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Pumps for nuclear facilities

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STUK • SÄTEILYTURVAKESKUS • STRÅLSÄKERHETSCENTRALEN
RADIATION AND NUCLEAR SAFETY AUTHORITY

Authorisation

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 (395/91) on General Regulations for the Safety of Nuclear Power Plants, the Finnish Radiation and Nuclear Safety Authority (STUK) issues detailed regulations concerning the safety of nuclear power plants.

YVL Guides are rules an individual licensee or any other organisation concerned shall comply with, unless STUK has been presented with some other acceptable procedure or solution by which the safety level set forth in the YVL Guides is achieved. This Guide does not alter STUK's decisions which were made before the entry into force of this Guide, unless otherwise stated by STUK.

Translation. Original text in Finnish.

1 General

The reliable operation of plant systems is essential for nuclear power plant safety. The design bases and requirements of systems determine the functional and structural requirements set for pumps. It is also important that a pump's type and operating mode fit the system entity in question; that the pump is correctly located in the piping; and that the necessary functional tests as well as inspections and maintenance are considered. In addition to normal operating conditions, the pump's operation and structural endurance are important also in potential transient and accident conditions.

Under Guide YVL 2.1, nuclear power plant structures, systems and components are classified to Safety Classes 1, 2 and 3 as well as Class EYT (non-nuclear). Also pumps and their motors are contained in the classification documents.

This Guide describes how the Finnish Radiation and Nuclear Safety Authority (STUK) controls pumps and their motors at nuclear power plants and other nuclear facilities. The scope of control is determined by the Safety Class of the pump in question. The various phases of control are as follows:

- review of construction plan
- control of manufacturing, and construction inspection
- commissioning inspection
- control during operation.

STUK controls Safety Class 1, 2 and 3 pumps at nuclear facilities as prescribed in this guide. STUK inspects Class EYT (non-nuclear) pumps separately or in connection with the commissioning inspections of systems.

This guide gives the control procedure and related requirements primarily for centrifugal pumps. However, it is also applied to the control of piston pumps and other pump types not mentioned in this guide.

2 Construction plan

Construction plans for Safety Class 1 and 2 pumps and their motors shall be submitted to STUK for approval before manufacturing is commenced in accordance with Guide YVL 1.2. The submission of construction plans for Safety Class 3 pumps and their motors is not tied to the commencement of manufacturing. In the construction plan, reference can be made to previously submitted documents.

The construction plan shall state the following:

- manufacturer
- design bases
- material specification
- quality control programme
- dimensioning of pumps
- drawings
- motors
- auxiliary systems of pumps and their motors
- measuring and control devices of pumps and their motors
- installation plan for pumps and their motors
- data on type tests and operating experience.

The scope of the construction plan is determined by the safety significance of the pump and how demanding its construction and functions are.

The design data for the pump's installation and maintenance as well as its motor, auxiliary systems and related equipment can be provided later. This data shall be given in good time before installation is commenced, however.

The necessary documentation for pumps and their motors, which are to be connected to Class EYT/A (non-nuclear/A) piping, shall be presented as part of the piping documentation referred to in Guide YVL 3.3 or submitted as a separate document, which shall contain at least the following data:

- manufacturer
- design bases
- materials and standards references plus a material certificate

- design standards
- basic dimensioning as per subsection 2.5
- manufacturing instructions (welding, annealing, coating, etc.)
- quality control requirements
- assembly and installation drawings
- possible special requirements relating to installation
- operation curve of pumps
- mode of operation of pumps (continuous, intermittent, parallel, etc.)
- operating values of motors
- data on type testing or operating experience
- for the pressure-bearing parts of motors of the so-called wet type, data equivalent to that provided for the pump proper.

If pumps and their motors are to be connected to Class EYT/B (non-nuclear) piping that meets the requirements of Guide YVL 3.3, it will not be necessary to submit the relevant construction plans or documentation to STUK.

2.1 Manufacturer

Documentation shall be provided to show that the pump manufacturer has sufficient expertise and experience in supplying the pumps in question. The documentation shall include an organisation description confirmed by the corporate management and a description of the company's quality assurance arrangements.

The manufacturer of Safety Class 1 and 2 pumps shall submit a description of the company's quality assurance procedures, e.g. the quality assurance manual.

