
INSPECTION PROCEDURE 70702

PART 52, INSPECTION OF PREOPERATIONAL TEST PERFORMANCE

PROGRAM APPLICABILITY: 2504 Appendix A

70702-01 INSPECTION OBJECTIVES

- 01.01 To provide guidance for inspection of any type of preoperational test at a new nuclear power plant with a combined license (COL) in accordance with Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants,” of Title 10 of the Code of Federal Regulations (10 CFR Part 52).
- 01.02 To ensure the preoperational tests are technically adequate to perform the testing as described in the Final Safety Analysis Report (FSAR), are adequately performed and documented in accordance with the procedure and program requirements, and that the test results demonstrate that the plant, procedures, and personnel are ready for safe operation.

70702-02 INSPECTION REQUIREMENTS

The Initial Test Program (ITP), described in section 14.2 of the plant FSAR, consists of Construction and Installation Tests, Preoperational Tests and Startup Tests (which includes power ascension tests). Preoperational testing activities verify operational performance of structures, **systems**, and components (SSCs) prior to fuel load, and should address tests required by Regulatory Guide 1.68, (RG 1.68), “Initial Test Programs for Water-Cooled Nuclear Power Plants,” and the related RGs referenced in RG 1.68, First-of-a-Kind (FOAK) tests, and testing required by license conditions.

In accordance with 10 CFR 52.47(b)(1), Inspections, Tests, Analyses and Acceptance Criteria (ITAAC), are those tests the licensee shall perform, and the acceptance criteria that, if met, are necessary and sufficient to provide reasonable assurance that the facility has been constructed and will be operated in conformity with the license, the provisions of the Atomic Energy Act, and the Commission’s rules and regulations. ITAAC should be included in section 14.3 of the FSAR and may be accomplished by preoperational testing.

FOAK tests are in-plant functional tests to verify that new, unique, or special design features will perform as required. FOAK tests can also be designated as First-Plant-Only-Test (FPOT) or some variation (such as **First 3 Plant Only Tests (F3POT)**). FOAK tests should be described in section 14.2 of the FSAR and may be license conditions. FOAK tests may be accomplished by preoperational testing.

Vogtle Units 3 and 4 submitted License Amendment Request (LAR) LAR 14-10 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14325A835) requesting changes to its Initial Test Program (ITP). The LAR requested an exception to Updated Final Safety Analysis Report (UFSAR) Certified Design Material Section 3.4, "Initial Test Program," and UFSAR Chapter 14 "Initial Test Program," Section 14.2, "Specific Information to be included in the Standard Safety Analysis Report," and Section 14.3.6, "Initial Test Program." The change redefined "component tests" as a specific subset of "construction and installation tests" during initial energization of components that were moved to the first phase of the ITP. The ITP now identifies three categories of testing once the equipment to be tested reaches its final in-situ location in the plant:

- Construction and Installation Tests (Component Tests for AP1000 only)
- Pre-operational Tests and,
- Start-up Tests

The LAR requested the NRC staff approve the removal of language describing construction and installation tests and replace that language with component tests that are typically performed during construction and installation testing. Additionally, the LAR requested NRC approval to move component tests to the ITP and let them serve as prerequisite tests that are completed before system preoperational tests begin. The safety evaluation for LAR 14-10 (ADAMS Accession No. ML15138A052), concluded that the proposed changes are acceptable to revise the description of the ITP in UFSAR Certified Design Material Section 3.4 and UFSAR Sections 14.2 and 14.3.6 to allow for component tests.

The inspection requirements above apply only to AP1000 plants. Other plant designs may have different inspection requirements related to component and FOAK tests within the scope of the preoperational test program.

