required in the inspection plan.

The general inspection procedures referred to in subsection 4.3 shall be complemented and specified in accordance with component specific requirements and details. The procedures shall cover destructive and non-destructive testing methods with their material certificate and control requirements, non-destructive testing during manufacturing, and testing of the end product (e.g. pressure, leakage and functional tests).

6 Manufacturing, inspection and testing of nuclear piping and piping components

6.1 Manufacturing requirements

Guide YVL 3.4 gives the requirements for nuclear piping and piping component manufacturers. The manufacturer shall have an advanced quality system, competent and experienced personnel as well as appropriately qualified methods, facilities and equipment for manufacturing and operation. If the manufacturer uses subcontractors for the welding, forming or heat treatment of piping, any clarifications concerning these may be presented when the main manufacturer is presented for approval.

Procedures with essential parameters shall be drawn up for demanding work processes such as welding, forming and heat treatment, which affect material strength and properties. In addition, the necessary procedures shall be drawn up for other manufacturing methods such as surface treatment.

Manufacturer specific welding procedure specifications (WPS) in piping manufacturing shall be qualified by procedure qualification tests. Welders and welding operators shall have qualifications equivalent to the WPS used. In addition, heat treatment as well as hot and cold forming procedures shall be qualified by procedure qualification tests.

Guide YVL 3.4 presents the qualification of manufacturing procedures and persons carrying out manufacturing. Qualifications are valid in accordance with the qualification standard applied. A procedure qualification specification with an inspection plan as well as a summary report shall be drawn up of the procedure qualification tests.

In demanding cases the applicability of manufacturing procedures shall be ascertained by pre-production tests. This shall be the case also whenever the equivalence of a procedure qualification test with actual working conditions is inadequate. Pre-production tests mean tests performed during the manufacturing of a structure, or in advance, and carried out by actual participants to manufacturing. Pre-production test plans equivalent to those drawn up for procedure qualification shall be prepared. Pre-production tests are temporarily valid and e.g. individual, component, joint or cladding specific.

The minimum requirement level for procedure qualification tests and pre-production tests shall be in accordance with ASME Code, Section III [7], or SFS-EN 13480 [8].

Manufacturing shall be within the range of essential variables of procedure qualification. Guide YVL 1.14 gives the requirements and procedures for manufacturing control by the licensee and manufacturer.

6.2 Inspection and testing requirements

Guide YVL 1.15 gives the construction inspection requirements for nuclear piping.

Guide YVL 1.3 gives the requirements for testing organisations and individuals performing non-destructive and destructive materials testing.

Destructive and non-destructive testing shall be done after the final heat treatment, unless otherwise approved on the basis of manufacturing procedure qualification, applicable standards or approved working procedures.

The testing procedures shall define the testing method and scope, the acceptance criteria, reporting, and the requirements for testing personnel certification. For details, applicable standards may be referred to.

6.3 Third party

Within the scope of their competence areas, a notified body or a recognised third party may act as a third party who, within the scope of the general inspection plan and the construction plan, wit-

nesses sampling, destructive and non-destructive testing as well as qualifications in Safety Classes 1 and 2. STUK's approval for other organisations acting as a third party shall be obtained based on the same principles applied in the approval of an inspection organisation in accordance with Guide YVL 1.3.

A description of the expertise of a third party carrying out manufacturing control shall be attached to the construction plan of the relevant component or structure.

7 Construction inspection of nuclear piping

Guide YVL 1.15 gives the requirements for the construction inspection of piping and its support structures.

The licensee shall see to it that all completed piping is subjected to a construction inspection. However, intermediate inspections that cannot easily be made later shall be performed during manufacturing. Components thus inspected may include for example pipe bends, flanges, couplings, bellows expansion joints as well as branchtrees, expanding and reducing sections and accessories such as closing devices, safety and drainage valves, measuring and control equipment, and pumps. Records covering the entire system's piping shall be compiled of the intermediate inspections.

8 Design, manufacturing and construction inspection of class EYT (non-nuclear) piping

8.1 Design and manufacturing of piping components

The provisions of the Pressure Vessel Act (869/1999) and the Decision of the Ministry of Trade and Industry on Pressure Equipment (938/1999), issued by virtue of the Act, apply to technical requirements, verification of safety and other prerequisites for the placement on the market of Class EYT piping components.

8.2 Design and manufacturing of piping

A construction plan in accordance with the principles stated in Chapter 5 shall be drawn up for Class EYT piping.

The design bases shall include accessibility requirements for piping inspection during plant operation as well as for condition monitoring, preventive maintenance and repairs. The licensee shall ensure receipt of sufficient documentation during purchasing.

