INSPECTION PROCEDURE 75001 ATTACHMENT 05

MECHANICAL SYSTEMS AND COMPONENTS

Effective Date: April 1, 2026

PROGRAM APPLICABILITY: IMC 2573

75001.05-01 INSPECTION OBJECTIVE

To verify that safety-related (SR) and non-safety-related, safety-significant (NSRSS) mechanical systems and components can perform their required safety functions (RSFs).

75001.05-02 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 mechanical systems and components.

02.02 SSC Inspection Samples:

Verify that mechanical systems and components are designed and constructed in accordance with ASME code requirements.

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

02.03 Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). 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:

Verify activities for the implementation of the following operational programs are being performed satisfactorily in accordance with the established requirements:

- Pre-Service Inspection (PSI) or the Reliability and Integrity Management Program (RIMP),
- Environmental and Seismic Qualification of Electric and Mechanical Equipment Important to Safety
- Functional and Pre-Service Testing (PST) of Pumps and Valves.

75001.05-03 INSPECTION GUIDANCE

General Guidance

The purpose of this inspection procedure is to provide insights into the quality of work performed in the inspection area for mechanical systems and components. 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 during each inspection may vary widely 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.

This IP does not include HVAC, Fire Protection, piping, pipe supports and restraints, or the reactor vessel as these are covered in other IPs.

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 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 for a particular attribute.

03.02 Design and Construction Requirements

a. Verify that the SR and NSRSS mechanical components are constructed in accordance with the applicable ASME Code specified in the design specification and design report

consistent with the safety analysis report (note: they may refer to ASME Section III, Division 1 for LWRs, or Division 5 for high temperature reactors).

b. ASME Code Section III design specifications and design reports should exist and be reviewed by the inspector to determine that the ASME Code design requirements for the as-built SR and NSRSS mechanical components are met and are consistent with the design specification, approved safety analysis report and any engineering design change(s).

c. The inspectors should refer to IP 75001.ENG, “Inspection of Engineering and Design and Fabrication Requirements,” for additional inspection guidance related to component design, fabrication, and design changes.

d. SR and NSRSS as-built mechanical components shall conform to the rules of construction of the ASME Code (welding, non-destructive examination (NDE) and pressure testing should be a focus). ASME Code Section III Data Reports should exist and be reviewed by the inspector to determine that the requirements of ASME Section III, the design specification, design report, and SAR are met, and that the authorized nuclear inspector (ANI) has signed the ASME Data Reports when required by the Code.

e. Inspectors should observe welding and NDE activities and confirm the activities conform to the requirements of ASME Section IX and Section V respectively. The inspectors should refer to IP 75001.WELD, “Inspection of the Welding and Nondestructive Examination Programs,” for inspection guidance on welding and NDE.

f. The inspectors should observe/review the hydrostatic/pressure tests of the mechanical components during the construction phase and verify that the tests are in accordance with the applicable code, as specified, in the design specifications.

g. Protective features should be installed in accordance with the as-built Pipe Break Hazard Analysis Report and safety-related SSCs should be protected against or qualified to withstand the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems.

h. Reports should exist and be reviewed to determine that the SR and NSRSS heat exchangers have a heat removal capacity sufficient to transfer their design heat load.

i. ASME Code Section III Data Reports should exist and be reviewed to determine that the relief valves (excludes thermal relief valves) meet the valve’s required set pressure, capacity, and overpressure design requirements and that each relief valve is provided with an ASME Code Certification Mark that identifies the set pressure, capacity, and overpressure.

j. Overspeed testing and NDE of the large flywheels attached to centrifugal pumps, to maintain flow during coastdown, should be performed and the results reviewed to verify that the flywheel maintains structural integrity during an overspeed condition.

03.03 ITAAC Verification

Review the licensee’s plan for completion of applicable ITAAC associated with the work activities being inspected. Review the activities that the licensee intends to credit for future ITAAC closure. For example, if the licensee intends to rely on a specific quality

control (QC) observation during the installation of an SSC, then the inspector should review a sample of these QC observations to determine whether the activity was performed in accordance with applicable quality and technical requirements. Because ITAAC has special regulatory significance, licensees should document ITAAC closure under their QAP. This means that even if an ITAAC is for a non-safety-related SSC, the completion package and subsequent notifications on ITAAC will be controlled by the QAP.