Persons responsible for design and fabrication shall be designated for deliveries defined in the construction plans for Safety Class 1 and 2 pumps, if these are not indicated in the organisational and quality assurance documentation.

The examination rights of a manufacturer responsible for quality control or of a separate examination organisation and their personnel are applied for as described in Guide YVL 1.3.

If necessary, STUK assesses the manufacturer's suitability and the quality assurance programme's sufficiency by making audits to the manufacturer's premises.

2.2 Design bases

The design bases shall be presented to such extent that, on their basis, the type of the pump, the operational prerequisites of the system and the structural requirements of the pump can be assessed.

Design data shall be given on all situations at the nuclear facility (normal operation, transient and accident conditions) for which requirements concerning the operability of pumps are set.

The design data shall be summarised on a form in the first place. When necessary, this summary is to be supplemented with a more extensive account.

All pumps and their motors that are manufactured for use in nuclear facilities shall be equipped with the necessary condition monitoring measurement systems.

2.2.1 System-specific design bases of pumps

System-specific design bases include i.a. the following:

- description of system-specific functions of pumps
- safety class
- leaktightness requirements
- mode of operation (continuous or intermittent operation, parallel operation, etc.)
- pumped medium and its properties, temperature and temperature changes
- inlet pressure variations
- required operating points and/or ranges (volume flow, head)
- possible operability requirements for maintaining flow/pressure values in case the actuator is lost

- ambient conditions required by the installation status of pumps and their motors in normal operation and during transients (chemical effects, temperature, pressure, humidity and radiation dose rate) and the duration of exceptional circumstances
- fire resistance requirements
- decontamination requirements
- earthquake-resistance.

2.2.2 Structural design bases of pumps

Normal operation and transient and accident conditions shall be included in the structural design bases of pumps.

The structural design bases include i.a. the following:

- design temperature
- design and testing pressure
- pressure and temperature variations used in dimensioning, and their number
- upper limits for forces and torques from piping to pumps
- operation curve showing also the NPSH value i.e. the lowest required suction head
- pressure, flow, temperature and purity requirements for cooling, sealing and flushing water
- required shaft output within the operating range during start-up and with the highest possible loading
- the minimum flow required
- selection criteria for bearings
- permissible vibrations and bearing temperatures
- construction data on shaft seals
- maintenance intervals recommended by pump manufacturer for continuous and/or intermittent operation during normal plant operation
- possible special requirements concerning start-up (e.g. start-up against a closed valve, need for lubrication in start-up, and waiting time before restart)
- protection of pumps against hydraulic shocks or back flow
- special requirements for the support and installation of pump unit structures (pump, motor, gearing and clutch)
- tests and inspections to control the condition of pumps
- list of measurements to control the operation and operating condition of pumps
- markings to indicate the rotation direction of pumps.

2.3 Material specification

The material specification shall give data on all pressure-bearing components. Corresponding data shall also be given on shafts, impellers and stator blades and any comparable components that affect operation. A chemical analysis shall be provided for the materials of non-loaded parts welded to the pressure frame and a certificate of conformance for sealings and the materials of their supporting structures.

The acceptability of a pump's materials and their applicability for their intended use shall be indicated by a material specification. Materials and filler materials shall meet the requirements of Guide YVL 3.9. The material specification shall include a part- and weld-specific list of materials and filler materials.

Base materials shall meet the requirements of standards mentioned in connection with the base materials. Any additional requirements set for the materials shall be mentioned in the material specification. Welds and heat-affected zones (HAZs) shall meet the strength and toughness requirements set for the base material of the final product.

Testing methods and the scope of sampling are determined by safety class, material type, operating conditions and dimensioning.

The manufacturing and repair welding processes of Safety Class 1 and 2 pumps shall be qualified by procedure tests. Also material data shall be given on the materials and filler materials used in procedure tests. Procedure test plans for demanding welding work and also the results of finished procedure tests shall be included in the material specification or quality control programme. If a method has been standardised, a reference to the standard suffices.

