INSTITUTE OF RADIATION PROTECTION

GUIDE YVL 5.7
Dec 14, 1977 1 (18)
Translated June 11, 1980

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

# INSPECTION OF NUCLEAR POWER PLANT PUMPS

CONTENTS



A4 75-2658 b/4

Postadress
P.O. BOX 268
00101 HELSINKI 10
FINLAND

Telephone
659588

Telex
122691 STL - SF

# 1 GENERAL

The Institute of Radiation Protection (IRP) controls nuclear power plant pumps of Safety Class 1, 2 and 3 as provided in this guide. Classification principles are presented in Guide YVL 2.1/1/. No special inspections are conducted of other pumps in a nuclear power plant; they are considered as piping accessories and are attended to in connection with the commissioning inspection of the piping.

The various control phases are

- pre-inspection
- control of fabrication and construction inspection
- commissioning inpsection
- supervision of pre-operational testing
- supervision of inservice testing
- supervision of inservice inspections
- maintenance during operation

In this guide, one control phase is dealt with in each section as well as the significance of Safety Class to the scope of supervision.

# 2 PRE-INSPECTION

The pre-inspection material consists of:

1. description of manufacturer (only in Safety Class 1)
2. design bases
3. material report
4. description of fabrication (only in Safety Class 1)
5. quality control programme

6. basic dimensioning
7. drawings
8. data on pump coupling to motor and pump connection to piping
9. data on motor
10. data on type tests and operating experience

Items 1 to 7 do not apply to motors or transmission elements.

The pre-inspection documents are submitted to the IRP following the procedure presented in Guide YVL 1.2/2/ using the division employed in this guide (YVL 5.7).

2.1
Description of Manufacturer (Only in Safety Class 1)

The description is intended to demonstrate the competence of the manufacturer. A description of the organization, confirmed by the management of the firm, shall be included, presenting assignment of duties, fields of responsibility and competence and quality assurance arrangements. The quality assurance report may be based on the quality assurance manual used at the factory.

The above information shall also be provided on sub-contractors and consultants who take part in fabrication or quality control of the pressure retaining parts of the pump. An approval of the inspection agency and inspectors is applied for in accordance with Guide YVL 1.3/3/.

If the document would be, in essential parts, identical with a document submitted to the IRP on a earlier date, references and an account of potential changes will suffice.

2.2
Design Bases

Design bases shall include the data necessary for examination of material selection, strength analysis and quality control programme.

Information shall be provided on pump performance requirements and boundary conditions including

- the function of the pump and process designation
- tightness requirements
- design pressure and testing pressure
- upper limits for piping forces and torques acting on the pump
- the characteristics, temperature and potential rapid temperature changes of the pumped water
- range of variation of suction pressure
- required operating point (volume flow, head)

Pump characteristics include

- characteristic curves and required NPSH
- cooling and/or seal water demand
- required minimum flow rate
- allowable vibrations and bearing temperatures
- required maintenance frequency in continuous operation, and required maintenance frequency when the pump is not in continuous operation during normal power plant operation
- potential special requirements concerning starting (start-up against a closed valve, lubrication water demand during start-up etc.)

2.3
Material Report

The material report is meant to demonstrate the qualification of materials for intended use as well as to give data on materials and their properties which unambiguously define the acceptance criteria and limits.

The material report contains material data on all parts that are pressure retaining or welded directly to the pressure frame, including filler metals. In addition, material data on the shaft, impeller or comparable load-bearing parts are provided. In case the structure incorporates weld seams, data on materials used in the fabrication procedure qualification tests are included.

The material report shall include base and filler material specifications provided with the part numbers used in drawings and standard markings.

In safety Class 1 and 2, additional clarifying information shall be provided on each material, specifying

- the basis for material selection, if needed
- the standard to which the material conforms
- the potential approval of the material for construction of pressure retaining components
- fabrication method of components (forging, casting etc.)
- delivered condition and instructions for heat treatment
- specific requirements for material properties unless determined by the standards
- method and scope of sampling and testing
- type of material certificate

The base materials shall satisfy the criteria of the standards after which they are designated. Potential additional material requirements shall be presented in the material report.

