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In-service inspections for primary coolant circuit components of light water reactors — Part 3: Hydrostatic testing

Contrôles périodiques des composants du circuit primaire des réacteurs à eau légère — Partie 3: Essais de pression

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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The committee responsible for this document is ISO/85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 6, *Reactor technology*.

ISO 20890 consists of the following parts.

- *Part 1: Mechanized ultrasonic testing*
- *Part 2: Magnetic particle testing and penetrant testing*
- *Part 3: Hydrostatic testing*
- *Part 4: Visual testing*
- *Part 5: Eddy current testing of steam generator heating tubes*
- *Part 6: Radiographic testing*

In-service inspections for primary coolant circuit components of light water reactors — Part 3: Hydrostatic testing

1 Scope

This standard shall be used for in-service system pressure tests of the reactor coolant circuit of light water reactors.

This standard specifies the test technique, the requirements for measuring equipment and additional devices, the preparation and performance of the test as well as the recording and documentation, for the purpose to ensure the reliability and comparability of tests.

NOTE Data on (test) pressure, (test) temperature, scope of testing, rates of change of pressure and temperature, test schedule and test intervals can be obtained from the applicable national nuclear codes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8596, *Ophthalmic optics— Visual acuity testing — Standard optotype and its presentation*

EN 837-1, *Pressure measuring equipment — Part 1: Pressure measuring equipment with Bourdon tubes; dimensions, measuring technology, requirements and testing*

EN 837-2, *Pressure measuring equipment — Part 2: Selection and installation recommendations for pressure measuring equipment*

VDI/VDE 3511 Sheet 5, *Technical temperature measurements — installation of thermometers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

Test equipment

<Pressure testing>Reactor coolant or deionate

3.2

Test temperature

temperature to which the pressure retaining boundaries of the reactor coolant system and the *test medium* are to be heated for

3.3

Test pressure

overpressure to which the reactor coolant system is exposed during the test

3.4

Maximum operating pressure (design pressure)

overpressure for which the reactor coolant system is designed with regard to safety, operational and constructional requirements.

4 Test system

4.1 General

The in-service system pressure test provides a global statement of integrity regarding the reactor coolant system and, as a safety measure for monitoring the consequences of alleged operationally induced damage mechanisms, is a part of the concept for assuring component integrity during operation.

4.2 Standard system

The in-service system pressure test is an integral test covering pressure retaining components of the reactor coolant system. After filling the reactor coolant system with the test medium, the system is pressurised in accordance with a pressure-temperature-schedule to the test pressure, which shall be applied continuously during a defined holding time. The pressure is then reduced to the operating pressure and a visual (inspection) examination of the pressure-retaining components is performed for leakages.

When planning and performing the visual (inspection) examination, aspects of minimising the radiation exposure must be considered.

5 Requirements

5.1 Test personnel

The test personnel shall have the skills to perform the work they are to carry out. In particular, they shall possess adequate experience in performing and evaluating system pressure tests on pressurised containers and piping and relevant knowledge about the reactor coolant system and about operationally induced damage. Evidence of the qualification of test personnel shall be validated in accordance with Table 1.

Table 1 — Minimum requirements for the test personnel

Test personnel	Qualification
Test inspector	Persons who have studied at a technical college, are state-certified trained technicians or have relevant skilled-worker or industrial training as well as have proof of participation in pressure testing
Test supervisor	Persons who have studied at a university or a technical college and have proof of training for performing pressure tests and knowledge of reactor operation

The test supervisor shall have sufficient experience of evaluation and be familiar with the characteristic appearances of operational-induced flaws. Responsible for the evaluation of abnormalities is the test supervisor, who shall possess the necessary experience with regard to the reactor coolant system, test tasks and test procedures.

The test personnel shall provide annual validation of their visual abilities, which has been determined by an ophthalmologist, optician or other medically recognised person. The following requirements shall be fulfilled:

- The visual acuity testing shall be conducted using standard symbols according to ISO 8596. Here a near vision of 1.0 at 0.33 m test distance and a distance vision of 0.63 with at least one eye with or without vision aid shall be certified;
- The ability to distinguish between colours and between grey shading shall be certified using colour sense test plates. The validation can typically be conducted with the help of Ishihara colour boards as well as the "shades of grey test". In case of anomalies, the ability to see colours is sufficient for the test assignment.

5.2 Test object

The reactor coolant system shall be ventilated and shut off to avoid unintentional pressure building up in the connecting systems. All components and measuring equipment required for the system pressure test shall be dimensioned in accordance with the test pressure.

The test object shall be stripped of insulation at representative points, taking into account the following non-destructive testing and the aspects of minimising exposure to radiation.

Suitable safety devices shall be provided to limit the test pressure.

5.3 Measuring equipment

5.3.1 General

The measuring equipment shall be calibratable. The operation instrumentation may be used if it complies with the requirements specified in 5.3.2, 5.3.3 and 5.3.4.

If necessary, further measuring equipment shall be provided in addition to the operation pressure and temperature measuring instrumentation. A test manometer shall be connected.