Furthermore, as regards Safety Class 1 and 2 pumps, separate material-specific descriptions shall be presented, giving i.a. the following information:

- justification for the choice of material if only limited operating experience exists of the use and characteristics of the material for the structures in question, or if the material deviates from recommendations given in material standards
- the component manufacturing method (forging, casting, coating, heat treatment, etc.) if the technique used is unconventional, or if special care has to be exercised to achieve successful results with the method in question
- specific requirements for the characteristics of materials, unless unambiguously determined by standards or, if deviating from them
- testing methods and the scope of sampling, unless defined in the applicable material standard, or if the requirements of the standard are deviated from
- supervision of sampling and testing.

2.4 Quality control programme

The quality control programme shall describe the quality control of pumps and the inspection and testing procedures to be followed.

The quality control programme shall include:

- inspection programmes
- inspection instructions.

2.4.1 Inspection plans

Inspection plans shall be provided for all quality control that covers materials, possible procedure and work tests, manufacturing as well as the finished product.

The inspection plans shall give:

- component and weld specific numbering in accordance with drawings
- name and number of components
- standard markings of materials and filler materials
- procedure tests for qualification of manufacturing welds and possible repair welds (of pressure-bearing parts that affect the operation of Safety Class 1 and 2 pumps)
- inspections of each inspection item, and the identification codes of inspection instructions
- examiner/controller (e.g. manufacturer, plant supplier, approved examination organisation, orderer, authority)
- timing of inspection (fabrication of materials, fabrication and installation of pump parts).

2.4.2 Inspection instructions

Inspection instructions shall be prepared for all inspection and control activities. An inspection instruction shall give the method, manner and scope of inspection as well as the requirements for approval and reporting of the inspection. Standards can be referred to for further details.

Routine quality control actions for which inspection instructions are drawn up are as follows:

- review of construction plans and drawings
- identification and marking of materials and material certificates
- sampling and supervision of test pieces from materials and procedure tests
- destructive examination
- non-destructive examination
- competence of welders
- supervision of welding
- supervision of heat treatment
- supervision of coating or surface finishing
- inspection of the dimensions of structures
- visual inspection
- balancing of rotating parts
- leak and pressure tests
- functional tests and their supervision by manufacturers
- inspections of pumps that have been disassembled after functional tests
- supervision and inspection of installation
- functional tests and their supervision at the nuclear facility.

The dimensions of hydraulic parts of pumps as well as their clearances, fits and passes shall be checked with special care. The same applies to

the way checking is performed, and to the accepted accuracy limits of dimensions and the reporting of the inspections.

The pressure tests of pumps shall be conducted in accordance with the standards used in their dimensioning. If no such standard exists, the requirements of Standard SFS 3321/1/ shall be complied with. It is recommended that functional tests be conducted according to Standards ISO 3555/2/, ISO 2548 (SFS 4448) /3/, BS 599, 1966 and their supplements 3/76 and 9/77 /4/, and DIN 1994, 1968 /5/.

2.5 Dimensioning

It shall be shown by dimensioning that the structural solutions of pumps meet the strength and performance requirements set by the system.

2.5.1 Strength calculations

Strength calculations for pressure-bearing components shall be divided into basic dimensioning, and stress and fatigue analysis.

A pump's design conditions shall be the input values of basic dimensioning, usually excluding changes in temperature and load. The forces and torques from piping can be taken into account as equivalent pressure increase.

The dimensioning shall be clarified by drawings, which include system data and the necessary dimensions and loads.

Safety Class 1 pumps shall be dimensioned in compliance with the requirement level of ASME Code Section III, NB-3400, 1992 /6/. STUK can also approve the use of some other equivalent dimensioning standard, case by case. The possibility of brittle fracture shall be ruled out. Demonstration can be for example according to Standard ASME III NB-3211 (d), 1992 /7/.

Safety Class 1 pumps shall undergo stress and fatigue analysis in which the loads to which a structure is subjected are taken into consideration as realistically as possible. The input values will then include pressure and temperature changes, dynamic loads, recurrent loads, and forces and torques from piping and piping supports.

Analyses shall be made to demonstrate that a pump's pressure-bearing parts maintain their integrity under every possible load situation. STUK's approval for a stress and fatigue analysis shall be obtained before the pump is made operable. The applicable requirements are presented in more detail in Guide YVL 3.5.