03.04 Operational Program Inspection Activities

ASME Pre-Service Inspection (PSI) / Reliability Integrity Management (RIM) Program

Verify the licensee is implementing activities related to PSI / RIM of SR and NSRSS as-built mechanical components per the requirements of ASME Section XI, Division 1, "Rules for Inservice Inspection of Nuclear Power Plant Components," or Division II, "Requirements for Reliability and Integrity Management (RIM) Program for Nuclear Reactor Facilities," as described in the SAR and the licensee's PSI or RIM program requirements. Refer to IP 75001.WELD for inspection guidance.

Mechanical Components Seismic and Environmental Qualification

Verify the SR and NSRSS mechanical components are qualified for the applicable environmental and seismic conditions specified in the design specifications, the licensee's environmental qualification program requirements, and the SAR and that they are installed in a manner bound by the qualification. Refer to IP 75001.QUAL for additional inspection guidance.

Functional and Pre-Service Testing of Pumps and Valves

Verify the SR motor operated valves (MOVs) are qualified to perform their function up to and including the design basis accident (DBA) conditions in accordance with the design specification, the SAR, and either ASME *Operation and Maintenance of Nuclear Power Plants*, (OM Code) Division 1 or ASME OM-2-2024 Code, "Component Testing Requirements at Nuclear Facilities." Qualification reports should exist and be reviewed to determine that the power-operated valves with an active safety function can perform their function under the full range of fluid flow, differential pressure, electrical, temperature, and fluid conditions up to and including DBA conditions. Refer to IP 75001.QUAL for inspection guidance.

Verify the as-built SR and NSRSS pumps and valves are tested in accordance with the licensee's pre-service testing (PST) program, the SAR, and either ASME *Operation and Maintenance of Nuclear Power Plants*, (OM Code) Division 1 or ASME OM-2-2024 Code, "Component Testing Requirements at Nuclear Facilities." Refer to IP 75001.QUAL for inspection guidance.

75001.05-04 RESOURCE ESTIMATE

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

75001.05-05 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 the construction activities for mechanical systems and components are being accomplished with quality in accordance with the licensing basis requirements.

75001.06-06 REFERENCES

ASME Code Section III Division 1

ASME Code Section III Division 5

ASME Section XI

IMC 2573, “Inspection of the Advanced Power Reactor ‘Quality of Reactor Plant Construction’ Strategic Performance Area”

IP 75001, “Inspection of Manufacturing and Construction Quality for Advanced Power Reactor Structures, Systems, and Components”

RG 1.29, “Seismic Design Classification”

END

List of Attachments:

Attachment 1: Supplemental Inspection Guidance
Attachment 2: Revision History for IP 75001.05

Attachment 1: Supplemental Inspection Guidance

The purpose of this attachment is to provide guidance for inspection of mechanical systems and components 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. System Walkdowns

Perform an independent inspection (walkdown, measurement, etc.) to determine whether the critical attributes of as-built SSCs conform to the final design. Inspection of as-built characteristics generally requires verification of location, alignment, dimensions, and functionality, and may also involve direct measurements and sizing. For example, the inspectors could measure the thickness of a structural wall, measure the thickness of a pipe, measure the relative location of a support, etc. During the walkdown of the selected system(s), inspectors should consider the following questions and as-built attributes.

- Is the installed system consistent with the piping and instrumentation diagram?
- Will equipment and instrumentation elevations support the design function?
- Has adequate slope of piping and instrument tubing been provided?
- Are required equipment protection barriers (such as walls) and systems (such as freeze protection) in place and intact?
- Is the location of the equipment, and potential susceptibility to flooding, fire, high energy line breaks, or other environmental concerns accounted for in the equipment design and qualification?
- Has adequate physical separation/electrical isolation been provided?
- Are there any non-seismic structures, systems, and components surrounding the system which require evaluation for impact upon the system?
- Can the failure of the as-built Seismic Category II and non-safety SSCs impair the ability of safety-related SSCs and non-safety-related safety-significant SSCs to perform their intended safety functions following a seismic event?
- Does the location of equipment facilitate manual operator action, if required?
- Are ladders, catwalks and platforms available to support manual operation?
- Are all required special tools or personal protective equipment staged and available?
- Are base plates, hangers, and struts installed properly?
- Is the system piping intact? Is insulation installed as necessary? Are blank flanges installed or removed as necessary?