Approval in accordance with Guide YLV 3.4 is not required for the piping manufacturer but they must fulfil the requirements of Guide YVL 3.4.

8.3 Construction inspection of piping

The licensee shall ensure that a construction inspection is conducted on the completed piping system. The results of the construction inspections of piping components shall be included in the documentation for the piping construction inspection.

Guide YVL 1.15 presents the requirements for the construction inspection of piping and its support structures.

9 Installation of piping

A construction plan for the installation of the nuclear facility's piping shall be drawn up to which the requirements of Chapter 5 apply to the appropriate extent. The installation construction plan is presented separately or as part of the piping construction plan. Piping installation drawings with parts lists and location drawings in the form of isometric projections to visualise the routing of (DN > 50) piping shall be presented of the piping.

A description of the connecting of the piping to other systems, pipe supports and possible jet impingement shields shall be attached to the installation construction plan. Guide YVL 4.2 gives the requirements for pipe whip restraints.

A manufacturer installing nuclear piping shall have approval in accordance with Guide YVL 3.4. A manufacturer installing Class EYT piping is subject to the same requirements that apply to a piping manufacturer under subsection 8.2.

Piping supports can be connected to other structures by means of anchor plates or other

fastenings as presented in Guide YVL 4.1. A separate procedure shall be drawn up for the manufacturing and inspection of the anchor plates and attachment points of piping supports. The procedure shall pay attention to the following matters, among others

- materials
- dimensioning
- welded joints
- surface treatment
- inspection.

Drawings by support type shall be presented of all non-standard piping supports.

The anchor bolt fasteners used shall have a type approval that is in force in Finland or approval based on tests carried out by an approved testing organisation, as well as mounting instructions. They must not be used without a justified reason for

- fastenings that may become dynamically loaded
- the securing of Safety Class 1 and 2 piping, small-diameter piping excluded.

A separate procedure for the installation of anchor bolt fasteners and inspection of the installation work shall be prepared, which includes specification of installer competence. Guide YVL 4.1 gives requirements for anchor bolts installation.

A description shall be prepared of the use, mounting and inspection of any other kind of fasteners for attachment to the construction plan.

10 Commissioning

Piping shall not be commissioned before it has been approved with its accessories and supporting structures. However, to adjust the equipment and to test operational readiness, pre-operational testing of the piping prior to the commissioning inspection is allowed provided that sufficient care is taken.

The licensee shall draw up measurement plans for piping thermal movements and vibrations. The plans shall present how thermal movements of Safety Class 1 and other primary circuit pipework are controlled by measurements during the commissioning inspection. The acceptability of measured thermal movements shall be judged on the basis of piping flexibility calculations.

Vibrations in Safety Class 1 piping shall be monitored by means of measurements both under circumstances corresponding to normal operation and during tests causing dynamic impact loads. The measurements shall show highest vibration stresses in the piping either directly or by means of a calculation model applied to the results. In addition, vibrations in all accessible piping shall be visually controlled applying the criteria approved by STUK for each case. Compliance with the criteria shall be demonstrated by measurements, where necessary.

If the criteria are exceeded the vibrations shall be attenuated to an acceptable level by appropriate means such as by finding out and removing their initiator or by altering the construction of supporting.

Guide YVL 3.5 sets forth the general requirements for adequate strength and the control procedures relating to the pre-operational testing of the nuclear facility.

11 Control during plant service life

Safety Class 1 and 2 piping shall be examined at regular intervals by non-destructive testing methods in accordance with Guide YVL 3.8, which presents the qualification of inspection systems as well.

The licensee shall draw up condition monitoring and preventive maintenenace programmes for piping. The methods of control include for example wall thickness measurements, monitoring of vibrations, inspection of supports and brackets as well as monitoring of pressure and thermal transients. The licensee shall submit to STUK a summary of the results of piping inspections and the most significant observations in accordance with Guide YVL 1.5.

12 Control by the Radiation and Nuclear Safety Authority

12.1 Inspection areas

Guide YVL 3.0 sets forth the general principles regarding the division of inspection areas applied in piping inspection. It prescribes that inspection of nuclear piping components and nuclear facility piping is carried out by STUK, an inspection organisation approved by STUK or the licensee. The construction plans of EYT piping components are reviewed and the construction inspection of the piping is performed by an inspection organisation referred to in the Pressure Equipment Act.

Upon application by the licensee STUK specifies the division of inspection areas in more detail in its decisions.