In addition to pressure-bearing components, dimensioning calculations shall also be presented for the shaft and other components bearing significant loads. When the dimensioning scope of components is determined, for instance the standard ASME Code N-119-6, 1985 /8/ can be applied.

Loads from centrifugal forces shall be taken into account in the dimensioning of rotating parts. The impeller of the primary circulation pump of a PWR must maintain its integrity under every possible load situation. This can be demonstrated for example according to US Regulatory Guide 1.14, 1975 /9/.

A standard in general use in the manufacturing country and applicable for pumps at nuclear facilities can be applied in the basic dimensioning of Safety Class 2 and 3 pumps.

In addition to internal pressure, Safety Class 2 and 3 pumps shall be dimensioned to withstand the severest possible force from piping. The piping design shall be such that the severest forces and torques quoted by the pump's manufacturer will not be exceeded.

The impact of earthquakes on dimensioning shall be taken into account according to Guide YVL 2.6.

The basic dimensioning of Safety Class EYT/A pumps shall be calculated. Dimensioning standards for pressure vessels approved in the manu-

facturing country, or other applicable standards, can be used in the dimensioning.

2.5.2 Flow rate calculations

The suitability of a pump's construction for the intended use of the pump shall be demonstrated by flow rate calculations.

It will not be necessary to submit the flow rate calculations of pumps to STUK if the type of pump in question has been in production before and sufficiently detailed operation curves based on functional tests can be presented. Operation curves based on functional tests conducted in connection with pump type testing are also sufficient to authenticate the correctness of the flow rate calculations. The flow rate calculations and operation curve mentioned here cannot replace pump-specific functional tests.

2.6 Drawings

Drawings shall be presented of pumps, motors, their coupling, installation and parts of the auxiliary systems associated with the pump structures. The drawings shall contain the data needed for assessment of the acceptability of the dimensioning, fabrication, installation and operation of the pump structures.

If the pump must undergo inservice inspections in which non-destructive examination methods are used, as stipulated in Guide YVL 3.8, the information given in the drawings shall make it possible to assess whether it is possible to reliably inspect the pump housing and its welds and the welds between the pump and piping.

The drawings shall give

- assembly data, with lists of parts and materials
- dimensions and shapes used in dimensioning, or defined by dimensioning, with the permissible tolerances, and the finishing of surfaces
- types, locations and dimensions of joints and fixtures
- coatings of materials
- clearances, fits and passes essential to operation
- sufficiently detailed information about groundwork and installation.

2.7 Motors

2.7.1 Design bases and dimensioning of motors

A construction plan in accordance with Guide YVL 5.5 shall be provided for motors of all Safety Class 1 and 2 pumps and for those Safety Class 3 pump motors whose safety classification is based on the functional requirements set for the pumps. The following data shall be given in the plan:

- manufacturer
- design bases
- description of functioning
- quality control programme.

Of a motor's design bases, i.a. the following shall be given:

- safety class of motor
- standards used and possible deviations thereof
- rated voltage, frequency and power
- rated current and start current
- speed of rotation
- rated, start and maximum torque
- power ratio and power factor
- rated mode of operation
- moment of inertia
- cooling system
- installation position
- enclosure and insulation class
- dimensional drawing
- permissible rating under exceptional conditions (ambient temperature, grid voltage and frequency)
- selection criteria of the bearings
- permissible vibration on bearing supports
- permissible bearing temperatures.

If the motor is operated using a frequency converter, the suitability of the motor for such operation shall be found out.

If the motor is of a so-called wet motor type, the same data shall be provided on the motor's

pressure loaded parts as on the pump itself (subsections 2.1–2.6 above).

The structure of the motor's protection, monitoring and control system shall be described. It can be submitted even later as individual reports. However, the report shall be presented well before the installation of the motor is started.

The exclusion of the aforementioned information where Safety Class 3 items are concerned shall always be separately justified.

If a diesel motor is used as a pump's regulating unit, the requirements of Guide YVL 5.1 shall be taken into account in the unit's design for applicable parts.

STUK assesses the acceptability of a turbine as a pump regulating unit case by case, on the basis of submitted construction plans.

