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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 70 Related to ESBWR Design Certification Application – Initial Test Program – RAI Numbers 14.2-36 through 14.2-38, 14.2-42, 14.2-43, 14.2-45 through 14.2-49, 14.2-52 through 14.2-55, and 14.2-57**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

D068

Reference:

1. MFN 06-382, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 70 Related to ESBWR Design Certification Application,* October 10, 2006

Enclosure:

1. MFN 07-061 – Response to Portion of NRC Request for Additional Information Letter No. 70 Related to ESBWR Design Certification Application – Initial Test Program – RAI Numbers 14.2-36 through 14.2-38, 14.2-42, 14.2-43, 14.2-45 through 14.2-49, 14.2-52 through 14.2-55, and 14.2-57

cc: AE Cubbage USNRC (with enclosures)
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eDRF 0000-0061-7037

Enclosure 1

MFN 07-061

Response to Portion of NRC Request for

Additional Information Letter No. 70

Related to ESBWR Design Certification Application

Initial Test Program

RAI Numbers 14.2-36 through 14.2-38, 14.2-42, 14.2-43, 14.2-45 through 14.2-49, 14.2-52 through 14.2-55, and 14.2-57

NRC RAI 14.2-36

DCD Tier 2, Revision 1, Chapter 14.2.8, Individual Test Descriptions, did not list tests in the table of contents. To find a specific component test, you have to look through the whole chapter, which is extremely time consuming. Please list all tests in the table of contents. Table of Contents for other new reactors have also classified tests in categories for safety-related functions, defense-in-depth functions, non-safety-related radioactive system functions, and additional non-safety-related functions.

GE Response:

Chapter 14 Table of Contents will be revised in the next revision to list the Preoperational Test Procedures in Subsection 14.2.8.1 and the General Description of Startup Tests in Subsection 14.2.8.2. . By including a list of all test procedures in the table of contents, a reader will be able to locate tests on topics of interest with relative ease. The test discussions and associated startup test numbers used in this chapter of the ESBWR DCD generally follow the organization historically used by GE in more recent BWR and ABWR DCDs and test programs. Although organizing the tests into new sub-categories may prove useful for some users of the DCD, the reorganization would also create confusion for those users who have previous experience with the "standard" GE chapter 14-2 organization. In addition, the four categories suggested are only a few of the many sub-categories of systems and design bases that could be used to create various test organizations. Further, GE is not aware of a regulatory basis for the particular recommended test organization or other organizational standard to use in the DCD, that GE could follow that would support creating consistent test sub-categorization across the industry. Therefore, no organizational changes will be made to Section 14.2. Additionally, the word "Test" will be added to the title of each 14.2.8.2 Subsection to clarify the description.

DCD Impact:

DCD Tier 2, Section 14.2 Table of Contents will be revised as noted in the attached markup.

NRC RAI 14.2-37

Standard Review Plan (SRP) Section 14.2, Revision 2 - July 1981, Subsection II "Acceptance Criteria" included a list of Regulatory Guides (RGs) that provided more detailed information pertaining to testing. DCD Tier 2, Revision 1, Section 14.2.3, "Test Programs' Conformance with Regulatory Guides," did not list all of RGs recommended by SRP 14.2.II. DCD Tier 2, Revision 1, Chapter 1 listed applicable RGs and RGs 1.56,1.128, 1.136 are listed "yes" for ESBWR. Please provide justifications for why you are not using RGs 1.56, 1.128, or 1.136 in Chapter 14 for initial test program.

GE Response:

Regulatory Guide 1.56 is listed in Subsection 14.2.3 on page 14.2-6. No DCD change is required.

Regulatory Guide 1.128 was not listed and will be included in the next revision of Section 14.2.

Regulatory Guide 1.136 is listed in DCD Tier 2, Revision 1, Chapter 1, Table 1.9-21, page 1.9-77 as "yes" for ESBWR, however, it is not listed in SRP 14.2.II in the list of Regulatory Guides providing more detailed information pertaining to tests called for in Regulatory Guide 1.68. Therefore, no DCD change is required.

DCD Impact:

DCD Tier 2, Subsection 14.2.3 will be revised as noted in the attached markup.

NRC RAI 14.2-38

The term "proper" is used throughout the DCD. For example, in DCD Tier 2, Revision 1, Subsection 14.2.8.1.65, it states, as a bullet, "Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip". The term proper is vague and subjective. For this example, how is proper operation defined in conjunction with all combinations of logic and instrument channel trip? In general, how is proper defined? Does the same definition of proper, which is used extensively, apply throughout the DCD?