12.2 Construction plan review

The licensee shall submit for approval construction plans for the manufacturing of nuclear piping components as well as for the manufacturing and installation of nuclear facility piping in compliance with the division of inspection areas and following the practices presented in Guide YVL 1.2.

The licensee shall submit also the necessary reference material for information to the organisation reviewing the construction plan.

The manufacturing of nuclear piping components and nuclear facility´s piping can commence after the construction plan has been approved in compliance with subsection 5.1. Installation of nuclear piping can commence after the installation construction plan has been approved. The plan can be submitted separately or as part of the piping construction plan.

During the review of the construction plans for nuclear piping components as well as for the nuclear facility's piping and its installation, the approving organisation ensures the fulfilment of the requirements of Chapters 5, 8 and 9 of this guide.

The construction plan shall refer to the fulfilment of the requirements of YVL guides. If the plan does not fulfil them, or those in STUK's decisions, it shall always be submitted to STUK for approval. In these cases, a clarification is required of how the requirements of YVL guides were deviated from and how the safety level set in the guides is then achieved.

Upon application STUK can approve the use of dimensioning standards other than those referred to in subsection 5.4.2. Justification shall be presented plant by plant in conjunction with a construction licence application or a construction plan to be submitted to STUK. One prerequisite for approval in Safety Class 1 is that a piping design and strength analysis standard with corresponding principles has previously been complied with in constructing a similar type of nuclear power plant.

12.3 Construction inspection

The construction inspections of nuclear piping components as well as nuclear facility piping and its installation are performed in accordance with Guide YVL 1.15 and sections 7 and 8 of this guide.

12.4 Commissioning inspection

The commissioning inspection of the nuclear facility's piping is performed in accordance with Guide YVL 3.7. The inspection establishes that the construction plans for the entire system in question as well those for its components and accessories have been approved and the structures inspected. The functional tests check that the piping and its accessories important to its safety operate appropriately. Furthermore, it is checked that piping supports operate as designed and thermal movements and vibrations are monitored by measurement programmes.

During the commissioning all accessible piping and related structures and equipment shall be inspected for adequate thermal play. During cool-down to initial temperature the restoration of thermal transitions shall be ensured.

During the commissioning inspection it is ascertained that the piping is in compliance with the Final Safety Analysis Report, i.a. with the process and instrumentation charts, among others.

In some cases it may be necessary to continue inspection of the mechanical operation of piping even after the nuclear facility's start-up to ascertain appropriate operation of the piping with

normal operating parameters.

Measurement programmes run at different power levels and result reports on the monitoring of piping thermal movements and vibrations shall be sumbitted to the inspecting organisation for approval during the system's commissioning.

12.5 Inspection of repairs and modifications

Repairs and modifications are inspected in accordance with Guide YVL 1.8. Spare parts design and construction inspections are performed correspondingly and in a scope equal to that of original parts.

12.6 Other inspection and control

In Safety Classes 1 and 2, where necessary, STUK's approval for a third party shall be applied for in accordance with subsection 6.3. Information on the third party shall be included in the construction plan.

Safety Class 3 and 4 welding procedure qualification specifications shall be submitted to STUK for approval and the relevant qualification reports for information if welding procedure qualification is not within the sphere of authority of the inspection organisation in question.

In addition to document review, STUK carries out inspection and control by inspections and audits at the premises of manufacturers, testing and inspection organisations as well as at nuclear facilities. STUK oversees the functionality of the division of inspection areas presented in subsection 12.1 during its inspection activities or by separate visits.

In addition to the YVL guides referred to in subsections 12.3, 12.4 and 12.5, other YVL guides set forth requirements for inspection and control as follows:

- a nuclear facility's management system, Guide YVL 1.4
- approval of manufacturer, Guide YVL 3.4
- approval of testing and inspection organisations, Guide YVL 1.3
- approval procedure for construction and welding materials, Guide YVL 3.9
- control/inspection of manufacturing, Guide YVL 1.14
- review of location plan, Guide YVL 3.0
- periodic inspections and in-service inspections, Guide YVL 3.0 and Guide YVL 3.8
- control during plant service life, Guide YVL 3.0
- other periodic inspections, Guide YVL 3.0.

13 References

1. Nuclear Energy Act (990/1987).
2. Government Decision on the general regulations for the safety of nuclear power plants (395/1991).
3. Nuclear Energy Decree (161/1988).
4. Decision of the Ministry of Trade and Industry on pressure equipment (938/1999).
5. Decree of the Ministry of the Interior SM-1999-967/Tu33.
6. Pressure Vessel Act (869/1999).
7. ASME Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components, American Society of Mechanical Engineers, New York, 2004.
8. SFS-EN 13480 Metallic industrial piping.