A separate document shall also be submitted to show that the electrotechnical dimensioning of Safety Class 1, 2 or 3 pump motors plus their supply cables and protection sufficiently ensure that the motors maintain their operating capability not only under normal operating conditions but also under transient and accident conditions occurring towards the end of their design-basis operating lives and which are more demanding as regards dimensioning. The analysis shall assume that the loading, ambient conditions, grid frequency and terminal voltage of the motors deviate from the limits defined for normal operation in a way least favourable for the motors.

The impact of an earthquake on dimensioning shall be taken into consideration in accordance with Guide YVL 2.6.

2.7.2 Type testing of motors

Data on the type testing and operating experience of motors shall be presented according to Guide YVL 5.5. Tests shall be conducted to demonstrate an electric motor's operation in such accident conditions for which operability requirements are set for the motor.

2.8 Auxiliary systems of pumps and their motors

Design data shall be provided for auxiliary systems required in the operation of a pump and its motor.

Such systems include i.a.:
- sealing systems
- cooling systems
- lubricating systems
- minimum flow piping
- testing systems
- flywheel
- possible missile shields
- electromagnetic bearings.

The maximum times that each auxiliary system may be out of service during pump operation shall be defined in the document. In the same way, possible requirements for auxiliary systems during pump start-up readiness and start-up shall be presented.

2.9 Measuring and control equipment of pumps and their motors

The data required on the measuring and control equipment of the pump and its motor are given in Guide YVL 5.5. If the data have already been submitted to STUK earlier, a reference to the document in question is sufficient.

Concerning the measuring and control equipment of the pump and its motor, i.a. the following data shall be provided:
- type of measuring instrument
- measuring range
- accuracy of measurement.

Measuring and control equipment include i.a. the following devices:
- flow meters
- pressure meters, alarms and switches
- temperature meters, alarms and switches
- vibration meters
- devices for measuring the displacement and/or bending of shaft
- measuring devices controlling the lubrication of bearings

- devices for measuring and adjusting bearing forces.

The assembly, installation and system drawings shall show the location of the transducers and detectors and/or metering and control devices.

2.10 Installation plans for pumps and their motors

The installation plan shall show the dimensioning, structural solutions and inspections of groundwork, fixtures and supports. The groundwork of Safety Class 1 and 2 pumps shall be planned in such a way that the significant characteristic vibration frequencies of the pump unit and the groundwork are not the same. The characteristic vibration frequencies of the groundwork and the pump unit shall be measured if necessary to check the dimensioning of the groundwork. The measurements of characteristic vibration frequencies can replace the vibration calculations of the groundwork. The measurements cannot replace earthquake calculations.

Attention shall also be paid to the design of the groundwork of Safety Class 3 pumps, specifically whenever the pumps in question are large, continuously operating pumps whose operability has a bearing on plant safety. Such pumps could be e.g. pumps contributing to the emergency cooling chain or the assurance of feedwater supply.

The design bases for and the drawings of a pump's coupling to the motor shall be given. A reference to the applicable standard suffices for Safety Class 3 pumps.

If special requirements are placed on the dimensions, materials and installation of piping to be joined to the pump, these shall be given.

The plan shall describe the installation phase by phase, as well as the limits placed on the installation accuracy. A description shall be given of the installation welding work of pumps connected to piping by means of welding.

The installation plan for Safety Class 3 pumps can be submitted in connection with the construction inspection of the installation.

It shall be reported how the operations of subcontractors who participate in the installation are controlled.

2.11 Type testing and operating experience

The purpose of type tests and operating experience data is to show that the pump and its motor are reliable in long-term operation under all system and environmental conditions defined in the design bases.

The type-testing programme shall be submitted to STUK for approval in connection with the construction plan. If the results of some type tests conducted previously are submitted for approval, the applicant shall annex the results of the tests to the type test programme submitted to STUK.

Operating experience encompasses the number of similar pumps fabricated earlier, the inservice times of the pumps and any other operating experience. Sufficient operating experience can replace the above-mentioned type tests.

Requirements for the type testing of motors are given in subsection 2.7.2.

3 Supervision of fabrication and construction inspection

STUK supervises the fabrication of Safety Class 1 and 2 pumps and motors by audits at the factory. STUK shall be given the opportunity to view the organisation and quality assurance procedures of the manufacturer and to follow fabrication and testing. For the audits, STUK shall be informed in good time of the dates of

inspections specified in approved inspection plans for pumps and their motors. STUK witnesses the fabrication as deemed necessary.