GE Response:

The use of the word "proper" in the DCD is consistent with the frequent use of this word in Regulatory Guide 1.68 and its attachments (for example on page 1.68-4, Section C Regulatory Position, 2. Prerequisites for Testing). The DCD uses the word "proper", in accordance with GE's understanding of the use of the word in Regulatory Guide 1.68, as synonymous with "appropriate", "per design" or "per design requirements". As GE uses the word proper in a manner consistent with both standard English usage and Regulatory Guide 1.68, no change to the DCD is required.

DCD Impact:

No DCD changes will be made in response to this RAI.

NRC RAI 14.2-42

DCD Tier 2, Revision 1, Section 14.2.8.2.3: Regulatory Guide 1.68, Revision 2 - 08/1978,Appendix A, Section 2, recommended tests AFTER the core is fully loaded. List C required "Final functional testing of the reactor protection system to demonstrate proper trip points, logic, and operability of scram breakers and valves. Demonstrate operability of manual scram functions". However, in DCD Tier 2, Revision 1, Subsection 14.2.8.2.3, the RG 1.68 recommended tests were planned PRIOR TO (instead of "after") commencing fuel loading. Please provide information if GE will perform the tests listed above after the core is fully loaded or justify if there is no such plan.

GE Response:

Regulatory Guide 1.68, Rev 2 – 08/1978, Appendix A, Section 2 recommends a list of tests and verifications that should be conducted during OR following initial fuel loading (See the end of the paragraph preceding test description a in Regulatory Guide 1.68, App A, Section 2). The "Final functional testing of the reactor protection system to demonstrate proper trip points, logic, and operability of scram breakers and valves. Demonstrate operability of manual scram functions" is contained in this list. Therefore, the seventh bulleted item under DCD Tier 2, Subsection 14.2.8.2.3, as stated above will be removed and the requirement will be added to Subsection 14.2.8.1.9, Reactor Protection System Preoperational Test, under "General Tests Methods and Acceptance Criteria".

DCD Impact:

DCD Tier 2, Subsections 14.2.8.2.3 and 14.2.8.1.9 will be revised as noted in the attached markup.

NRC RAI 14.2-43

DCD Tier 2, Revision 1, Section 14.2.8.2.3: Regulatory Guide 1.68, Revision 2 - 08/1978,Appendix A.2, Initial Fuel Loading and Precritical Tests require "Prediction of core reactivity should be prepared in advance to aid in evaluating the measured responses to specified loading increments". In test description 14.2.8.2.3, it is not clear if GE will make predictions of core reactivity and what actions will be taken if the measured results deviate from expected values. Please clarify.

GE Response:

Currently, shutdown margin tests provide the greatest assurance of core subcriticality. GE will make predictions of Shutdown Margin prior to initial fuel loading. In order to comply with the requirements of Regulatory Guide 1.68, Revision 2 -08/1978, Appendix A.2 the following statement will be added to the description under Subsection 14.2.8.2.3 in DCD Tier 2:

"Criteria for and actions required to address any deviations from expected results will be delineated in the fuel loading procedures as described in Subsection 14.2.2."

DCD Impact:

DCD Tier 2, Subsection 14.2.8.2.3 will be revised as noted in the attached markup.

NRC RAI 14.2-45

DCD Tier 2, Revision 1, Section 14.2.8.2, includes the transient tests. Does GE have plans to validate TRACG code using the data obtained from these transient tests (for the first ESBWR which will come to operation)?

GE Response:

The TRACG code has already been validated against an extensive test database. The data obtained from the transient tests will be compared to the TRACG code predictions and any differences will be evaluated by both the site test review group and by GE.

DCD Impact:

No DCD changes will be made in response to this RAI.

NRC RAI 14.2-46

DCD Tier 2, Revision 1, Section 14.2.8.1.44: Revise bullet #4 on Page 14.2-42. Add "condensate, condensate booster, and feedwater pumps" for consistency with position C.1.a of Regulatory Guide (RG) 1.68.1, Revision 1 - 01/1977.