02.01 Inspection Sample Selection

- a. Selection criteria for inspection of preoperational testing includes, as a minimum:
 - 1) targeted ITAAC, which are part of the preoperational test program; 2) preoperational FOAK tests; 3) preoperational license condition tests, and; 4) other component preoperational tests based on risk significance, uniqueness, or complexity, that are selected during the NRC inspection planning process
1. Targeted ITAAC are required to be inspected and may be part of a larger test. Inspection of non-targeted ITAAC is addressed under 02.01.a.4. ITAAC that are performed during preoperational testing are inspected under IMC 2503, "Construction Inspection Program: Inspections of Inspections, Tests, Analyses and Acceptance Criteria (ITAAC) Related Work," and the associated inspection procedures (IPs). This procedure may be used for additional guidance. The resource hours for targeted ITAAC inspection are included in the resource hours specified for IMC 2503.
2. FOAK (or FPOT) tests are required to be inspected. This procedure is used to inspect those FOAK preoperational test inspections. If a FOAK test is also an ITAAC test, ensure both the ITAAC IPs and this procedure are used. For FOAK

tests, a more detailed level of test procedure review and test results review is expected to be performed. The resources required for FOAK test inspection are included in the resource hours specified for IMC 2504 or IMC 2503 (for any ITAAC FOAK tests).

3. If there are any preoperational license condition tests, they are required to be inspected. For license condition tests, a more detailed level of test procedure review and test results review is expected to be performed. The resources required for license condition tests, are included in the resource hours specified for IMC 2504 or IMC 2503 (for any ITAAC license condition tests).
4. Additional preoperational tests, outside the targeted ITAAC, FOAK, or license condition tests, may be selected by the NRC for inspection when resources allow, based on risk significance, uniqueness, or complexity, and selected during the NRC inspection planning process.
 - i. Since the targeted ITAAC are normally part of a larger test, additional parts of the test may be inspected as allowed by the normal resources assigned to a targeted ITAAC.
 - ii. Additional ITAAC tests would be inspected under IMC 2503 and the associated IP's. Additional non-ITAAC tests would be inspected under IMC 2504 and this procedure.
 - iii. If, during the NRC inspection planning process, the construction site residents propose to increase inspection scope requiring additional resources, NRC Region 2 management must authorize the additional resources.
- b. The preoperational test inspection scope may be increased based on poor licensee or test organization performance. Criteria to select additional tests for inspection include: 1) similarity to identified problem areas; 2) risk significance of the SSC; 3) lack of previous inspections of that SSC; 4) availability of the testing to inspect; 5) availability of resources to perform the inspection, and; 6) selected during the inspection planning process.

02.02 Inspection Preparation

Inspection preparation includes: verifying licensee scheduling of the test, reviewing the applicable licensee commitments and regulatory requirements related to the test, reviewing the applicable design documents and test procedures, and ensuring NRC resources are available to perform the inspection.

02.03 Procedure Review

Review the selected test procedure to verify: that the testing is performed in accordance with the FSAR, license, and NRC requirements; that the test adequately verifies important SSC performance attributes; and that the test contains clearly identified acceptance criteria.

02.04 Test Witnessing

Witness the test to verify that the pretest requirements are performed; the test is conducted in accordance with the approved procedure; test changes, anomalies, problems, interruptions, and deficiencies are identified and controlled; and observed data is properly recorded.

02.05 Test Results Review

Review the test results to ensure that the SSC was tested, and will operate, in accordance with the FSAR, license, and NRC requirements. Verify that the test acceptance criteria were met and that test changes, anomalies, problems, interruptions, and/or deficiencies, were appropriately dispositioned.

02.06 Quality Assurance Program (Problem Identification and Resolution)

Evaluate the implementation of the quality assurance program requirements related to preoperational testing. Confirm that problems identified during preoperational testing are entered into the corrective action program in accordance with program requirements.

70702-03 INSPECTION GUIDANCE

03.01 Inspection Sample Selection

No additional guidance.