5.3.2 Pressure measurement of the operating instrumentation

The pressure measurement instrumentation of the normal operation system used shall provide results accurate to within 1% of full scale for analogue gages and 1% over the calibrated range for digital gages.

Note: This requirement complies with Class 1 of EN 837-1.

5.3.3 Test manometer

The additional test manometer used shall provide results accurate to within 0,6% of full scale for analogue gages and 0,6% over the calibrated range for digital gages and shall be installed in accordance with EN 837-2. Available pressure measurement points shall be used for the installation.

Note: This requirement complies with Class 0.6 of EN 837-1.

5.3.4 Temperature measurement

The temperature limits to be complied with for protection from brittle fracture shall be monitored with measuring equipment with maximum discrepancy of ± 2 K. National regulations shall be taken into account, if additional instrumentation is installed.

5.4 Pressure generation system

The pressure generation system shall be designed such that the test pressure can be hold during test time.

It shall be ensured that the specified maximum rate of pressure change and the test pressure are not exceeded.

NOTE To avoid irregularities over the course of the pressure increase, an automatic or manual deactivation (Emergency Off) of the pressure feed shall be provided.

6 Testing

6.1 Standard test procedures

The standard test procedures shall contain the following specifications:

- a) Test range and scope of test,
- b) the following set-up parameters:
 - Test pressure, test temperature range of the reactor pressure vessel and component-relevant test temperature ranges,
 - Pressure-Temperature-Time diagram,
- c) Pressure and temperature measuring equipment to be used and its adjustment,
- d) Measuring range and classes in accordance with 5.3 for the additional instrumentation,
- e) List of the additional documentation, equipment and auxiliary devices used,
- f) Specification for certification of the calibration of the measuring equipment used,
- g) Type and scope of the required temporary measures for the required systems and of the safety measures,
- h) Type and scope of data recording in accordance with Clause 7 and documentation in accordance with Clause 8.

6.2 Preparations

The test personnel shall be trained sufficiently and in good time in the special requirements of the hydrostatic test.

All requisite documents (e.g. standard test procedures, drawings) necessary for conducting the test shall be made available to the test personnel.

The temporary measures required for preparation of the system pressure test shall be carried out and documented. All necessary measuring equipment for the system pressure test must be calibrated. The safety devices for limiting the test pressure shall be tested for operability. The specified protection zones shall be defined and marked.

It shall be ensured that the representative bared points are adequately accessible. Sufficient transportable lighting equipment shall be available to enable these points to be adequately illuminated. The reactor coolant system shall be completely filled with test medium and ventilated.

The reactor coolant system shall be heated to temperatures within the specified component-relevant test temperature ranges. At the same time, a sufficient temperature balance between test medium and pressure retaining boundary shall be ensured. This can be achieved for example,

- before or during the feed,
- during circulation via heat exchangers or heating in the pressuriser ,
- during circulation via main coolant pumps.

Heating is carried out, dependent on the plant, at a system pressure below the permissible operating pressure, whereby the rate of pressure and temperature increase shall comply with the specifications stated in the operation manual.

Before the pressure is increased from the operating pressure to the test pressure

- it shall be ensured that the operation and safety systems present do not influence the performance of the test and are not themselves damaged by the pressure test,
- it shall be checked whether all preparation work has been carried out.

6.3 Performance

The test pressure shall be applied according to the specified Pressure-Temperature-Time plan. The pressure displayed on the test manometer is definitive for controlling the pressure. It shall be ensured that fluctuations in the test pressure are kept within unavoidable system- and process-induced values during the holding time pressurization to test conditions. If the pressure drops during the test, the reason shall be tried to ascertain.

Leakage quantities may be replenished in agreement with the expert consultant, provided that all aspects of personnel protection and minimisation of exposure to radiation in the plant are taken into account. Otherwise the system pressure test shall be abandoned and repeated after carrying out remedial measures. Leaks which could not be replenished shall be treated according to national standards.

If it is not possible to prevent a drop in the test temperature below the permitted value during the test time, the pressure shall be reduced to a value of less than or equal to the permissible operating pressure. Before increasing the pressure again, the pressure retaining boundaries shall be heated to the required test temperature.

After the holding time, the pressure shall be reduced to the operating pressure and a visual examination shall be performed for leakages of the pressure retaining boundaries.

A hydrostatic testing has been passed if the components tested have withstood the test pressure during the holding time.

6.4 Final measures

After completing the system pressure test, the additional measuring equipment, other equipment and auxiliary devices used shall be removed. The temporary measures taken for performing the pressure test shall be reversed and documented.

7 Recording

The record shall be compiled concerning the test. The following data shall be included as a minimum:

- a) Date of the test;
- b) Name of the power station;
- c) standard test procedure;
- d) Deviations from the standard test procedure;
- e) Designation of the components;
- f) Recording of pressure and temperature profile during the test time;

- g) Abnormalities (e.g. leakage, deposits);
- h) Result of the testing.
- i) Test report with calibration data for the measuring equipment used
- k) Place, date, name, signature, certificate number of the test inspectors and test supervisor of the operator or the test company commissioned by him and the third party.

ISO xx-3 shall be noted as the test basis in the test protocol.