The weld and heat affected zone of the finished product shall meet the same strength and toughness requirements as set for the base materials of the finished product.

The method and scope of sampling and testing shall be determined on the basis of the Safety Class, material type, operating conditions and dimensions of the component involved. If such data as is not meant to be corrobarated by testing is included in the material report, it must be clearly stated.

An example of an acceptable material certificate is the test certificate 3 B conforming to standard SFS 3/4/.

## 2.4
## Description of Fabrication (only in Safety Class 1)

The description of fabrication process is to give a general description of the fabrication methods and implementation of quality control at the various stages of manufacture. Heat treatment data and a welding plan shall be included. A description of fabrication is required only for pressure retaining parts.

## 2.5
## Quality Control Programme

The quality control programme describes the regular quality control measures that the pump is subject to as well as the inspection procedure.

The quality control programme concicts of

- inspection instructions
- inspection plans

2.5.1
Inspection Instructions

Inspection instructions shall cover all activities listed in the inspection plan. The instructions shall specify the method, scope, requirements and reporting of each inspection. As for details, reference can be made to relevant standards.

The most common quality control measures presented in the inspection instructions can be divided as follows:

- identification, marking and material certificate of the materials
- sampling method
- destructive material testing
- non-destructive material testing
- control of welding
- control of heat treatment
- chech of the dimensions of the construction
- leak and pressure tests
- performance tests
- visual inspection of a disassembled pump
- inspections carried out by the manufacturer

The pressure test described in the inspection instructions shall be conducted in accordance with the standard, or series of standards, used in dimensioning. If such standard does not exist, the standard SFS 3321/6/ shall be adhered to in Safety Class 2 and 3. It is recommended that the performance tests be carried out in accordance with DIN 1944/7/ or BS 599/8/ or a comparable standard.

2.5.2
Inspection Plans

The inspection plans shall comprise quality control measures applied to materials, fabrication, procedure tests and the finished product.

The inspection plans must cover all parts important to safety.

The inspection plan shall include

- numbering of each part and weld in accordance with drawings
- name of the part
- the standard markings of base and welding filler material
- division of inspections per colums in accordance with inspection instructions
- inspection phase (fabrication of material, fabrication of pump, installations)
- excecutor and/or supervisor of inspection (e.g. manufacturer, facility supplier, recogrized inspection agency)

Procedure tests associated with fabrication are not required for Safety Class 2 and 3 pumps, provided the tests have been performed on the pump model or extensive operating experience in available.

2.6
Basic Dimensioning

The purpose of basic dimensioning is to demonstrate that the dimensions and shaping of the pump meet the requirements of the standards in design conditions.

Pumps of Safety Class 1 shall be dimensioned to fulfill the criteria set forth in ASME Code Section III, NB-3400/9/. As to other pumps, the general standard for nuclear power plant pumps adopted in the country of fabrication can be applied.

In addition to pressure retaining parts, basic dimensional calculations shall be presented for the shaft and other significant load-bearing parts.

In addition to basic dimensioning, specific stress analysis is required for pumps of Safety Class 1, showing that the pressure retaining parts of the pump will retain their integrity under all loading conditions. The stress analysis need not necessarily be included in the pre-inspection material. Relevant criteria are set forth in Guide YVL 3.5.

## 2.7 Drawings

Drawings shall depict the overall assembly and the details of the construction so that the size, shape and fabrication of the pump is presented in sufficiently great detail.

The drawings shall be unambiguous and clear. They shall depict

- the sizes and shapes used in, or arrived at by, stress analysis
- location, dimensions and details of joints
- assembly data including part and material specifications

## 2.8 Data on Pump Coupling to Motor and Pump connection to Piping

A drawing of the pump coupling to motor shall be provided, presenting the structure of the coupling and the potential gear as well as the main dimensions of the assembly.

