

PART 52, INSPECTION OF STARTUP TEST PROGRAM

PROGRAM APPLICABILITY: IMC 2504 App B

72401-01 INSPECTION OBJECTIVES

This inspection guidance is to confirm that the licensee's administrative controls over startup testing have been developed in accordance with Final Safety Analysis Report (FSAR) commitments, Technical Specifications (TS) requirements, license requirements, and regulatory requirements.

72401-02 INSPECTION REQUIREMENTS

If this inspection has been completed at the first unit of a multi-unit construction site, then inspection at a subsequent unit may not require the same level of inspection as that conducted for the first unit. The inspectors shall focus on program differences developed and employed since completion of program inspection for the first unit.

02.01 Test Program

The startup test program is part of the Initial Test Program (ITP) described in Section 14.2 of the facility FSAR. The ITP consists of Construction and Installation Tests, Preoperational Tests and Startup Tests. Startup Tests include all the testing required by the ITP performed after the Commission makes the Title 10 *Code of Federal Regulations* (10 CFR) 52.103(g) finding that the combined license acceptance criteria have been met. The startup test program includes initial fuel load, pre-critical tests, initial criticality, low power physics tests, and power ascension tests.

- a. Verify that the licensee has prepared a description of the startup test program. General areas of testing should be identified, and responsibilities should be assigned, in accordance with FSAR and license requirements for the following:
 1. Fuel loading into the core.
 2. Pre-criticality tests.
 3. Initial criticality tests.
 4. Low power (less than 5%) tests.
 5. Power ascension tests.
 6. Applicable first-of-a-kind (FOAK) tests.
 7. Applicable license condition tests.

- b. Verify that the licensee's startup test program addresses the following items when not performed as part of preoperational testing, or if required to be performed again as part of the startup test program. General areas of testing should be identified, and responsibilities assigned for the following:
 - 1. Flushing and cleaning of nuclear steam supply system (NSSS) and auxiliary systems, and components.
 - 2. Hydrostatic tests of piping, vessels, and systems designed to contain pressurized or radioactive fluids.
 - 3. Instrument calibration.
 - 4. System turnover from the constructor, testing organization, or maintenance organization.
 - 5. Functional demonstration of equipment in all modes throughout its operating range, including applicable flow tests.
 - 6. Electrical, mechanical, and instrument and control testing.
- c. Verify by review of the site administrative control manual for startup test program that the licensee has established administrative procedures to control the format and content of startup test procedures sufficient to satisfy the procedure review guidance contained in IP 72304, "Startup Testing for "AP1000 Startup Test Inspections," Section 2.01, "Review of Startup Test Procedures," or the applicable IP for the reactor design being tested.

02.02 Test Organization

- a. Verify that the operating organization has been assigned overall control of all startup test activities.
- b. Verify that the method and responsibility for appointing key personnel in the test program are formally specified in writing.
- c. Verify that the lines of authority and responsibilities of test personnel and the interface with the operating organization are formally specified in writing and that the operating organization's overall control is not circumvented.
- d. Where interfaces exist between organizations involved in the test program, verify that organizational responsibilities are clearly established in writing.
- e. Verify that the required responsibilities, qualifications, and training of management and staff (including the NSSS vendor, architect-engineer, and other major contractors, subcontractors, and vendors, as appropriate), who will develop startup test procedures and who will conduct the startup tests (including operating, and other procedures used in the test program) are formally specified in writing.

1. Ensure the following areas of the test program are included:
 - (a) Test procedure preparation.
 - (b) Test procedure approval.
 - (c) Test performance and documentation (including how to perform test changes and exceptions).
 - (d) Test results review and approval.
2. Verify that the required training includes the following:
 - (a) Administrative controls for testing.
 - (b) QA/QC for testing.
 - (c) Technical objectives of testing.
 - (d) Nuclear Safety Culture or Safety Conscious Work Environment.

