
INSPECTION PROCEDURE 75001 ATTACHMENT 04

REACTOR PRESSURE VESSEL (RPV) AND RPV INTERNALS

Effective Date: April 1, 2026

PROGRAM APPLICABILITY: IMC 2573

75001.04-01 INSPECTION OBJECTIVES

To verify that safety-related (SR) and non-safety-related, safety-significant (NSRSS) reactor pressure vessels (RPV) and reactor vessel internals can perform their required safety functions (RSFs).

75001.04-02 INSPECTION REQUIREMENTS

02.01 Vertical Slice Inspection of Quality Assurance

Verify the licensee, manufacturer, or project vendor is effectively implementing its quality assurance (QA) and quality control (QC) requirements in accordance with the quality assurance program (QAP) for activities associated with SR and NSRSS RPV and RPV internals. Inspection guidance for this portion of the inspection is provided in inspection procedure (IP) 75001, Appendix A.

02.02 Structures, Systems, and Component (SSC) Inspection Samples

Verify the RPV and RPV internals are designed and constructed in accordance with ASME Code requirements.

Verify the as-built RPV and RPV internals meet the design requirements in the design specifications, the design report, and the safety analysis report (SAR).

02.03 ITAAC Inspections: (Only applicable for construction under a combined operating license (COL))

Verify the inspections, tests, and analysis (ITA) are performed and that the acceptance criteria (AC) in the COL are met.

02.04 Operational Program Inspections

Inspect implementation of the operational programs related to the reactor vessel material surveillance program and the comprehensive vibration assessment program, if applicable.

75001.04-03 INSPECTION GUIDANCE

General Guidance

The purpose of this inspection procedure is to provide insights into the quality of work being performed in the inspection area for reactor vessels and reactor vessel internals. These insights will support the Advanced Reactor Construction Oversight Program's (ARCOP) continual assessment process described in Inspection Manual Chapter (IMC) 2572, "Assessment of Advanced Reactor Construction Projects."

The specific components selected for inspection, and the depth and breadth of inspection information gathered during each inspection may vary widely between inspections and will depend on the structure, system, and component's (SSCs) risk significance for the design, the timing and location of the inspection, and the construction activities completed or in progress at the time of inspection.

Each inspection using this IP will constitute at least one inspection sample, regardless of how many sections are implemented during the inspection. As described in IMC 2572 and IMC 2573, "Inspection of the Advanced Power Reactor 'Quality of Reactor Plant Construction' Strategic Performance Area," the number of inspection samples needed to complete inspections in the inspection area are determined by the specified range of inspection samples listed in the project-specific inspection scoping matrices and on the results of the continual assessment process.

This IP is used for various advanced reactor designs and is scalable and flexible. Completion of every section/step of this IP is not expected or required for individual inspections or to complete the baseline inspection program for a project. Inspectors should perform the inspection activities in the following sections of this IP, as available.

In addition to the guidance below, inspectors may refer to Attachment 1 of this IP for supplemental inspection guidance and to other IPs as necessary to aid in completing the inspections in this procedure.

Inspection samples shall be selected in accordance with the ARCOP project-specific inspection scoping matrices, as described in IMC 2573.

Specific Guidance

03.01 Quality Assurance Implementation

The inspectors should refer to IP 75001, "Inspection of Manufacturing and Construction Quality for Advanced Power Reactor Structures, Systems, and Components," and IP 75001, Appendix A, "Implementation of the Quality Assurance Program," for additional inspection guidance. The inspectors should select a sample of QA attributes to inspect during each inspection based on the scope and content of the planned inspection, the prior completed samples, and indication of potential issues in a particular attribute.

03.02 SSC Inspection Samples

a. Code Design and Construction Requirements

Verify that SR and NSRSS RPV structures, components, and internals conform to applicable codes and standards, such as the ASME Boiler and Pressure Vessel Code (BPV Code), the design specification, and relevant regulatory requirements. The inspection should confirm that components are installed at the correct location, orientation, and configuration, and that mounting hardware, supports, and anchors meet design and material requirements. Special attention should be paid to critical attributes such as the as-installed elevation and azimuth of the vessel, as deviations from design may result in unacceptable cold spring of connecting piping and must be resolved using appropriate engineering analysis.