In case special requirements are set for the dimensions or materials or the piping to be connected to the pump, they shall be specified here. As to pumps connected to piping by welding, a description of the installation welding is required. In Safety Class 1, data on support structures are required as well.

2.9
Data on Motor

If the motor is of the so called wet motor type, the same data is provided on the pressure retaining parts of the motor as on the pump itself (items 2.1 through 2.7 above).

At least the following items shall be provided on all motors

- manufacturer
- operating principle
- operating voltage
- power required at operating point, starting condition and the greatest possible load
- efficiency
- torque as a function of rotational speed
- cooling system
- insulation and shielding class
- allowable vibration at bearing suppors
- a drawing presenting the main dimensions

2.10
Data on Type Tests and Operating Experience

Type tests and operating experience data are needed to show that the pump functions reliably in long-term operation and is not prone to potential external disturbances.

The nature of type tests depend upon the application field and operating conditions of the pump, wherefore no generally applicable requirements can be laid down. However, some examples of what the IRP expects a type test to include are listed below.

- 500 hr trial run in the worst environmental conditions where the pump is required to function
- cavitation tests to determine the minimum NPSH at various flow rates
- pump behaviour in the event of loss of cooling or seal water
- vibration measurements in various operating conditions
- assurance of the ability to withstand overspeed without failure by sufficient margin to normal rotational speeds
- measurement of rotational speed and flow rate as a function of time following loss of current feed

A description of the type tests is included in the pre-inspection material.

No type tests are required if operating experience is sufficient and the data available.

Operating experience encompasses the number of similiar pumps fabricated to-date, the longest and average in-service life of the pumps as well as potential failures and their frequency.

## 3
## CONTROL OF FABRICATION AND CONSTRUCTION INSPECTION

The IRP controls the fabrication of Safety Class 1 pumps by conducting inspection tours on the factory. An opportunity of viewing the organization of the factory as well as fabrication methods and quality control procedures shall be arranged for the IRP. For inspection tours, the fabrication schedule of the pump, complete with dates for inspections required by the quality control programme, shall be filed with the IRP in good time. The IRP supervises these inspections as it deems appropriate. If the IRP finds it necessary to control the fabrication of a pump of some other Safety Class, the concerned parties will be notified thereof.

In general, the construction inspection is conducted in the factory on the basis of accepted pre-inspection records. A construction inspection is requested for in writing well in advance of the inspection date.

The construction inspection is divided up into four parts:

- examination of quality control records
- witnessing of leak and pressure test
- witnessing of performance test
- physical inspection of pressure retaining parts including shaft and impeller or comparable load-bearing parts

In Safety Class 1, the IRP conducts a full construction inspection of all pumps. In Safety Class 2, the IRP examines the quality control records on each pump, conducting the remaining part of the construction inspection as agreed. A full inspection is usually conducted of only one pump in a series of similiar pumps in one consignment. In Safety Class 3, the IRP may authorize the owner of the nuclear power plant or a person in the employ of an inspection agency to carry out the construction inspection.

Records shall be kept on construction inspections of all pumps and submitted to the IRP in connection with the commissioning inspection.

## 4 COMMISSIONING INSPECTION

The IRP conducts an commissioning inspection of all Safety Class 1, 2 and 3 pumps.

The commissioning inspection is carried out after the pump is installed in its final place. The inspection is requested for in writing well in advance of the inspection date.

In the acceptance inspection, the following items are presented:

- the approved pre-inspection material and decision as well as a written report on fulfillment of the conditions contained in a conditional decision
- construction inspection records
- written reports of the comments made in the construction inspection
- records of performance test

The commissioning inspection does not involve special functional tests - they are conducted as part of the pre-operational testing of the facility.