02.03 Test Program Administration

- a. Verify that formal methods have been established for the operating or testing organization to receive (from construction or other organizations) the jurisdiction over systems, components, and instrumentation before beginning to test those items. If the test organization performing testing is not under the control of the operating organization for a particular test, ensure formal administrative controls provide for:
 1. Requirement that all systems, structures, or components (SSCs) not under the control of the operating organization are considered inoperable and cannot affect any operable SSCs.
 2. The operating organization must formally control the isolation boundaries between the operable SSCs and the SSCs being tested.
- b. Verify that formal administrative measures have been established for jurisdictional control of SSC status before, during, and subsequent to testing. Administrative measures should provide for:
 1. Control of system status before testing.
 2. Return of SSC to construction or other organizations (if necessary to support modifications or repairs).
 3. Control of system status subsequent to testing, including measures necessary to prevent invalidation of test results.

- c. Verify that formal administrative measures have been established governing the conduct of testing including:
1. Method for verifying a test procedure is current before its use.
 2. Consideration of the effect of testing on other nuclear facilities (units, spent fuel, new fuel, etc.) at the same site.
 3. Consideration of the effect of testing on SSCs that are considered operable.
 4. Requirement that any actions that could affect reactivity be under the direction of a licensed operator.
 5. Requirements for conducting pretest briefings which should include discussion of the risk to personnel and equipment, possible malfunctions/failure modes including consequences and contingencies, operating experience applicable to the testing performed, and criteria to abort the test.
 6. Methods to ensure personnel involved in the conduct of a test are knowledgeable of the test procedures.
 7. Requirements for procedure use (procedure in hand or other acceptable methods, performance of steps out of sequence allowance, procedure compliance, etc.).
 8. Methods to change (both major and minor) a test procedure during the conduct of testing. Minor changes do not affect the intent of the procedure or the acceptance criteria. Major changes require revision of the test procedure.
 9. Criteria for termination or interruption of a test and continuation of an interrupted test.
 10. Methods to coordinate the conduct of testing including test (shift) turnover requirements for continuity, communication methods to be used, and clear identification of the test director.
 11. Methods to document significant events, unusual conditions, or interruptions to testing.
 12. Methods for identifying deficiencies, documenting their resolutions, and documenting retesting.
 13. Method for providing the current test procedure and marked-up drawings showing current modification status to the operators before test commencement.
- d. Verify that formal methods have been established to control scheduling of test activities. Scheduling and changes to the schedule should include evaluation of the effect on risk (risk assessment required by 10 CFR 50.65 (a)(4)) as described in Regulatory Guide (RG) 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." Reference IP 62712, "Part 52, Maintenance Rule," Section 02.06, for additional guidance.

- e. Verify that a formal program for evaluation of test results has been established. The program should provide for the following:
 - 1. Test data is properly verified and compared to expected test results in a qualitative, quantitative, meaningful and understandable form.
 - 2. Test results are checked and compared with previously determined performance standards, limits, or acceptance criteria.
 - 3. Deficiencies are clearly identified and appropriate corrective action has been proposed, reviewed, and completed.
 - 4. After corrective actions or modifications have been completed, tests or portions of a test have been rerun as necessary to ensure that tests on the as-built system are adequate and meet standards, limits, or acceptance criteria.
 - 5. Test result evaluations were reviewed and approved by appropriate licensee personnel and/or contractor personnel, including the person(s) responsible for approving the original test procedures.
 - 6. Determination of the acceptability of test results should include an independent review (this can occur at different stages in the review).
 - 7. Management approval should be obtained prior to proceeding to the next power level for further testing.

02.04 Document Control

a. Test Procedures

- 1. Verify that formal administrative measures have been established which control the test procedure processes for review, approval, and issuance. The controls should specify:
 - (a) Review of test procedures by the testing organization and engineering (including normal operating procedures used for testing).
 - (b) Verification that test procedures comply with the FSAR and TS.
 - (c) Validation method for the procedures.
 - (d) Operations organization review and approval for procedures that affect or may affect operational systems.
 - (e) Approval authority for the test procedures.
 - (f) Issuance and distribution of procedures.