Purchase orders and accompanying documentation for RPV and internals should comply with design requirements. Receipt inspections must identify any nonconformances and confirm that their disposition is acceptable. Inspectors should verify that quality documentation, such as Certified Material Test Reports (CMTRs), demonstrates compliance with material specifications as required by the design documents. For example, materials in the beltline region of the RPV may have specific mechanical property requirements such as a minimum Charpy upper shelf value at a designated temperature. Additionally, storage and handling procedures should be strictly followed to prevent damage or contamination, with specific consideration for separation of stainless steel and carbon steel components, and use of appropriate rigging and lifting devices that have been properly tested and examined by nondestructive examination (NDE) prior to use.

Documentation for installed RPV internals must demonstrate compliance with ASME Section III requirements, if applicable. Inspectors should confirm that welding activities are performed in accordance with Nuclear Steam Supply System (NSSS) specifications and Code requirements, and that bolting materials and preload specifications meet design requirements. Final documentation must include as-built drawings, reconciliation of deviations, and completed Code data reports signed by the assigned Authorized Nuclear Inspector, providing assurance that the installation meets design and code requirements.

Additional considerations are found in Attachment 1.

b. As-Built Seismic and Functionally Qualifications

Inspectors should verify that SR and NSRSS as-built RPV structures, components, and internals are seismically and functionally qualified as specified in the design specification, qualification reports, and the safety analysis report (SAR). This includes review of qualification data packages, such as seismic analysis reports, alignment verifications, and interface requirements. The installed configuration must be consistent with design basis assumptions, and any changes in location, mounting, or interface must not invalidate the qualification.

Seismic qualification of RPV and internals typically involves a combination of analysis and testing to ensure that the components can perform their safety functions during and following design basis events. Inspectors should confirm that the as-built installation is bounded by the qualification analysis, including precise placement established using

laser equipment or other approved surveying method, and that the support structure is adequate to bear the vessel's weight and prevent flooding. Verification should include the review of completed alignment checks and hydrostatic test results, confirming that acceptance criteria have been met. Inspectors should also ensure that any field changes or deviations have been evaluated and reconciled with the original design documents.

Additionally, inspectors should confirm that protective measures are in place during and after installation to prevent physical damage and entry of foreign materials, which could compromise the as-built qualification of RPV and internals. Foreign material exclusion (FME) practices must be maintained throughout construction, with procedures for vessel protection and control of access to installed components strictly enforced.

c. Testing Activities

Inspectors should verify that testing activities for SR and NSRSS as-built RPV structures, components, and internals conform to applicable codes and standards (e.g., ASME) and the licensee's testing requirements. Testing should include activities such as hydrostatic testing, alignment verifications, and nondestructive examinations (NDE) of welds. Inspectors should confirm that all required tests and examinations are performed using current, approved procedures and calibrated equipment, and that personnel performing the tests are qualified for the methods and procedures being used. Additional inspection information can be found in Attachment 1 to this procedure.

Testing records should indicate immediate recording of test results and disposition of any discrepancies. For welding, inspectors should review NDE results to confirm that acceptance criteria are met, and that examiners are qualified for the specific method and procedure. Observing NDE in progress on a sample of welds is encouraged, but if NDE is not being performed during the inspection, inspectors should perform a record review. Final testing activities must demonstrate that the RPV and internals can achieve their required performance under expected service conditions and meet all safety and design requirements.

The final documentation package should contain all necessary information and references to confirm that the installation and testing meet design and code requirements, including unique identification of components and consumables, welding and NDE procedures and personnel, as-built drawings, and records of all required tests and examinations. Code data reports must be complete and signed off by the assigned Authorized Nuclear Inspector, providing assurance that the installation is in accordance with the licensing basis.