GE Response:

The ESBWR does not have Condensate Booster pumps. The Reactor Feed Pump has a booster pump and a main pump on the same shaft and motor. Therefore, DCD Tier 2, Subsection 14.2.8.1.44: bullet #4 on Page 14.2-42 will be revised to state: "Proper operation of pumps and motors in all design operating modes (Condensate and Reactor Feed Pumps)

DCD Impact:

DCD Tier 2, Subsection 14.2.8.1.44 will be revised as noted in the attached markup.

NRC RAI 14.2-47

DCD Tier 2, Revision 1, Section 14.2.8.1.44: Clarify if feedwater flow control valve testing will verify proper response of valves for the design operating range, correct operation and protective features, as described in regulatory position C.1.d of Regulatory Guide 1.68.1,Revision 1 -01/1977.

GE Response:

The ESBWR uses valve control for low flow control of feed water flow and feed pump speed control for normal at power feed water flow rate control. Preoperational Testing, to the extent practical, of the Feed Water Control System is described in section 14.2.8.1.2 Feedwater Control System Preoperational Testing. However, to ensure that complete testing of the low feedwater flow control valve is performed as required by C.1.d of Regulatory Guide 1.68.1, DCD Tier 2, Subsection 14.2.8.1.44, bullet #3 will be revised to state:

- Proper operation of system valves, including timing, under expected operating conditions, and proper response of flow control valves for the design operating range and correct operation of protective features;

DCD Impact:

DCD Tier 2, Subsection 14.2.8.1.44 will be revised as noted in the attached markup.

NRC RAI 14.2-48

DCD Tier 2, Revision 1, Section 14.2.8.1.44, does not include a comprehensive feedwater control system test as described in regulatory position C.1.f of Regulatory Guide 1.68.1, Revision 1 - 01/1977. Provide a justification or an alternative method of demonstrating operability of the feedwater control system.

GE Response:

DCD Tier 2, Subsection 14.2.8.1.44, covers the Condensate and Feedwater Systems Preoperational Tests and is not the appropriate place to address a comprehensive feedwater control system test. Subsection 14.2.8.1.2 covers the Feedwater Control System Preoperational Test and is the appropriate location to address this concern. Subsection 14.2.8.1.2 addresses the individual components of the feedwater control system but does not address the overall response of the control system as stipulated in Regulatory Guide 1.68.1, Revision 1 – 01/1977. A bullet will be added to Subsection 14.2.8.1.2. as follows:

- Proper overall response of the control system including the final control element. This will include control system response to simulated control system malfunctions and simulated plant transients at full flow including MSIV closure and Turbine Trip without bypass capability. (Control system response will be verified, and mechanical / electrical component responses will be tested to the extent possible under preoperational test conditions.)

DCD Impact:

DCD Tier 2, Subsection 14.2.8.1.2 will be revised as noted in the attached markup.

NRC RAI 14.2-49

Perform a global revision to the title of DCD Tier 2, Revision 1, Section 14.2.8.1.47 to maintain consistency with DCD Tier 2, Revision 1, Section 10.4.2, "Condenser Air Removal System."

GE Response:

DCD Tier 2, Subsection 14.2.8.1.47 heading will be revised in the next revision to be "Condenser Air Removal System Preoperational Test", to be consistent with DCD Tier 2, Subsection 10.4.2. The global search revealed that there are 4 other occurrences of Main Condenser Evacuation System in chapters 1 (3 times) and 11 (1 time). These discrepancies have been directed to the appropriate personnel in charge of those chapters and will be corrected on the next revision.

DCD Impact:

DCD Tier 2, Subsection 14.2.8.1.47 will be revised as noted in the attached markup.

NRC RAI 14.2-52

Revise typo in the prerequisites of DCD Tier 2, Revision 1, Section 14.2.8.1.55. Second sentence should read "...to the extent necessary..."

GE Response:

The word "the" will be added and "extend" will be changed to "extent" in the next revision. The second sentence will read:

"The preoperational tests of the turbine valves and bypass valves have been completed to the extent necessary to support integrated system testing."

DCD Impact:

DCD Tier 2, Subsection 14.2.8.1.55 will be revised as noted in the attached markup.

NRC RAI 14.2-53

Revise the DCD Tier 2, Revision 1, Section 14.2.8.1.59, to include testing of the overspeed trip system.

GE Response:

The following bullet will be added to DCD Tier 2, Subsection 14.2.8.1.59:

- Proper operation of the turbine overspeed protection system to provide mechanical overspeed trip and electrical backup overspeed trip as specified in Subsection 10.2.2.4 and the manufacturer's technical instruction manual. (During the preoperational test phase, simulated speed signals will be used for these tests.)