- Are support systems, such as instrument air, cooling water or control power, installed and intact?
- Are valves installed correctly? Check items such as tightness of body to bonnet bolts or nuts, tightness of flange bolts, valve hand wheels or operators installed correctly.
- Are component labels present and properly installed?
- Are flow direction sensitive components installed in the correct orientation?

As appropriate, the inspectors should check the following as-built attributes:

- Item identification
- Location and orientation of components
- Leveling and alignment
- Clearances and tolerances
- Tightness of connections and fastenings
- Fluid levels and pressures
- When systems are filled, the systems are completely filled, vented, and voids have been removed in systems regardless of fluid media.
- Absence of leakage
- Physical integrity
- Cleanliness
- All foreign materials are removed and excluded from re-entering the mechanical component.

b. Purchase and Receipt of Materials

Select purchase orders for components such as pumps, valves, tanks, heat exchangers, etc. and verify the following:

- The selected components conform with their purchase specifications.
- Quality documentation is the type required by the purchase order (e.g., Certified Material Test Report (CMTR) or Certificate of Compliance).
- Any chemical and physical test results, including heat treatment, as applicable, for a CMTR, comply with the material specification required by the design documents.
- Marking and identification of the components are clear and legible.

- There is no evidence of damage to the components, e.g. excessive corrosion, gouges, chemical damage, etc.
- The components comply with their cleanliness requirements.
- The necessity of surface protection, closures, and packaging for the materials is stated in purchase order.
- Receipt inspection reports were generated and conform to the licensee's procedures.
- Nonconformances affecting the integrity of the materials and components were properly addressed in accordance with the licensee's procedures.

Inspectors should pay particular attention to the traceability of material and equipment to prevent the use of incorrect or defective materials, parts and components.

Inspectors should ensure that the required identification of the item is maintained by heat number, part number, serial number or other similar means, either on the item or on records traceable to the item, and that required markings are on the item.

In the case of fasteners, compliance with the material specification (e.g., ASTM or ASME material and grade) should be verified by required markings on the bolts and nuts and the certified material test reports or certificates of conformance as required by the procurement drawings and specifications and/or by the codes and specifications.

In the case of vendor-supplied equipment assemblies containing fasteners, samples should be inspected to verify compliance with approved vendor drawings and specifications and other information such as materials used for equipment qualification tests and/or analyses.

c. Storage and Handling

Verify components are being properly stored and handled in accordance with approved procedures. Typically, storage inspections include the following inspection items for the components stored.

- Proper storage classification.
- Status of protective measures at the time of receipt and initial storage.
- Soundness of dunnage or packing material.
- Soundness and the correct placement of such things as end caps for pumps and valves and protective coverings for weld preparation areas.
- Soundness and correct placement of weather protection in the form of canvas or plastic coverings.
- Protective storage measures to prevent saltwater damage (chloride contamination), e.g., near oceans.
- Protective storage measures against invasion of sand or windblown grit.

- Correct and readily visible material identification, in accordance with the purchase order, and with no damage incurred by handling and/or environment.

- Controls against the use of fire retardants near stainless steel components to prevent any exposure to excessive halogens or chlorides.

- Component manufacturer maintenance recommendations are being implemented.

d. Installation Attributes

Prior to and during the observation of in-process work activities, the inspectors should verify that the conditions of the work area conform to specified requirements and precautions have been taken to prevent conditions that could adversely affect the quality of the items during installation. The inspectors should also observe in-process work activities to verify that in-process work activities do not adversely affect other (already installed) SSCs (Reference ASME NQA-1, Part II, Subparts 2.3 and 2.8). Requirements can be in engineering drawings, engineering specifications and the work packages. The inspectors should observe in-process work activities to determine whether (as applicable):

- Installation requirements including proper location and placement, valve and actuator orientation; volume, area dimensions, quantity, material type/shape/size, special features such as coatings and insulation, alignment, seismic and other mounting requirements (i.e., torquing or tightening of nuts, bolts and expansion anchors), flow direction, lubrication, tolerances, and expansion clearance are met.

- All packaging materials are removed from mechanical components at the time of installation in accordance with the installation procedure.