03.02 Inspection Preparation

- a. The preoperational test phase may be very fluid with emergent schedule changes. The NRC inspection planning process and the NRC inspectors need to maintain current information on the testing schedule.
- b. Comprehensive inspection planning guidance should include the following:
 1. For ITAAC tests review the ITAAC and the IP (65001 series) associated with the ITAAC.
 2. Review the final safety analysis report (FSAR) associated with the test and SSC being tested.
 3. Review any associated RGs for the test (such as RG 1.68).
 4. Review the applicable site data in the Construction Inspection Program Information Management System (CIPIMS) to determine if any previously identified open issues, findings, or observations are relevant to the inspection being planned.
 5. Review the applicable licensee specifications, procedures, and work control documents to understand the scope and content of the licensee's programmatic controls and how the test or activity to be inspected may be affected.

6. FOAK and license condition preoperational tests require more detailed level procedure review and review of results discussed in sections 03.03 and 03.05.
7. FOAK and license condition preoperational tests require notification to the Director of the Office of New Reactors, Division of Construction Inspection and Operational Programs, or designee, during the inspection planning phase. Certain FOAK and license condition tests will require Headquarters staff participation in the inspection preparation and performance.
8. Develop an inspection plan that identifies the specific aspects that need to be inspected.

03.03 Procedure Review

The inspector should evaluate the following attributes for each test procedure for review.

The inspector should verify that the test procedure adequately meets all the regulatory and license requirements. This level of review should normally be performed for FOAK and license condition tests, and for tests that are not going to be witnessed. For test procedure adequacy review, complete steps a - d below in their entirety.

- a. Obtain a current revision of the selected test procedures and associated documentation (e.g., electrical diagrams, piping and instrumentation drawings, calibration records, etc.) in sufficient time to allow a procedure review to be completed prior to the date scheduled for the test. Review the procedures for technical adequacy and completeness. If deficiencies are noted during this review, identify these conditions to the responsible organization for disposition in their corrective action program.
- b. Review the Design Control Document (DCD), FSAR, Safety Evaluation Report, Technical Specifications, and facility license. Verify that the test procedure adequately address FOAK test requirements, license condition requirements, license commitments, and NRC requirements relating to preoperational tests (including RG 1.68 and the RGs referenced in RG 1.68) and any associated ITAAC.
- c. Ensure that important equipment performance attributes are adequately confirmed by the preoperational test and any associated ITAAC. The focus of this review should be on the technical adequacy of the test procedure to accomplish the preoperational test and the ITAAC rather than the format of the document.
- d. Review the test procedures to ensure they include the following attributes:
 1. Appropriate staff and management approval is indicated on the document.
 2. Test objectives are clearly stated. Verify that any related FSAR commitments are included.
 3. Any required testing prerequisites are identified, e.g.,:
 - i. Required plant systems availability is specified.
 - ii. Any associated facility procedures are specified.

- iii. Prior completion of calibration checks, limit switch setting, protective component settings, etc. are included where applicable.
 - iv. Any special supplies and test equipment needs are specified.
 - v. Special environmental conditions and hold times, if any, are identified.
 - vi. Test precautions and limitations are specified.
4. Test acceptance criteria are clearly identified and the procedure requires comparison of results with acceptance criteria. The source of the acceptance criteria is also identified (e.g., preoperational test descriptions, ITAAC, FSAR, technical specifications, facility license, etc.).
5. Initial test conditions are specified.
 - i. Valve lineups
 - ii. Electrical power and control requirements
 - iii. Any temporary installations or equipment modifications (instrumentation, electrical, and piping)
 - iv. Any necessary special conditions e.g. temperatures, pressures, flows, water chemistry, etc.
6. The procedure includes a listing of references to appropriate preoperational test descriptions, ITAAC, FSAR sections, technical specifications, drawings, design specifications, industry codes, and other requirements.
7. Step-by-step instructions for the performance of the procedure, including hold points, if needed, are included to the extent necessary to ensure that the test is performed correctly and the test objectives are met.
8. Blank spaces are provided for initialing all items, including prerequisites, to document performance.
9. Provisions are made for recording details of the conduct of the test, including any test anomalies or observed deficiencies, their resolution, and any necessary retesting.
10. Procedure requires that any temporary connections, blind flanges, disconnections or jumpers be restored to normal at the end of the test, or references their control by another procedure.
11. Procedure provides for the identification of both personnel conducting the testing and those evaluating the test data. Provision is made for the evaluator to document acceptability of the data.
12. Procedure provides for quality control, quality assurance, engineering, or other specified individual verification of critical steps or test parameters.