DCD Impact:

DCD Tier 2, Subsection 14.2.8.1.59 will be revised as noted in the attached markup.

NRC RAI 14.2-54

DCD Tier 2, Revision 1, Section 14.2.8.2.33, states that operation and testing of power conversions systems is discussed in Chapter 10. However, Chapter 10 testing descriptions, in general, are limited to pre-operational testing. Provide specific acceptance criteria for each of the power conversion systems and components, similar to the descriptions provided in Section 14.2.12.2.39, Level 2 acceptance criteria of the ABWR DCD to ensure all power conversion systems and components meet their design criteria.

GE Response:

The detailed test criteria, including the level of the criteria that defines the actions required if the test criteria is not met, will be provided in the Test Specifications that will be created for each plant. This is a COL Holder item to be submitted 60 days prior to use. However, for clarification the criteria section of Subsection 14.2.8.2.33 will be changed to read:

"Performance characteristics (such as pressures, flows, temperatures, voltage, amps) of the various systems in the power conversion systems and related subsystems will be monitored and the data obtained will be evaluated against the systems process flow diagrams or equivalent design basis information. Any deviations observed will be evaluated to determine the cause and significance of the deviation."

DCD Impact:

DCD Tier 2, Subsection 14.2.8.2.33 will be revised as noted in the attached markup.

NRC RAI 14.2-55

DCD Tier 2, Revision 1, Section 14.2.8.1.35: On page 14.2-34 of DCD Tier 2, the sixth bullet which states 'Verify that safety-related batteries are capable to support essential loads for a period of 24 or 72 hours;' does not accurately reflect the newly revised DCD for chapter 8 (i.e., the ESBWR design will only utilize Class 1E batteries with a 72-hour duty cycle). Justify the discrepancy.

GE Response:

DCD Tier 2, Subsection 14.2.8.1.35: On page 14.2-34 of DCD Tier 2, the sixth bullet will be revised to read:

- Verify that safety-related batteries have the capacity to support essential loads for a period of 72 hours;

DCD Impact:

DCD Tier 2, Subsection 14.2.8.1.35 will be revised as noted in the attached markup.

NRC RAI 14.2-57

DCD Tier 2, Revision 1, Section 14.2.8.1.36: Provide the system tests that demonstrate proper termination of power and control cables.

GE Response:

Per Regulatory Guide 1.68, Appendix A, construction and preliminary tests, including wiring continuity and separation checks, are performed prior to the start of preoperational testing. These tests will verify the proper termination of power and control and include point to point continuity, high pot, and fiber optic optical checks as applicable. Therefore, no change to Subsection 14.2.8.1.36 is needed to address demonstration that power and control cables are properly terminated.

DCD Impact:

No DCD changes will be made in response to this RAI.

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14.2 INITIAL PLANT TEST PROGRAM FOR FINAL SAFETY ANALYSIS REPORTS

14.2.1 Summary of Test Program and Objectives

The initial test program consists of a series of tests categorized as construction, preoperational, or initial startup tests. The construction acceptance tests determine correct installation and functional operability of equipment. Preoperational tests are those tests normally conducted prior to fuel loading to demonstrate the capability of plant systems to meet performance requirements. Initial startup tests begin with fuel loading and demonstrate the capability of the integrated plant to meet performance requirements.

The objectives of the initial test program are to:

- Ensure that the construction is complete and acceptable;
- Demonstrate the capability of structures, systems, and components to meet performance requirements;
- Effect fuel loading in a safe manner;
- Demonstrate, where practical, that the plant is capable of withstanding anticipated transients and postulated accidents;
- Evaluate and demonstrate, to the extent possible, plant operating procedures to provide assurance that the operating group is knowledgeable about the plant and procedures and fully prepared to operate the facility in a safe manner; and
- Bring the plant to rated capacity and sustained power operation.

14.2.1.1 Construction Test Objectives

Construction tests are performed to demonstrate that components and systems are correctly installed and operational. These tests include, but are not limited to, flushing and cleaning, hydrostatic testing, initial calibration of instrumentation, checks of electrical wiring and equipment, valve testing, and initial energization and operation of equipment and systems. Completion of this phase assures systems are ready for preoperational testing. Abstracts of these tests are not provided as part of this chapter.