2. Verify that formal administrative measures have been established which define major and minor changes. Minor changes do not affect the intent of the procedure or the acceptance criteria. Major changes require revision of the test procedure.
3. Verify that formal administrative measures have been established which control revision of approved procedures. The controls should specify:
 - (a) Review by same persons and/or groups as the original procedure.
 - (b) Approval by same persons and/or groups as the original procedure.
 - (c) Issuance of revisions and control of obsolete procedures.
 - (d) Screen changes to procedures for compliance with the FSAR and TSs. When the review process identifies the need for a change to the FSAR and/or TSs, verify that procedures and responsibilities are established to ensure that the changes will be made in accordance with the requirements in the applicable Section VIII of the 10 CFR Part 52 Appendices, "Process for Changes and Departures." See IP 35007, "Quality Assurance Implementation During Construction and Pre-Construction Activities," and IP 35101, "QA Program Implementation Inspection for Operational Programs," for additional information.
4. Verify that responsibilities have been assigned in writing to ensure that the procedure controls identified above will be implemented.

b. Engineering Drawings and Vendors' Manuals

1. Verify that administrative controls have been established which require that current approved drawings, including piping and instrumentation diagrams, and vendor technical manuals will be provided to the plant site in a timely manner during the test program.
2. Verify that master indexes are available for drawings and manuals which indicate their current revision numbers.
3. Verify that a mechanism exists which ensures that affected test procedures will be updated when manual or drawing revisions occur.

02.05 Design Changes and Modifications

a. Design Change Control

1. Verify that a formal method has been established to bring proposed or implemented design changes to the attention of the operating organization and test group for incorporation into the test program.

b. Temporary Modifications, Jumpers, and Bypasses

1. Verify that written administrative controls have been established for controlling temporary modifications, jumpers, and bypasses.

2. Verify that the review process, including assignment of responsibility, provides for assuring that all proposed temporary modifications, jumpers, and bypasses are reviewed for potential FSAR, TS, and startup test program impact.
3. When the review process identifies the need for a change to the FSAR and/or TS, verify that procedures and responsibilities are established to ensure that the changes will be made in accordance with the requirements in the applicable Section VIII of the 10 CFR Part 52 Appendices, "Process for Changes and Departures." See IPs 35007 Appendix 3 and 35101, Section 03.03 for additional information.
4. Verify that the controls require that a formal log be maintained of the status of jumpers, lifted leads, control equipment, temporary set/trip points, etc.
5. Verify that the controls assign responsibility for maintaining the log.
6. Verify that installed jumpers or lifted leads will be readily identifiable by their physical appearance.
7. Verify that controls are established to account for installation and removal of spool pieces, strainers, blank flanges, and valve internals where testing requires modification to fluid systems.
8. Verify that the controls assign responsibility for determining when independent verification is required following installation or removal of temporary jumpers, lifted leads, temporary bypasses, temporary set/trip points, or fluid system modifications.
9. Verify that the controls assign responsibility for determining when functional testing of equipment is required following installation or removal of temporary jumpers, lifted leads, temporary bypasses, temporary set/trip points, or fluid system modifications.

02.06 Plant Maintenance/Preventive Maintenance

Verify that the licensee has placed their normal station processes and administrative procedures for maintenance and preventative maintenance in effect during startup testing. IMC 2504 provides for inspection of Operational Programs including Maintenance, prior to the 10 CFR 52.103(g) finding. IP 42401, "Part 52, Plant Procedures," performs the inspection of plant procedures for Part 52 plants, including maintenance procedures, and IP 62712 performs an inspection of Maintenance Rule for Part 52 plants. For SSCs that have not been turned over to the station operating organization, ensure that the SSCs are being maintained (maintenance and preventative maintenance) under the normal station process, or the process used during the preoperational test program inspected in IP 70367, "Inspection of the Preoperational Test Program."

02.07 Equipment Protection and Cleanliness

- a. Verify that a formal program for housekeeping activities during startup testing has been established. The program should include provisions for:

1. Protection of equipment and control of personnel access to prevent damage from adjacent construction or maintenance activities.
 2. Implementation of cleanliness zones, keyed to the progress of construction and testing.
 3. Control of facilities and equipment including cleanliness, environment, and fire protection/prevention.
 4. Periodic inspection to ensure the adequacy of housekeeping.
- b. Verify that responsibilities have been assigned in writing to ensure that the control methods identified above will be implemented.
 - c. Verify that a program for maintaining the appropriate degree of cleanliness of nuclear plant components and piping during startup testing has been established.
 - d. Verify that water chemistry controls have been established for fluid system undergoing startup testing, including:
 1. Water quality requirements.
 2. Layup of systems and components.
 3. Sampling requirements.
 4. Procedures to be followed for "out-of-specification" conditions.