03.03 ITAAC Verification

Verify the ITA are performed and that the acceptance criteria AC in the COL are met.

03.04 Operational Program Inspections

The site's licensing basis should indicate which NRC Regulatory Guides (RGs), ASME codes, or ASTM codes are applicable. A review of the entire program is not required as part of this inspection activity. For selected SSCs, inspectors should determine if the material surveillance program and comprehensive vibration assessment program, as applicable, are being properly implemented during plant construction.

a. Reactor Vessel Material Surveillance Program

The purpose of the material surveillance program is to ensure that the reactor vessel functions properly throughout the life of the nuclear plant by monitoring changes in reactor vessel materials which result from exposure to neutron irradiation and the thermal environment. Material specimens are placed during construction and are periodically withdrawn during plant operations

Note that some non-light-water cooled reactor designs are not required to have a reactor material surveillance program. Inspection activities should include verifying that:

1. capsule brackets (CBs), or equivalent, are designed, fabricated, and installed in accordance with the design document and operational program description. This includes proper materials and welding requirements.
2. capsules, or equivalent, are designed, fabricated, and installed as per design documents and operational program description. This includes capsule locations and sample loading.
3. test specimens included in capsules conform to the reactor vessel capsule surveillance program per design documents and operational program description.

b. Comprehensive Vibration Assessment Program (CVAP)

The purpose of the comprehensive vibration assessment program is to ensure that reactor vessel internals are not adversely impacted by flow, acoustic, or mechanically induced vibrations and resonances during plant operations. The most effective way to verify this is through preoperational testing inspections using IP 75001.10, "Preoperational Testing." However, during fabrication and assembly of systems, inspectors should observe the installation of vibration monitoring equipment and verify that it is consistent with the design specifications and quality assurance requirements. Inspectors should also evaluate any changes or deviations from the approved CVAP and verify that they have been appropriately justified, documented, and, if necessary, submitted for NRC review.

If other CVAP testing is observed using this IP (i.e., outside of preoperational testing inspection area), then the inspector should observe testing activities associated with the CVAP to ensure that the test procedures are adequate and are being implemented as described in the licensee's commitments. This includes verifying that vibration measurements are being collected during relevant plant operating conditions (e.g., cold and hot functional testing), that data acquisition is consistent with the CVAP plan, and that acceptance criteria are clearly defined and met. The inspector should also assess the licensee's process for evaluating test results, addressing anomalies, and documenting findings.

75001.04-04 RESOURCE ESTIMATE

The number of inspection samples and inspection hours are identified in the site-specific inspection scoping and planning matrix.

75001.04-05 PROCEDURE COMPLETION

Completion of this IP is based on 1) completing the minimum required inspection samples identified in the site-specific inspection scoping matrix and 2) an assessment pursuant to IMC 2572 that there is reasonable assurance that the activities for RPV structures and components, including internals, are being accomplished with quality in accordance with the licensing basis requirements.

75001.04-06 REFERENCES

ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Facility Components"

ASME Boiler and Pressure Vessel Code, Sections V, "Nondestructive Examination"

ASME Boiler and Pressure Vessel Code Section IX, "Welding, Brazing, and Fusing Qualifications"

ASME Boiler and Pressure Vessel Code Section XI, "Inservice Inspection of Nuclear Power Plant Components,"

ASTM E531, "Standard Practice for Surveillance Testing of High-Temperature Nuclear Component Materials."