14.2.1.2 Preoperational Test Objectives

Preoperational tests are conducted prior to fuel loading in order to verify that plant systems are capable of operating in a safe and efficient manner compatible with the system design bases. The general objectives of the preoperational test phase are as follows:

- Ensure design specification and test acceptance criteria are met;
- Provide documentation of the performance and safety of equipment and systems;
- Provide baseline test and operating data on equipment and systems for future reference;
- Run-in new equipment for a sufficient period so that any design, manufacturing, or installation defects can be detected and corrected;
- Ensure plant systems operate together on an integrated basis to the extent possible;

- Give maximum opportunity to the permanent plant operating staff to obtain practical experience in the operation and maintenance of equipment and systems;
- Establish and evaluate normal, abnormal, and emergency operating procedures to the extent possible;
- Establish and evaluate surveillance testing procedures; and
- Demonstrate that systems and safety equipment are operational and that it is possible to proceed to fuel loading and to the startup phase.

14.2.1.3 Startup Test Objectives

After the preoperational test phase has been completed, the startup phase begins with fuel loading and extends to commercial operation. This phase may be generally subdivided into the following four parts:

(1) Fuel loading and shutdown power level tests

(2) Testing during nuclear heatup to rated temperature and pressure (approximately 5% power);

(3) Power testing at low power, mid-power and high power; and

(4) Warranty demonstration.

The tests conducted during the startup phase consist of major and minor plant transients, steady-state tests, and process control system tests. These tests are directed towards demonstrating correct performance of the nuclear boiler and the various plant systems while at power.

The general objectives of the startup phase are to:

- Achieve an orderly and safe initial core loading;
- Accomplish testing and measurements necessary to assure the approach to initial criticality and subsequent power ascension is safe and orderly;
- Conduct low-power physics tests sufficient to ensure test acceptance criteria have been met;
- Conduct initial heatup and an orderly safe power ascension program, with requisite physics and systems testing, to ensure that integrated plant operation at power meets test acceptance criteria; and
- Conduct a successful warranty demonstration.

14.2.1.4 Organization and Staffing

Normal Plant Staff

Normal plant staff responsibilities, authorities, and qualifications are given in Chapter 13. During the construction cycle and the various testing phases, the plant owner/operator, GE Nuclear Energy (GE-NE), and others supply additional staff.

Startup Group

The startup group is an ad hoc organization created for the purpose of ensuring that the initial test program of preoperational and startup tests is conducted in an efficient, safe, and timely manner. The startup group is responsible for the planning, executing and documenting of the startup and testing related activities that occur between the completion of the construction phase and commencement of commercial operation of the plant. At approval to load fuel, the plant operations organization assumes complete responsibility for the plant. The licensed RO/SRO's have legal responsibility. The start-up organization will report to the operations department for testing support. At completion of the startup program, the startup group is dissolved and the normal plant operating staff assumes complete responsibility for the plant. Ideally, the startup group includes individuals assigned temporarily from the various departments and disciplines within the normal plant and utility organization. This assures maximum transfer and retention of experience and knowledge gained during the startup program for the subsequent commercial operation of the plant. The normal plant staff is included in as many aspects of the test programs as is practicable considering their normal duties in the operation and maintenance of the plant.

General Electric Company

GE-NE is the designer and supplier of the ESBWR power plant. During the construction and testing phases of the plant, GE-NE personnel are onsite to direct the work of the constructor and to offer consultation and technical direction. The GE-NE resident site manager is responsible for these activities , and is the official site spokesman for GE-NE. He coordinates with the combined operating license (COL) licensee's normal and augmented plant staff for the performance of his duties, which include:

- Reviewing and approving test procedures, changes to test procedures, and test results for equipment and systems within the plant;
- Providing technical direction to the station staff;
- Managing the activities of the GE-NE site personnel in providing technical direction to shift personnel in the testing and operation of the plant;
- Providing liaison between the site and the GE-NE home office to provide rapid and effective solutions for problems which cannot be solved onsite; and
- Participating as a member of the Startup Coordinating Group (SCG). [Note: The official designation of this group may differ for the plant owner/operator referencing the ESBWR design, and SCG is used throughout this discussion for illustrative purposes only.]

Others

Other concerned parties (outside the plant staff organization) such as the constructor, the turbine-generator supplier, and vendors of other systems and equipment, are involved in the testing program to various degrees. Such involvement may be in a direct role in the startup group as discussed above or in an indirect capacity offering consultation or technical direction concerning the testing, operation, or resolution of problems or concerns with equipment and systems for which they are responsible or are uniquely familiar with.