02.08 Measuring and Test Equipment

Verify by review of administrative procedures that controls have been established for all measuring and test equipment (M&TE) (normal, temporary, and special instrumentation) used to provide data to show an acceptance criterion has been met or to ensure significant limitations are not exceeded that include:

- a. A listing of controlled test equipment, the calibration requirements, and the calibration history.
- b. Controls for storage and issuance to preclude use of test equipment which has not been calibrated within the specified interval.
- c. Requirements for recording test equipment identity and calibration date in test procedures to permit evaluation of the need for retest if equipment is subsequently found out of calibration.
- d. Controls for ensuring that installed instrumentation has been calibrated before being used to provide data to show an acceptance criterion has been met.
- e. Requirements for when M&TE or reference standards are found out of calibration, lost, or stolen, including a documented evaluation of the validity of previous tests.

03.01 Test Program

- a-b. 10 CFR 50.34 (b)(6)(iii) and 10 CFR 52.79 (a)(28) requires a description of the preoperational testing and initial operations in the FSAR. Regulations 10 CFR 50.34(h), 10 CFR 52.47(a)(9), and 10 CFR 52.79 (a)(28) require the licensee to evaluate the facility against NUREG-0800, "Standard Review Plan (SRP)." SRP Section 14.2 addresses the ITP in the FSAR and references RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants." FSAR Section 14.2 should document facility commitments to the ITP. The guidance in RG 1.68 should be interpreted as one acceptable method of meeting the regulations in 10 CFR Part 50 and 10 CFR Part 52.
- c. Regulatory Guide 1.33, "Quality Assurance Program Criteria (Operation)," (which endorses industry guidance); and RG 1.68, Appendix C, provide guidance for the preparation of startup testing procedures. Section 14 of the FSAR should also describe the preparation of these procedures. Test program administrative procedures controlling preparation of test procedures should be consistent with this guidance and FSAR commitments.

03.02 Test Organization

Section 14 of the FSAR will normally specify the organizational requirements necessary to support the ITP. Qualifications and resumes of key personnel may be included. The licensee's administrative documents should identify specific qualifications and responsibilities of key personnel in the test program. Qualification requirements may be specified by reference to FSAR commitments. Where contractor/vendor personnel are participating in the test program, their responsibilities and qualifications should be specified. Interfaces and boundaries should be defined between the licensee's operations group, construction forces, design authority, vendor personnel, and the startup organization. Some facilities use the assistance of various outside organizations to support preoperational testing; these working relationships should be defined in administrative procedures.

- a-d. No additional guidance.
- e. Chapter 14 of the FSAR describes the Test Program and should state the required training or indoctrination of those persons involved in the test program.

03.03 Test Program Administration

- a. Methods for turnover control should include measures for partial as well as complete turnover of a system or component. Where the licensee's operations and test organizations are separate, jurisdictional control upon turnover should be specified. Contents of a "turnover package" should be specified.
- b. Criterion XIV of Appendix B to 10 CFR Part 50 requires the licensee to establish controls to indicate the status of tests performed and to identify items which have passed required tests. Administrative procedures should require the use of logs, marked-up drawings, and tags on systems or components to implement these controls.