ASTM E185, "Standard Recommended Practices for Surveillance Tests for Nuclear Reactor Vessels"

ASTM E185-82, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels"

EPRI 1000986, "Crane Maintenance and Application Guide"

EPRI 1007676, "Guidelines for Using Synthetic Slings for Lifting and Rigging"

EPRI 1007914, "Lifting, Rigging, and Small Hoist Usage Program Guide"

EPRI 1009706, "Riggers Handbook"

RG 1.20, "Comprehensive Vibration Assessment Program for Reactor Internals during Preoperational and Startup Testing"

RG 1.31, "Control of Stainless Steel Welding"

RG 1.39, "Housekeeping Requirements for Water-Cooled Nuclear Power Plants"

RG 1.65, "Materials and Inspections for Reactor Vessel Closure Studs"

U.S. Code of Federal Regulations, Title 10, Energy, Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements"

END

List of Attachments:

Attachment 1: Additional Considerations for Code Design and Construction Requirements

Attachment 2: Revision History for IP 75001.04

Attachment 1: Supplemental Inspection Guidance

The purpose of this attachment is to provide guidance for inspection of RPVs and internals per Section 02.02 of the main body of this IP. Some of the sections and guidance in this attachment may not apply to all facilities. ITAAC are only applicable to facilities constructed under a COL. Inspectors may consider:

- a. The purchase order and accompanying documentation should be in compliance with the design requirements. The licensee's receipt inspection should identify any nonconformances and whether the disposition of each was acceptable. Typical attributes included in receipt inspections are:
 1. Components in conformance with purchase specification
 2. Marking and identification
 3. Evidence of damage
 4. Cleanliness at time of receipt
 5. Surface protection, closures, and packaging
 6. Maintenance of inert gas cover

- b. The RPV and internals require special handling and storage considerations due to their size, mass, and cleanliness requirements. The storage and handling of the RPV head, including the control rod drive mechanisms (CRDMs), must follow the design specification and approved procedures. Rigging devices, temporary CRDM supports, and pathways must be specifically designed and tested and/or examined by nondestructive examination (NDE) before use. For example, prior to transporting the RPV to the building, the access roadway may require extensive rework, and a test load transported over it. Procedures will require that the lifting device and rigging support the load for some designated time before commencing the lift, and the lift rate should be controlled. This is done to verify lifting device stability and wire rope stretch. Travel speed while being transported must be controlled. Rigging and lifting procedures for these components must be strictly followed. Consider including inspection of these attributes using IP 75001.09, "Load and Fuel Handling Equipment."

- c. The RPV and internal components are often stored outdoors and exposed to the elements in lay-down areas located around the construction site. As such, carbon steel components may develop a light coating of oxidation (rust). This condition is generally acceptable; however, welding surfaces such as machined or ground bevels must have the rust completely removed prior to the welding operation. Stainless steel components should be stored separate from carbon steel components as contact with carbon steel will contaminate the stainless steel and cause surface rust to appear. Likewise, carbon steel chains should be avoided when rigging to lift stainless components. Any tape used on stainless steel, such as for holding end caps in place, should be verified as containing low halogens (including chlorides) as these are known to promote cracking. The following should be addressed for storage of the RPV head:
 1. The reactor vessel is stored in accordance with approved procedures.
 2. The condition of seals and devices to maintain and indicate vessel internal atmospheric conditions are in accordance with requirements.