13. Any special precautions for personnel and equipment safety are specified.
14. Expected performance of any automatic functions or controls, e.g. response to step and ramp control changes, is specified.
15. Procedure provides for verification of calibration of measuring and test equipment (M&TE) and recording of any temporarily installed or used M&TE equipment identification and calibration date.

03.04 Test Witnessing

The inspector shall review the following attributes for each of the tests selected for witnessing.

- a. Confirm that a current revision of the test procedure is available at the test location and is being used by test personnel. Before witnessing a test, the inspector should have completed a review of the test procedure in accordance with 03.03. The inspector should be familiar with the test procedure in order to adequately witness the testing described in the procedure. Communication must be maintained between the inspector and the licensee so that the licensee's test dates are known far enough in advance for the inspector to be ready to witness the selected tests. The inspector should determine the current procedure revision by examining the licensee's document control system. Ensure by observation and discussions that test personnel are using the current procedure revision and are familiar with the procedural requirements, especially the limitations and precautions.
- b. Confirm that test personnel **qualification** requirements are met. The procedure and preoperational test program should specify the responsibilities of test personnel. The inspector should, on a sampling basis, ensure that both requirements are met.
- c. Confirm that pretest briefings are conducted and appropriate shift turnover is performed to ensure continuity in ongoing test activities. Pretest briefings should include discussion of the risk to personnel and equipment, possible failure modes and effects, and Operating Experience applicable to the testing performed. Test personnel coordination and communication must be addressed. Clear identification of personnel assignments and who is the test director must be addressed. Criteria for test termination should be discussed.
- d. Confirm that all test prerequisites and initial conditions are met and those that are waived are reviewed and approved in accordance with current approved administrative procedures and preoperational test program. Verification should be performed by the inspector's review of the required records (e.g., valve lineup list, instrumentation calibration procedure, system checklist, or signoff item in the test procedure) or by direct observation (e.g., monitoring instrumentation indications, valve positions, equipment status, etc. or observation of personnel actions).
- e. On a sampling basis, confirm that any M&TE required by the procedure is calibrated and in service at the time of the test. Test data recording equipment required by procedure is calibrated to a common time base. Test equipment with possibly greater accuracy than installed control instrumentation is normally required for measuring important parameters to demonstrate equipment performance in accordance with design criteria. This M&TE must be properly calibrated within the prescribed time period. If the M&TE

was calibrated in the appropriate time period, it does not normally need to be recalibrated each time that piece of equipment is used, unless specified by the procedure or preoperational test program.

- f. Confirm that test personnel actions and coordination activities are adequately performed. Specifically, coordination can be an important aspect of a test if several personnel are involved in performing procedural steps. Many of these steps may involve coordinated activities between two or more personnel. The inspector should confirm through observation that the assigned individual directing the test activities is knowledgeable and that time sequencing, when required, is performed appropriately. On a sampling basis, the inspector should verify adherence to the procedural limitations and precautions, and the individual test steps.
- g. Review the Startup Test Engineers Log or equivalent, the Control Room Log, and the Shift Supervisor's Log, as applicable. Test anomalies, problems, interruptions, and deficiencies should be recorded in the logs and reviewed for inclusion in the appropriate corrective action program.
- h. Confirm that test personnel or test director performs a preliminary review of test results to determine that the observed test results meet the established acceptance criteria. The acceptance criteria shall be clearly stated in the test procedure. If practicable, verify by direct observation that overall test acceptance criteria have been satisfied. Review the preliminary test results to ensure that the initial test evaluation is consistent with inspector observations. The inspector should also, independent from the licensee or test organization evaluation, observe and evaluate certain critical events or data gathering during and following testing activities. These events or data gathering (e.g., pump starts, valve opens, recording of flow rates, etc.) activities should be selected during the inspector's preparatory review of the procedure.