## 5 SUPERVISION OF PRE-SERVICE TESTING

The Institute of Radiation Protection supervises the pre-service testing of pumps of Safety Class 1, 2 and 3.

The pre-service testing of pumps is supervised in accordance with Guide YVL 2.5/10/ in connection with system performance tests, in other words, by examining system-specific pre-operational testing programmes and tests reports and witnessing system testing.

The Institute of Radiation Protection requires that each pump be test run for the minimum of 50 hr in conditions reproducing the chracteristics of normal operation and without servicing or maintenance.

During pre-service testing, basic quantitative parameters shall be determined for each pump. The results of subsequent inservice testing are compared to these values. The purpose of this comparison is to detect potential hydraulic or mechanical changes in a pump. The hydraulic condition is characterized by a combinatio of rotational speed, differential pressure and flow rate measured at a given inlet pressure. Vibration and bearing temperature at certain locations describe the mechanical characteristics of a pump. Written instructions shall be compiled for determination of the basic parameters; these instructions shall be adhered to in inservice testing as well. The instructions shall specify the pumps they apply to, the method of each measurement, the instruments used including calibration requirements and documentation and storage of results. The instructions shall also include the accpetable measurement ranges and actions to be taken in case of deviation. It is recommended that ASME Code Section XI, Subsection IWP/11/ be used as an aid in preparing the instructions. The IRP does not grant a specific approval of the instructions but examines them when monitoring quality assurance activity during operation.

## 6 SUPERVISION OF INSERVICE TESTING

The Institute of Radiation Protection controls the inservice testing of Safety Class 1, 2 and 3 pumps.

The inservice testing interval is separately determined for each pump in the Technical Specifications of the nuclear power plant. Each test shall be carried out in accordance with the instructions referred to in section 5. An exception to this rule is the measurement of bearing temperature which need not be performed more than once a year. The licensee shall have a programme specifying the date of next testing of each pump and the instruction manual to be followed. The dates and results of previous testings shall be available in the plant records so that they can be checked as needed.

The IRP need not be specifically notified of inservice testing; the Institute controls the testing by examining the documentation stored in the plant records and occasionally witnessing the performance of measurements. A summary of inservice testings is submitted to the IRP every year in the annual report of the facility.

## 7
## SUPERVISION OF INSERVICE INSPECTIONS

Inservice inspections are non-destructive inspections conducted to monitor the condition of the pressure retaining parts of Safety Class 1 and 2 pumps.

The inservice inspection of pumps as well as other pressure retaining components are carried out in conformance with Guide YVL 3.8/12/.

## 8
## MAINTENANCE DURING OPERATION

### 8.1
### General

Records documenting the servicing, repair and maintenance activities of all pumps and pump motors regulated by the IRP

shall be kept at the facility.

8.2
Preventive Maintenance

Preventive maintenance means actions taken in accordance with a previously prepared servicing programme, designed to prevent pump or pump motor malfunctions. Typical such measures are e.g. the replacement of shaft sleeve, seal or bearing.

The IRP supervises the maintenance activites by checking the component files.

8.3
Remedial Maintenance

Remedial maintenance means actions taken to restore a pump or pump motor to original or design condition following a serious malfunction or inoperability. Such repairs shall be discussed in advance with the IRP which supervises the repair work as it deems appropriate.

Following remedial maintenance operations, the IRP conducts a construction inspection of the component and supervises potential functional tests.

8.4
Modifications

Modifications mean repairs as a result of which the pump or pump motor no longer conforms to the original design.

Measures described in Section 2 through 5 of this guide are taken when making modifications.

8.5
Spare Parts

The pre-inspection decision for a pump and pump motor is good for spare parts as well. Potential changes require a specific approval. The IRP conducts a construction inspection of spare parts as extensive as that of the originals.

8.6
Measurement of Reference Values

Following the maintenance operations mentioned under items 8.2, 8.3 and 8.4, the basic quantative parameters referred to in section 5 shall be determined for pumps and pump motors.