The parties concerned will be separately notified if STUK finds it necessary to supervise the fabrication of Safety Class 3 pumps or motors.

STUK usually conducts the construction inspection of Safety Class 1, 2 and 3 pumps at the factory. A request for the construction inspection shall be made in good time before the time of inspection. If the whole construction inspection is to be carried out in the course of one audit it is appropriate to request the audit to be conducted at a time when it is possible to witness functional tests and to carry out the subsequent visual inspections.

STUK carries out the construction inspections of Safety Class 1 and 2 pumps with the pumps disassembled and assembled. STUK reviews the fabrication documents of Safety Class 3 pumps in whole, and the rest of the construction inspection is carried out to an extent agreed upon separately. A complete construction inspection is usually conducted on one Safety Class 3 pump in any series of similar pumps in one consignment.

Should STUK require that an electric motor be subjected to a construction inspection, the decision that grants approval for the construction plan contains an additional requirement to this effect.

STUK supervises installation in the extent deemed appropriate. STUK shall be given in good time the date when the installation of Safety Class 1 and 2 pumps is started. On completion of the installation, STUK conducts a construction inspection on all Safety Class 1, 2 and 3 pumps.

Individuals who have STUK's approval for the job can also carry out the construction inspections of Safety Class 3 pumps.

General requirements applicable to construction inspections are given in Guide YVL 1.15.

4 Commissioning inspection

The commissioning inspection of the pump, which is to be conducted after its installation, shall be requested in writing from STUK well in advance. STUK conducts a commissioning inspection on all Safety Class 1 and 2 pumps and their motors. The commissioning inspection of Safety Class 3 pumps and motors is carried out by STUK or a person approved by STUK to conduct such inspections. The commissioning inspection of motors shall be made according to Guide YVL 5.5.

STUK conducts the commissioning inspections of Class EYT pumps in connection with the commissioning inspection of a system or its part. STUK does not make the commissioning inspections of pumps installed to Class EYT/B piping. The licence-holder shall see to it that the inspection and control of these pumps are appropriately arranged.

A commissioning inspection divides into two parts: verification of installation and inspection status, and supervision of functional tests. Verification precedes functional testing. In the verification of installation and inspection status, the pump's acceptability is evaluated for the granting of a functional test permit.

4.1 Verification of installation and inspection status

Documents concerning Safety Class 1, 2 and 3 pumps shall be collected in one place and kept separately for each pump. STUK checks the acceptance status of documents during the verification of installation and inspection status, and the document material shall include at least the following:

- document list
- covering letters and front sheets of documents
- STUK's decisions and letters
- STUK's inspection protocols
- written accounts for notes made during inspections

- pump design data
- results of functional tests conducted at the factory
- assembly and installation drawings
- results of the preservice examinations included in the inservice inspections.

During the verification, STUK's representative shall be provided with an approved construction plan and a written account to verify that the notes and additional requirements set forth in the decision have been complied with.

4.2 Supervision of functional tests

Functional tests relating to the commissioning inspection can be carried out as part of the preoperational and start-up testing of the system, as described in Guide YVL 2.5. STUK supervises start-up testing by reviewing system-specific start-up testing programmes and result reports and by following system tests. Preoperational testing shall demonstrate the realisation of the design bases of pumps and their motors and the general applicability of components to the system's various operational conditions.

Safety Class 1 and 2 pumps shall be subjected to a test run of at least 50 hours in conditions comparable to normal operation without interim maintenance or repair measures. Case by case, STUK assesses the scope of testing of Safety Class 3 pumps on the basis of the test run programme to be submitted to it.

During the testing, each pump and motor shall be assigned basic parameters characteristic of them and against which the results of periodical tests to be conducted later can be compared. These comparisons are intended to facilitate the detection of potential flow rate or mechanical changes in the operation of pumps.

Written instructions shall be prepared for the establishment of basic parameters. These instructions and start-up testing results form a basis for the preparation of periodical test procedures. These procedures shall specify the pumps subject to regular testing, the guidelines followed in each measurement, the measuring equipment with their calibration requirements and the method for recording the results. The procedures shall also show the acceptance limits for the results of measurements that are based on accident analyses and on the condition control requirements of pumps.