03.05 Test Results Review

The inspector should evaluate the following attributes for each test selected for results review. Two alternate levels of inspection are provided in this procedure for test results review.

The first level (i.e., more detailed review) involves independent inspection of test results. For the tests that are FOAK or license conditions, for tests that are not witnessed, and for other tests which the inspection plan requires independent inspector evaluation of test results, complete steps a – d below in their entirety.

The second level involves verification of licensee or test organization evaluation of tests results. For the remainder of the tests the inspection plan only requires verification that the test results have been adequately evaluated, and only step d below needs to be completed.

- a. Following test completion, the test data packages should be assembled by the licensees or the test organization. Review the "as-run" copy of the test procedure. Verify that individual test steps and data sheets have been properly initialed and dated. Verify that data sheets have been completed. Verify that all data is recorded where required and is within acceptance tolerances. Verify that test deficiencies and test procedure changes are properly identified in accordance with established administrative procedures.

- b. Review all test changes made during the performance of the test, including any testing deletions. Verify that each test was approved in accordance with the pertinent administrative procedures. Verify that the procedure is annotated to identify test changes. Verify that none of the changes have altered the basic objectives of the test.
- c. Review all test anomalies and deficiencies. Verify that these conditions have been documented, resolved, that the resolution has been accepted by appropriate management, and that retest requirements, if any, have been completed. Verify that any system performance problems identified by a test deficiency have been properly documented and reviewed. Verify that non-conformances, and conditions adverse to quality are documented in the appropriate nonconformance or corrective action system. Verify that any deficiencies which constitute a reportable occurrence as defined in 10 CFR Part 21, 10 CFR Part 50.55e, 10 CFR Part 50, and 10 CFR Part 52 have been properly reported.
- d. Review the test summary and **report which includes an evaluation of the results**. The inspector should apply independent technical analysis and judgment to ensure that the evaluation of test results has been performed correctly. Verify that those personnel, responsible for review and acceptance of test results, have documented their review and acceptance of the data package and the results evaluation. Verify that the licensees or test organization engineering staff has evaluated the test results and concluded that the testing demonstrated that the equipment met design requirements. Verify that the **results** evaluation compared test results with established acceptance criteria. For tests with complex analysis or where acceptance is established by engineering in lieu of specific acceptance criteria, consult with the appropriate NRC staff to verify acceptability of results. Verify that the Test Review Committee or equivalent group has examined the results in accordance with established administrative requirements. Verify that the Quality Assurance group or other independent review of test results has been accomplished as prescribed in the FSAR or other licensee commitments.

03.06 Quality Assurance Program (Problem Identification and Resolution)

This inspection is to ensure that problems are entered into the applicable process to ensure corrective actions appropriate to the circumstances, are developed and prioritized. The inspector may review actions to address similar or related problems that were previously identified, in order to check the extent of condition and confirm the effectiveness of the licensee's corrective measures. Inspections of Quality Assurance program implementation, effectiveness of problem identification and resolution, and self-assessments will be performed under the IMC 2504 process.

70702-04 RESOURCE ESTIMATE

Resources to implement this procedure are as specified for ITAAC inspection under IMC 2503, and preoperational test program inspection under IMC 2504. Therefore, no separate resource estimate is made for this procedure.

70702-05 REFERENCES

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

Inspection Manual Chapter (IMC) 2503, Construction Inspection Program: Inspections of Inspections, Tests, Analyses and Acceptance Criteria (ITAAC) Related Work, Appendix B, Site Specific ITAAC Matrix

IMC 2503, Appendix C, Site Specific ITAAC Sample Selection Process

Inspection Procedure (IP) 65001, Inspections of Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) Related Work

IP 35007, Quality Assurance Program Implementation during Construction and Pre-Construction Activities

IP 70367, Inspection of the Preoperational Test Program

Regulatory Guide 1.68, Initial Test Programs for Water-Cooled Nuclear Power Plants