- All foreign materials are removed and excluded from re-entering the mechanical component.

- The method of protection and exclusion is in accordance with the manufacturer’s guidance and adheres to the precautions to prevent damage during placement and mounting.

- The availability and use of specially trained personnel and special tools or equipment conforms to the manufacturer's instructions.

- Correct drawings and work procedures are available to installers, and the installation requirements, construction drawings, specifications, and work procedures are the latest revisions.

- Hold points are observed, and quality inspections are properly conducted, as required.

- Lifting and rigging are in accordance with procedures and requirements.

- Installation cold setting locations meet requirements.

- Preparation of installation and inspection records meets quality program requirements.

- Field changes that apply to the work being observed have been correctly processed.
- Design installation requirements that affect environmental qualification of mechanical components are satisfied, as applicable.
- Protection is provided as required, including protection against such conditions as inclement weather, adverse temperature, humidity, flooding, and foreign materials, such as dirt, dust, soda cans, and general debris.
- Lubrication, rotation, and electrical resistance checks are being performed, if required.
- Proper lubricant is used for valve stems, gearboxes, and limit switches, as applicable.
- Stem lubrication procedure for motor-operated valves should provide for removal of old lubricant and replacement with new lubricant over the entire stem, including the stem nut area.
- Installation of the item will not adversely affect the subsequent installation of materials and equipment.
- Repair or rework on any nonconforming items has been performed satisfactorily.
- Nonconformances for adjacent items potentially impacting the items being installed have been dispositioned or controlled.
- Records are being maintained, recording the status of installed components.
- Recording methods such as stamps, tags, markings, etc. are being used to prevent omission of inspections.
- Component manufacturer maintenance recommendations are being implemented.
- Nonconforming items are clearly identified, segregated, and dispositioned.
- Any design changes or field modifications relevant to the work observed were properly controlled and processed in accordance with quality and technical requirements.
- When required, verify the ASME Code stamping and nameplates have been attached as required by the Code.
- Records should document the status of the installed component. They should confirm the required inspections have been carried out by appropriately qualified personnel. The records should be properly stored in accordance with quality assurance requirements.

Typical problems which may occur in this area include, but are not limited to:

- Inadequate or unclear guidance for installers and inspectors.

- Use of improper or uncalibrated tools for installation and measurement.
- Incorrect orientation of the valve or actuator.
- Skipped hold points or other errors in installation.
- Record storage and/or retrieval problems.

e. Additional Guidance for Valves

Installation requirements for valves include proper location or placement; quantity; valve and actuator orientation; alignment; material type/shape/size; volumetric flow rate; flow direction; special features such as coatings and insulation; seismic and other mounting and support requirements; torquing of bolts; proper lubrication for each valve and actuator (including stem, gearbox, and limit switch, as applicable); and compliance with tolerance/clearance requirements.

All packaging material is removed at the time of installation in accordance with the installation procedure. Once the safety and pressure relief valves are installed, the valve gags should not be used to keep the valve from opening. Verify that all foreign matter is removed and is excluded from re-entering the valve and its operator. Verify that the method of protection and or exclusion is in accordance with the manufacturer's guidance. Remove caps from grease reliefs for actuators on motor-operated valves.

Design features to prevent potential pressure locking and thermal binding of safety related power-operated gate valves are as specified in the final design as appropriate for the valve application and performance.

Design requirements for environmental qualification of valves and their actuators are satisfied. For example, motors used on motor-operated valves must be appropriately designed with moisture relief T-drains as applicable to their environmental application.

For Squib Valves:

- Verify the squib valve to be installed is consistent with design requirements and specific application.
- Verify that squib actuator meets design qualification requirements for its application.
- Verify that the squib valve orientation is proper for the flow direction.
- Verify that electrical wiring is consistent with design requirements.

f. Component Welding

If welding is required for component installation, refer to IP 75001.WELD.

g. Guidance for ASME Records Review

For systems constructed in accordance with the ASME code, the inspectors should review completed ASME Code Design Reports and Data Reports to determine if these

reports If applicable, verify that a registered professional engineer prepared and certified the ASME Design Report in accordance with ASME Code requirements.