It is recommended that the procedures be prepared using ASME Code Section XI, Subsection IWP, 1992 /10/.

5 Control of pumps during operation

5.1 Periodical tests and condition monitoring

Safety Class 1, 2 and 3 pumps and their motors shall be subjected to periodical tests to verify their operability and condition. A programme shall be drawn up for the tests, which states the testing schedule for each pump and the rules and instructions to be applied in the tests. The test results shall be filed in such a way that subsequent results can be compared with them, as deemed necessary.

Continuous-operation condition control should be used to monitor the operability of safety-significant pumps and their motors.

STUK need not be separately notified of the periodical tests; STUK monitors the implementation of the periodical test programme and the use of continuous-operation condition monitoring equipment by regular inspections.

5.2 Non-destructive inservice inspections

The inservice inspections of pumps shall be conducted in compliance with the requirements set forth in Guide YVL 3.8.

5.3 Preventive maintenance

For the preventive maintenance of Safety Class 1, 2 and 3 pumps, programmes shall be prepared

that describe the preventive maintenance measures the pump and its motor (the pump unit) are subjected to. Such measures typically are e.g. oil changing, follow-up of the operating condition of the pump and the replacement of worn parts.

A database shall be kept of Safety Class 1, 2 and 3 pumps and their motors. The data entered in the database comprise accomplished maintenance and repair measures, etc.

Operational experience and advances in technology shall be considered when the scope of preventive maintenance is periodically assessed. The ageing of materials and chemicals shall also be taken into account when preventive maintenance is planned.

STUK controls the implementation of the preventive maintenance programme by regular inspections.

5.4 Modifications and repairs

The design and implementation of repairs and modifications as well as the installation of an approved spare pump shall be carried out according to the requirements set forth in Guide YVL 1.8.

STUK conducts the commissioning inspections of repaired pump motors if the construction plans for repairs or modifications are subject to STUK's approval.

5.5 Spare parts

The spare parts necessary for each type of pump and motor shall be purchased and their sufficiency monitored.

The construction plan for a pump and its motor is also valid for their spare parts. Any changes shall be submitted to STUK for approval. STUK conducts the construction inspection of spare parts in an extent equivalent to the construction inspection of original parts.

6 References

1 Finnish Standards Association, Standard SFS 3321, Inspection of pressure vessels. Pressure test

2 Centrifugal, mixed flow and axial pumps – Code for acceptance tests – Class B, ISO 3555

3 Centrifugal, mixed flow and axial pumps - Code for acceptance test. Class C, SFS 4448 (ISO 2548)

4 British Standards Institution B.S. 599. Methods of Testing Pumps, 1966 as amended 3/76 and 9/77

5 Deutsche Normen DIN 1944 Abnahmeversuche an Kreiselpumpen, 1968

6 ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, Article NB-3400 Pump Design, 1992

7 ASME Boiler and Pressure Vessel Code, CASE N-119-6, 1985

9 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.14, Reactor coolant pump flywheel integrity, 1975

10 ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWP, Inservice Testing of Pumps in Nuclear Power Plants, 1992

11 ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, Article NB-6000 Testing, 1992

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YVL 1.3 Mechanical components and structures of nuclear power facilities. Inspection licenses, 22 Oct. 1996 (in Finnish)

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YVL 1.5 Reporting nuclear power plant operation to the Finnish Centre for Radiation and Nuclear Safety, 1 Jan. 1995

YVL 1.6 Nuclear power plant operator licensing, 9 Oct. 1995

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YVL 2.5 Pre-operational and start-up testing of nuclear power plants, 8 Jan. 1991

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

YVL 2.7 Ensuring a nuclear power plant's safety functions in provision for failures, 20 May 1996

YVL 2.8 Probabilistic safety analyses (PSA), 20 Dec. 1996

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YVL 3.1 Construction plan for nuclear facility pressure vessels, 27 May 1997 (in Finnish)

YVL 3.3 Pressure vessels of nuclear facilities. Piping, 4 December 1996 (in Finnish)

YVL 3.4 Nuclear power plant pressure vessels. Manufacturer's competence, 16 December 1996 (in Finnish)

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