END

Appendix A:
Guidance for the Inspection of Preoperational Test Performance Involving Digital Instrumentation and Control (I&C) Systems

Attachment 1:
Revision History

Appendix A – Guidance for the Inspection of Preoperational Test Performance Involving Digital Instrumentation and Control Systems

A-01 INSPECTION OBJECTIVE

To ensure that Site Acceptance Tests (SATs) and preoperational tests involving digital Instrumentation and Control (I&C) systems adequately test input and output signals from digital I&C logic platforms. This includes priority logic where safety systems have priority over non-safety systems

To verify adequate overlap with prior testing, and verify that safety-related, important to safety, and normally operating digital I&C systems will perform their intended functions.

A-02 BACKGROUND

Most I&C systems for new reactors are developed and tested in a factory. I&C system hardware and software may also be developed and integrated into cabinets at the factory. The assembled I&C systems are then tested for functionality at the site. Integration and testing of I&C systems with other plant systems, as part of integrated plant operation and functionality occurs under the Initial Test Program (ITP). The ITP test criteria evaluates functional performance, including control, indication, and other support functions, which can be accomplished by digital or analog technology. Inspection, Tests, Analyses, and Acceptance Criteria (ITAAC) may be addressed during the ITP. The ITAAC addressed in the ITP may have technology-specific (i.e., analog or digital) components. However, in general, these ITAAC will also address higher level plant functionality. Although a significant amount of testing is performed in the factory, the ITP should accomplish the test scope and criteria as outlined in the plant's licensing basis.

A-03 DEFINITIONS

The following are definitions for various tests:

Factory Acceptance Tests (FATs): Typically, FATs are conducted at the factory or other remote facility during the design, fabrication and testing of digital I&C hardware and software primarily using simulated signals to validate system functional requirements. FATs are considered part of offsite construction and pre-installation activities prior to delivery to the licensee.

Site Acceptance Tests (SATs): Typically, SATs are conducted during construction through post-installation of digital I&C systems at the site, with the systems placed into, as close as practical, an operational environment to determine whether digital I&C systems will perform their required functions and enable the licensee to determine whether to accept the system.

Preoperational Tests: Following plant construction, preoperational testing is accomplished to demonstrate the proper performance of structures, systems, and components and design features in the assembled plant before fuel load. Tests and inspections include, for example, initial instrument calibration, flushing, cleaning, and wiring continuity and separation checks, hydrostatic pressure tests, and functional tests of components. To ensure valid test results,

preoperational tests should not proceed until construction of the system has essentially been completed, and prerequisite construction tests and inspections are completed.

Testing of digital I&C systems can include a significant number of test cases covering months of effort. In a factory setting, tests are typically conducted using automated test systems with simulated signals to represent plant systems and human-machine interactions. Repeating all factory tests in the plant environment would be impractical due to the level of effort and time that would be required. However, for preoperational testing that repeats selected factory tests or incorporates other unique on-site testing, such as detailed logic testing, the hardware and software configuration should be equivalent to and consistent with the configuration during FAT. Regression testing that validates the acceptability of the modified software should be performed in instances where changes to the software configuration occurred after completion of FAT and delivery of the software to the site. Preoperational testing of digital I&C components, subsystems, and systems in the plant operational environment (i.e., post-installation, preoperational integrated system configuration) should be conducted to: (1) verify consistent hardware and software configuration with FAT tests and licensing bases; (2) verify the validity of simulation used in the FAT; (3) verify plant requirements and assumptions used in the development of the digital I&C systems; and; (4) verify interface/integration testing of equipment/systems connected to the digital I&C system under normal and abnormal conditions (e.g., loss of channel, loss of division, loss of power, etc.).

A-04 INSPECTION GUIDANCE

In addition to the guidance provided in Section 70702-02 of this procedure, the following inspection guidance should be used for preoperational tests involving digital I&C systems.

A-04.01 Inspection Sample Selection

Refer to IP 70702-02.01 for additional guidance.