- c. 1-4. No additional guidance.
- 5-6. Methods to ensure personnel are knowledgeable may include pretest briefings and signoff sheets.
- 7. No additional guidance.
- 8. Minor changes, which do not affect intent of the test procedure or acceptance criteria, may be made "on the spot" by obtaining the approval of the test director, and two members of the plant staff, at least one being a Shift Supervisor, subject to subsequent review by the original approving body. Minor changes, hence, will not require the interruption of testing and are used to resolve items such as typographical errors, minor changes to sequence of test steps, etc. Major changes will require interruption of testing and the acceptance by the original approval body before testing continues. The application should define major and minor changes in administrative documents.
- 9. Criteria for stopping a test should be provided. A test should not be allowed to continue until prerequisites have been reestablished and documented in test notes, data sheets, or logs.
- 10-12. Logs should be maintained and retained as part of each test or as part of the shift operations log. They should contain historical information relevant to the conduct of the test and document interruptions; equipment deficiencies should be identified; and test results documented. Control and retention of the logs should be the same as required for shift operations log or the completed test procedure.
- 13. No additional guidance.
- d. Test schedules should exist that support the schedule given in the FSAR Chapter 14. Responsible individuals should be charged with maintaining and implementing the test program schedule.
- e. No additional guidance.

03.04 Document Control

- a. 1. Chapter 14 of the FSAR will normally describe the review, change, and approval methods for test procedures. The implementing instructions must provide the specific review and approval requirements for test procedures and test results. A method for issuance of revised procedures and disposal of obsolete procedures must be sufficient to ensure that all testing will be accomplished in accordance with the most recently approved revision of the procedure. If page changes to a procedure are issued, the licensee must have a cover sheet list of effective pages, etc., to enable the user of the procedure to account for the pages of the procedure. Some mechanism must be provided to ensure that all affected test procedures are updated as necessary to reflect any design changes. There may be a requirement that the responsible test engineer check all referenced drawings or vendor manuals for the latest revisions before testing, or there may be a cross-reference file which lists all procedures that reference a particular drawing so that each affected procedure would be updated when drawing changes are received.

2-4. No additional guidance.

- b. Some mechanism must be provided to ensure that all affected drawings and vendor manuals are updated as necessary to reflect any design changes. There may be a requirement that the responsible test engineer check a master list to ensure they have the latest revisions, or to check design changes to ensure they do not affect the testing.

03.05 Design Changes and Modifications

- a. Section 14 of the FSAR normally should describe the measures for incorporating any needed system modifications or procedure changes, based on the results of the tests (e.g., failure of equipment to meet performance specifications or finding that system operation differs from FSAR description). Regulatory Guide 1.28, "Quality Assurance Program Criteria (Design and Construction)," endorses industry guidance that identifies many of the actions that should be covered by the design control program.

After responsibility for SSCs has been turned over to the operating organization or test group for startup testing, a formal system is necessary to handle the design change and modification requests which may result from such things as: (1) unsatisfactory preoperational or startup test results; (2) failure of SSCs to meet functional requirements. Each change request should be documented in such a manner that the licensee can ensure himself that appropriate reviews will be conducted, and approvals obtained before effecting the change. The licensee should have a formal system for reviewing all routine work requests to ensure that they do not involve an unreviewed design change.

- b. Temporary Modifications, Jumpers, and Bypasses

- 1-5. Control of temporary modifications, jumpers, and bypasses is required whether the testing is being performed by the operating organization or a test organization. Otherwise, the performance of SSCs cannot be ensured subsequent to testing.
- 6. Installed jumpers should be easily identified when electrical equipment is inspected (e.g., made of long brightly colored strands of wire). Lifted leads should be uniquely tagged for ease of identification. Industry standards endorsed by RG 1.33 provide additional guidance.
- 7. Installation of temporary strainers or removal of check valve internals is not evident to a casual observer. Controls such as logs, physical tags, etc., should be used. Industry standards endorsed by RG 1.33 provide additional guidance.
- 8. Installation of electrical jumpers in crowded panels, the lifting of leads in congested areas, removal of check valve internals, etc., may warrant independent verification by a knowledgeable person to ensure that some safety function was not inadvertently negated through error. Industry standards endorsed by RG 1.33 provide additional guidance.
- 9. The nature of a bypass mechanism may be such that a functional test of the system(s) will be required after installation or removal, to ensure that a function was not inadvertently negated.

03.06 Plant Maintenance/Preventive Maintenance.

The normal station maintenance and preventative maintenance program should be in place and inspected by the NRC prior to fuel load.