Verify that the ASME Code Design Report included the proper supporting documentation. For example, supporting documentation should include:

- certified ASME Code Section III Data Report forms,
- construction records (including construction drawings, deviations, repairs, etc.),
- records of walkdowns of each piping segment to identify differences between as-designed and as-built critical functions (pipe supports, welds, component and pipe locations, weights, orientation/moments, etc.),
- procurement documentation,
- fabrication records,
- receipt inspection records, and
- other documentation as applicable.

h. As-Built Deviations / Nonconformances

Review documents that were used to identify differences between the as-designed and as-built SSCs to determine if the differences, if not corrected to comply with the as-designed conditions, were properly documented and incorporated in the final as-built drawings.

Verify that these conditions were properly evaluated, and that for those changes to the licensing basis that require NRC review, a License Amendment Request (LAR) has been submitted to the NRC, and NRC approval has been obtained.

Verify that differences between documents used for construction and the corresponding document used for a design analysis were appropriately reconciled with the design report by the person or organization responsible for the design. The differences, if corrected to comply with the as-designed configuration, were completed and accepted by qualified personnel.

i. Construction Testing

Installation acceptance testing and verification activities may include nondestructive examination activities (visual, surface, or volumetric examinations), surveying activities, torque tests, rotation checks, hydrostatic pressure test, etc.

Testing and verification activities should be accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, and other special requirements.

Test equipment should be properly calibrated.

Test data should be evaluated in comparison to acceptance criteria.

Unsatisfactory test results and any conditions adverse to quality identified as a result of licensee inspection or testing should be entered into the corrective action program.

1. Mechanical Components

   Mechanical components in primary systems include pressure retaining components such as steam generators and pressurizers in pressurized-water reactors. In other systems, mechanical components include heat exchangers, tanks, etc. Construction tests for these components involve final cleaning after assembly, Code-required pressure testing, and miscellaneous tests such as flywheel integrity tests for large pumps such as main coolant pumps.

   - Housekeeping and cleaning. The inspectors should observe foreign material controls and internal cleaning procedures during final close-up of components such as heat exchangers, tanks, etc.

   - Pressure testing. Code-required pressure testing for some major components (e.g., steam generators and other heat exchangers, pressurizers, etc.) will most likely be conducted at the fabrication facility. Components fabricated at the site, (e.g., tanks, etc.) may be tested in place prior to piping installation.

   Inspectors should be familiar with the fabrication code requirements called out in the licensee-approved specifications or procedures for the pressure testing to be observed. Guidelines provided in IP 75001.03, “Piping, Pipe Supports and Restraints,” should be used for guidance while observing component pressure tests.

   - Miscellaneous Tests. Construction testing for some mechanical components involves type-testing of sub-components such as:

     (1) Testing of flywheels for large pumps such as PWR reactor coolant pumps.

     (2) Testing of anti-rotation devices for pumps.

     (3) Testing of individual pump flows.

     (4) Testing of flow through heat exchangers for tube or baffle plate vibration.

2. Valves

   - Component Integrity Tests. Component integrity tests include Code-required pressure tests of valve bodies during fabrication activities and leak testing of assembled valve mechanical joints during pressure testing of piping systems.

     The inspector should be familiar with fabrication codes called out in the design specifications, and licensee-approved procedures prior to inspection of component integrity tests. Guidance for the observation of pressure tests is contained in IP 75001.02, “Containment and Containment Penetrations.”

- Operational Tests/Inspections. Operational tests and inspections include the following:

  (1) Proper installation and adjustment of motor operated valve torque switches, limit switches and bypass switches.

  (2) Loss of power testing to ensure that the valve either stays in, or moves to, the required safety position after a loss of motive power.

  (3) Accumulator capacity testing to validate that safety-related accumulators have the necessary capacity for accident analyses required number of valve actuations.

  (4) Bench testing of safety and relief valves for proper set pressure and/or capacity.

  (5) Leak testing system isolation valves such as main steam isolation valves.

  (6) Checking component orientations for correct flow direction.

Inspectors conducting valve operational test inspections should be familiar with the operational (and accident, if applicable) design requirements, applicable specifications, and the installation and/or testing work procedure pre-requisites and requirements.

END

Attachment 2: Revision History for IP 75001.05

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	ML26057A081 04/01/26 CN 26-011	Initial Issuance.	N/A	N/A