3. The condition of protective coating or/and protective covering is/are in conformance with requirements.
 4. The dunnage (i.e., packing materials) should prevent entry of dirt and water.
 5. The RPV's support structure should prevent flooding based on its height and have the appropriate strength to be able to bear the weight of the RPV.
- d. The location of the RPV and support system are generally established with laser equipment that is very precise. The RPV as-installed elevation and azimuth are critical, any deviation from design may result in unacceptable cold spring of connecting piping and must be resolved.
- e. The installed RPV will be exposed to a construction environment within the containment and must be protected from both physical damage and foreign material entry. The vessel closure head flange surface and vessel nozzles are particularly susceptible to physical damage. Foreign material exclusion (FME) practices must be maintained throughout construction. Inspection considerations may include:
1. Procedures for protection of the installed reactor vessel are followed.
 2. Protective devices installed around the top of the open vessel prevent entry of foreign objects and debris and protect the surface of the flange.
 3. Vessel side openings are blanked off to prevent entry of foreign objects, and nozzle ends are protected from construction damage.
 4. Work platforms and scaffolding inside vessel are nonflammable or treated to prevent the spread of accidental fires, and fire watch procedures are implemented when applicable.
 5. Access to RPV is controlled, i.e., entry of authorized tools, equipment, and personnel only.
- f. The extent of field welding activities of reactor vessel internals may vary significantly with different contractors. Welds will require some form of nondestructive examination. Accurate orientation of internals and maintenance of cleanliness requirements are of primary concern. The upper and lower internals assemblies, control rod drive mechanisms, and incore instrumentation guide tubes are classified as American Society of Mechanical Engineers (ASME), Section III components. Inspection considerations may include:
1. Documentation, such as Code data reports for internal components complies with ASME Section III requirements.
 2. The orientation and fit up of internal components are in accordance with the Nuclear Steam Supply System (NSSS) contractor and design document requirements. Application of excessive force to the extent of bending or cold springing of internal components is not permitted unless required by engineering analysis.
 3. Welding activities are in accordance with NSSS specifications and Code requirements.

4. Bolting material for internal components meets design requirements, and preload specifications have been met. RPV internal bolting will generally include some positive means for preventing loosening.
 5. Housekeeping and FME procedures must be strictly enforced. Ensure that the licensee has taken actions to verify removal of any foreign material introduced during but not limited to receipt, storage, transport, and installation.
 6. Final NDE has been performed on any installation welds and found acceptable, in accordance with the applicable code and the work package instructions. Examiners must be qualified for the method and procedure that they are performing. If NDE is not being performed during the inspection, perform a record review.
- g. The final documentation package for the RPV and internals installation should contain the necessary information and references to confirm that the installation meets the design and Code requirements, including:
1. Components and welding consumables are uniquely identified (e.g., heat number) such that the inspector can verify material composition and physical characteristics are in accordance with the design documents.
 2. Welding and NDE procedures and personnel are identified for each weld. NDE results indicate that acceptance criteria were met.
 3. As-built drawings are available and any deviations from original design are reconciled with the design documents (e.g., design report).
 4. Documentation indicates that all required tests (e.g., hydrostatic test) and examinations (e.g., alignment verifications) have met the acceptance criteria.
 5. Code data reports are complete and signed off by the assigned Authorized Nuclear Inspector.
- h. Reactor Pressure Vessel & Internals Pressure Testing
1. Housekeeping. Personnel entry and foreign material exclusion controls for the interior of the reactor vessel should meet the requirements of a Class A clean area.
 2. Cleaning. Final cleaning of the RPV internals, and interior surfaces of the vessel should be done with lint-free cloth and de-ionized water that meets licensee purity specifications. Cleaned surfaces should be tested for evidence of residual contaminants in accordance with licensee-approved specifications.
 3. Pressure Testing. Fabrication Code-required hydrostatic testing will most likely be conducted at the vessel fabrication facility prior to installation of internals. Inspection of the pressure tests will involve observation of the tests in process or evaluation of the final pressure test documentation package.

If the pressure test is to be observed, the pressure test inspection points listed in IP 75001.03, "Piping, Pipe Supports and Restraints," can be used as a basic outline for inspection. In preparation for the inspection, the inspector should be familiar with

the requirements of the fabrication code referenced in the design and construction documents or specifications, and any licensee-approved test procedure(s).

Consider observation of selected weld and weld repair area surface examinations after the hydrostatic test. Consider observing the examination of weld joints and heat-affected zones of Categories A, B, C, and D.

END

Attachment 2: Revision History for IP 75001.04

| Commitment Tracking Number | Accession Number Issue Date Change Notice | Description of Change | Description of Training Required and Completion Date | Comment Resolution and Closed Feedback Form Accession Number (Pre-Decisional Non-Public Information) |
|----------------------------|---|-----------------------|--|--|
| N/A | ML26057A080 04/01/26 CN 26-011 | Initial Issuance. | N/A | N/A |