A-04.02 Inspection Preparation

- a. Inspection preparation and procedure review should include technical I&C staff in order to provide sufficient background and expertise on I&C system licensing bases, development and testing processes, and significant aspects of the I&C design.
- b. Review the licensee's commitment to the following digital I&C regulatory guides: 1.68, 1.152, 1.153 and 1.168 through 1.173.
- c. The licensee should provide supporting Quality Assurance documentation (e.g., report of record, etc.) for FAT of components being used during the preoperational testing with the preoperational test procedure for review. Review the summary test report of FAT performed for the plant system under inspection. The inspector should apply independent technical analysis and judgment to ensure the evaluation of test results has been performed correctly. Ensure the evaluation compared test results with established acceptance criteria.
- d. Refer to IP 70702-03.02 for additional guidance.

A-04.03 Procedure Review

- a. Verify the test procedure adequately addresses first-of-a-kind (FOAK) test requirements, license condition requirements, license commitments, ITAAC acceptance criteria, and other NRC requirements relating to digital I&C systems and preoperational tests. Verify that the test procedure includes appropriate acceptance criteria and is consistent with the licensing requirements and commitments.
- b. If complete testing of a plant function requires a series of digital I&C system tests, including overlapped tests, verify the collection of test procedures contain an adequate test scope and acceptance criteria and will successfully verify the plant function as a whole. The inspectors may use FAT results to verify that the equipment was properly tested to satisfy the prerequisites that support the preoperational test.

The inspector should verify the licensee has a process to verify and validate overlapping test acceptance criteria. For example, the licensee may use a test requirements matrix with test information related to overlapping FAT and SAT acceptance criteria for individual component tests.

Note: It may be acceptable for previously conducted tests' acceptance criteria to be specifically credited for a specific preoperational test. Not every permutation and combination of normal and abnormal system conditions conducted on an installed and integrated system configuration needs to be tested to satisfy preoperational test requirements. The inspector should apply independent technical analysis and judgment to ensure that sufficient post-installation, preoperational testing is conducted to satisfy critical design characteristics, including how a system operates in a degraded condition, if it is part of its design criteria. For tests with complex analyses or where previously completed FAT are being used as acceptance criteria in lieu of specific acceptance criteria within the given preoperational test, consult with the appropriate NRC staff in NRO/DCIP with digital I&C expertise to verify acceptability of results.

- c. Review the test procedure to ensure that the acceptance criteria contains measurable and objective evidence for the test or associated battery of tests. The tests and associated acceptance criteria should cover at a minimum, the following areas:
 1. Proper continuity of electrical signaling, power supplies and communication networks of the component and the related integrated system
 2. Proper ranging verification
 3. Direct change of state information related to final actuation setpoints
 4. Anticipated control, alarm and indication information when a component, system, division, channel or sub-channel is forced into a fault condition within its design criteria.

Note: Only singular verification of a logic flow path should be used to provide reasonable assurance of proper functionality. For example, if one component within a division, channel or sub-channel were to undergo a simulated failure that entails the activation of a safety component or components (e.g., bypasses, permissives) with appropriate control functions, indications and alarms, it would

not be necessary to conduct a repeated test on other identical components (e.g., test only one bistable or logic processor within a sub-channel or channel, dependent on the system design) within the same sub-channel, channel or division to provide reasonable assurance of proper component, module or system operation.

- d. Refer to IP 70702-03.03 for additional guidance.