03.07 Equipment Protection and Cleanliness

- a-c. Industry standards endorsed by RG 1.28 provide additional guidance on cleanliness requirements during construction and operational phases.

Endorsed industry guidance defines cleanliness zones which may require different levels of cleanliness. The endorsed industry guidance gives additional criteria for storage of equipment, and more importantly, makes all the storage requirements applicable to items which have been installed.

Identification methods may include tagging, marked-up drawings, ribbons, etc. "Re-entry" controls for any activity that would open the boundaries of a cleaned system to foreign material should be defined.

- d. Industry standards endorsed by RG 1.28 provide additional guidance on water quality requirements. The water chemistry specifications should be included in Section 5 of the standard FSAR. The water chemistry specifications for Reactor Coolant System Components are included under NUREG-0800, SRP Section 5.4, "Reactor Coolant System Components and Subsystem Design." The Steam Generator Program chemistry is included under NUREG-0800, SRP Section 5.4.2.2, "Steam Generator Program," and BTP 5-1, "Monitoring of Secondary Side Water Chemistry in PWR Steam Generators."

This includes chemistry control of chloride, fluoride, other elements and chemicals within specified limits while in wet layup before, during and after completion of startup tests.

Water quality requirements for various conditions (temperatures) of preoperational testing should be specified. Makeup water, storage tank water, and process water quality should be specified.

Procedures for system layup should include water treatment, use of nitrogen blankets, recirculation requirements, and fill/drain requirements, where applicable.

Water chemistry controls may be applicable to carbon steel and stainless steel components.

03.08 Measuring and Test Equipment

Control of Measuring and Test Equipment. Section 17.1.12 of the SRP speaks to measures appropriate for the control of M&TE. Industry standards endorsed by RG 1.28 provide guidance appropriate for control of M&TE. Control of M&TE during startup testing should be consistent with the commitments and guidance contained in these documents. Additional inspection guidance on M&TE can be found in IP 35007, Appendix 12.

It is not intended that special calibration and control measures are needed for rulers, tape measures, levels, and other similar-type devices where normal commercial practices provided adequate accuracy.

If test equipment or installed equipment that requires no calibration is in use, the licensee may identify it with a "No Calibration Required" sticker and establish appropriate administrative controls.

72401-04 RESOURCE ESTIMATE

The resource estimate for this procedure is approximately 96 hours of direct inspection. This inspection may be conducted prior to or while performing startup test inspections described in IP 72304. Inspections should be coordinated by the **Senior Resident Inspector**. **The resource estimate for this procedure for an inspection of a subsequent unit focused on program differences is approximately 8 to 40 hours of direct inspection.**

72401-05 REFERENCES

Facility Final Safety Analysis Report (FSAR) and Design Control Document (DCD)

Inspection Procedure (IP) 35007, "Quality Assurance Program Implementation during Construction and Pre-Construction Activities"

IP 35101, "QA Program Implementation Inspection for Operational Programs"

IP 42401, "Part 52, Plant Procedures"

IP 37700, "Design Changes and Modifications"

IP 62712, "Part 52, Maintenance Rule"

IP 70367, "Inspection of the Preoperational Test Program"

IP 72304, "Startup Testing for the AP1000: Test Procedure Review, Test Witnessing and Test Results Evaluation"

Regulatory Guide (RG) 1.28, "Quality Assurance Program Criteria (Design and Construction)"

RG 1.33, "Quality Assurance Program Criteria (Operation)"

RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants"

RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"

NUREG-0800, "Standard Review Plan"

END

Attachment 1 - Revision History for IP 72401

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	ML14099A269 06/27/14 CN 14-014	Initial issue to support inspection of construction programs described in IMC 2504. Completed 4 year search of Historical Change Notices, and no commitments were found.	N/A	ML14099A272
	ML19228A069 09/26/19 CN 19-031	Removes redundancies between IP 72401 Section 2.01 and IP 72304 Section 2.01.	N/A	No comments received.
	ML20324A714x 12/07/20 CN 20-069	Minor revisions made to reflect that if this inspection has been completed for the first unit at a multi-unit construction site, then inspection of a subsequent unit may not require the same level of inspection as that conducted for the first unit.	N/A	N/A