INTERNATIONAL STANDARD

ISO 20890-3

First edition
2020-06

Guidelines for in-service inspections for primary coolant circuit components of light water reactors —

Part 3: Hydrostatic testing

Lignes directrices pour les contrôles périodiques des composants du circuit primaire des réacteurs à eau légère —
Partie 3: Essais de pression

Reference number
ISO 20890-3:2020(E)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 6, *Reactor technology*.

A list of all parts in the ISO 20890 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Guidelines for in-service inspections for primary coolant circuit components of light water reactors —

Part 3:
Hydrostatic testing

1 Scope

This document gives guidelines for in-service system pressure tests of the reactor coolant circuit of light water reactors.

This document 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 inspection 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 and clinical optotypes and their presentation*

ISO 18490, *Non-destructive testing — Evaluation of vision acuity of NDT personnel*

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

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:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
test medium
<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* (3.1) are to be heated

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 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.

A general test procedure shall be prepared. Annex A contains the items of the general test procedure.

4.2 Standard system

The 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 shall be considered.

5 Requirements

5.1 Personnel requirements

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.

Those personnel, using qualified procedures and equipment, should be qualified through one or any combination of the following:

— certification through a national personnel certification scheme;

— theoretical and/or open trials.

— assessment based on the procedure set by testing organization

Any personnel certification requirements invoking relevant national personnel certification schemes should be validated according to Table 1. Any additional personnel training requirements should also be specified in the qualification dossier.

If no relevant scheme exists or if extra personnel qualification is needed, the qualification body should determine the additional practical and theoretical examinations needed beyond those in the national certification scheme, include these in the qualification procedure and ensure that the test procedure also includes the necessary requirements. The qualification procedure should describe the proposed system.

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 visual acuity testing shall be conducted using standard symbols in accordance with ISO 8596 (Landolt rings) or ISO 18490 (E shaped character). Here a near vision acuity of 1,0 at a test distance of 0,33 m and a far vision acuity of 0,63 at a test distance of at least 4,0 m with at least one eye with or without optical aid shall be certified.

NOTE For reasons of readability, the male form is used with personal names, however the female form is also always intended.

5.2 Test object

The reactor coolant system shall be vented 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 able to be calibrated. 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 instructions

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

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 analog gauges and 0,6 % over the calibrated range for digital gauges 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 as specified in the manufacturer specification are not exceeded.

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 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 shall be calibrated. The pressure gauge is installed in the temporary equipment. 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 vented.

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, or

— 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, and

— it shall be checked whether all preparation work has been carried out.

6.2 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 cause shall be established.

Leakage of temporary gaskets and seals, installed for the purpose of conducting the hydrostatic test and which will be replaced later, may be permitted unless the leakage exceeds the capacity to maintain system test pressure for the required amount of time. Other leaks, such as those from permanent seals, seats, and gasketed joints in components, may be permitted when specifically allowed by the manufacturer specification. Leakage from temporary seals shall be directed away from the surface of the component to avoid masking leaks from other joints. All aspects of personnel protection and minimisation of radiation exposure in the plant shall be taken into account. Otherwise the system pressure test shall be abandoned and repeated after carrying out remedial measures.

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.

6.3 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 Test report

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

— date of the test;

— a reference to this document, i.e. ISO 20890-3:2020;

— name of the power station;

— standard test procedure;

— deviations from the standard test procedure;

— designation of the components;

— recording of pressure and temperature profile during the test time;