A-04.04 Test Witnessing

- a. Confirm the physical integrity of installed digital I&C systems, continuity, and correctness of electrical signal lines, power supplies, and communication networks.
- b. Confirm the appropriate ranges, parameters, and operation associated with electrical and electronic signals and communication networks.
- c. Confirm the digital I&C system is appropriately connected to other plant systems and other digital I&C systems for which it would need to interface in order to fully accomplish a plant function.
- d. As described in the plant licensing basis, confirm digital I&C systems operate correctly for normal and abnormal conditions. Confirm tests of functionality include how the digital I&C system operates with all final setpoints, controls, alarms, permissives and interlocks. To the degree possible, tests should be implemented with actual plant signals versus simulated signals. When simulated signals are used, they should be as close as practical to the device under test.
- e. If modification to the digital I&C system is required to address a test anomaly or deficiency, confirm the appropriate hardware and software maintenance activities have been completed per the licensing basis. These maintenance activities will likely involve design changes or modifications to design outputs that were originally accomplished in the factory, and the modifications may also occur at the site. The following activities should be confirmed by the inspectors:
 - 1. Analysis of the anomaly or deficiency and what portions of the digital I&C system need to be modified to address the anomaly or deficiency.
 - 2. Analysis as to how the modification could adversely impact proper digital I&C system functionality (e.g., software hazard analysis).
 - 3. Verification and validation efforts, such as design reviews, code walk-throughs, and regression testing, to ensure the modification was properly applied.
 - 4. Proper configuration management of hardware, software, and supporting documentation based on the modification. Configuration management should encompass all sites that could affect current and future software maintenance (e.g., factory and plant site)

Note: If the inspector is unable to confirm these activities during the test witnessing phase, the inspector should inform project management staff that these modifications should be flagged for potential inspection during the results review section of this IP.

- f. Refer to IP 70702-03.04 for additional guidance.

A-04.05 Test Results Review

- a. Review a sample of the test results to ensure that they adequately document measurable and objective evidence to support the satisfactory completion of the acceptance criteria.
- b. The selected preoperational test activities (e.g., logic testing) should provide objective evidence that the FAT logic testing provided consistent results with that obtained during preoperational testing. Based on this comparison, the documentation should demonstrate that the preoperational test results confirm the adequacy and sufficiency of the prior FAT results that are being used as specific acceptance criteria in the preoperational test procedure.
- c. The licensee may have used a test requirements matrix with test information related to overlapping FAT and SAT acceptance criteria for individual components tests. The inspector should evaluate that the licensee has a process to verify and validate overlapping test acceptance criteria such as what would be found in a test requirements matrix. The inspector should review the results in the matrix to verify that the licensee has adequately implemented their process and completed required overlap testing.
- d. Refer to IP 70702-03.05 for additional guidance.

A-04.06 Quality Assurance Program (Problem Identification and Resolution)

Refer to IP 70702-03.06 for additional guidance.

A-05 RESOURCE ESTIMATE

No additional guidance.

A-06 REFERENCES

NRC Regulatory Guide 1.68, Initial Test Program for Water-Cooled Nuclear Power Plants

NRC Regulatory Guide 1.152, Criteria for Digital Computers in Safety Systems of Nuclear Power Plants

NRC Regulatory Guide 1.153, Criteria for Safety Systems

NRC Regulatory Guide 1.168, Verification, Validation, Reviews and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants

NRC Regulatory Guide 1.169, Configuration Management Plans for Digital Computer Software Used in Safety Systems of Nuclear Power Plants

NRC Regulatory Guide 1.170, Test Documentation for Digital Computer Software Used in Safety Systems of Nuclear Power Plants

NRC Regulatory Guide 1.171, Software Unit Testing for Digital Computer Software Used in Safety Systems of Nuclear Power Plants

NRC Regulatory Guide 1.172, Software Requirements Specifications for Digital Computer Software and Complex Electronics Used in Safety Systems of Nuclear Power Plants

NRC Regulatory Guide 1.173, Developing Software Life Cycle Processes for Digital Computer Software Used in Safety Systems of Nuclear Power Plants

NRC Regulatory Guide 1.215, Guidance for ITAAC Closure Under 10 CFR Part 52

Attachment 1 - Revision History for IP 70702

| Commitment Tracking Number | Accession No. 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 | ML13294A482 01/15/14 CN 14-001 | 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 | ML13294A486 |
| N/A | ML17229B640 12/06/17 CN 17-028 | Updated to add Appendix A, Inspection of Preoperational Test Performance Involving Digital Instrumentation and Control (I&C) Systems. | N/A | ML17229B639 |