Interrelationships and Interfaces

Effective coordination between the various site organizations involved in the test program is achieved through the SCG, which is composed of representatives of the plant owner/operator, GE-NE, and others. The duties of the SCG are to review and approve project testing schedules and to effect timely changes to construction or testing in order to facilitate execution of the preoperational and initial startup test programs.

14.2.2 Test Procedures

In general, testing during the initial test program is conducted using detailed, step-by-step written procedures to control the conduct of each test. These specifically include safety precautions and limits as needed for the test to supplement those in the normal operating procedure. Such test procedures:

- specify testing prerequisites,
- describe desired initial conditions,
- include appropriate methods to direct and control test performance (including the sequencing of testing),
- specify acceptance criteria by which the test is to be evaluated, and
- provide for or specify the format by which data or observations are to be recorded.

The procedures are developed and reviewed by personnel with appropriate technical backgrounds and experience. This includes the participation of principal design organizations (including GE-NE) to establish test performance requirements and acceptance criteria. Specifically, GE-NE provides the COL licensee with scoping documents (i.e., plant preoperational and startup test specifications) containing testing objectives and acceptance criteria applicable to the plant design. Such documents shall also include, as appropriate, delineation of specific plant operational conditions at which tests are to be conducted, testing methodologies to be utilized, specific data to be collected, and acceptable data reduction techniques. Available information on operating and testing experiences of operating power reactors is factored into test procedures as appropriate. Test procedures are reviewed by the SCG and receive final approval by designated plant management personnel. Approved test procedures for satisfying the commitments of this chapter are made available approximately 60 days prior to their intended use for preoperational tests and 60 days prior to scheduled fuel loading for power ascension tests.

Conduct of Test Program

The startup group conducts the initial test program in accordance with the startup administrative manual. This manual contains the administrative procedures and requirements that govern the activities of the startup group and their interface with other organizations. The startup administrative manual receives the same level of review and approval, as do other plant administrative procedures. It defines the specific format and content of preoperational and startup test procedures, as well as the review and approval process for both initial procedures and subsequent revisions or changes. The startup administrative manual also specifies the process for review and approval of test results and for resolution of failures to meet acceptance criteria

and of other operational problems or design deficiencies noted. It describes the various phases of the initial test program and establishes the requirements for progressing from one phase to the next, as well as those for moving beyond selected holdpoints or milestones within a given phase. It also describes the controls in place that assure the as-tested status of each system is known and that track modifications, including retest requirements, deemed necessary for systems undergoing or already having completed specified testing. Additionally, the startup administrative manual delineates the qualifications and responsibilities of the different positions within the startup group. The startup administrative manual is intended to supplement normal plant administrative procedures by addressing those concerns that are unique to the startup program or that are best approached in a different manner. To avoid confusion, the startup program attempts to be consistent with normal plant procedure where practical. The plant staff typically performs their duties according to normal plant procedures. However, in areas of potential conflict with the goals of the startup program, the startup administrative manual or the individual test procedures address the required interface.

Review, Evaluation, and Approval of Test Results

Individual test results are evaluated and reviewed by members of the startup group. Test exceptions or acceptance criteria violations are communicated to the affected and responsible organizations who help resolve the issues by suggesting corrective actions, design modifications, and retests. GE-NE and others outside the plant staff organization, as appropriate, have the opportunity to review the results for conformance to predications and expectations. Test results, including final resolutions, are then reviewed and approved by designated startup group supervisory personnel. Final approval is obtained from the SCG and the appropriate level of plant management as defined in the startup administrative manual. The SCG and the designated level of plant management also have responsibility for final review and approval of overall test phase results and of that for selected milestones or hold-points within the test phases.

Test Records

Initial test program results are compiled and maintained according to the startup manual, plant administrative procedures, and applicable regulatory requirements. Test records that demonstrate the adequacy of safety-related components, systems and structures shall be retained for the life of the plant. Retention periods for other test records are based on consideration of their usefulness in documenting initial plant performance characteristics.

14.2.3 Test Program's Conformance with Regulatory Guides

The development of the initial test program uses NRC Regulatory Guides listed below (see compliance section 1.8):

- Regulatory Guide 1.68 — "Initial Test Programs for Water-Cooled Nuclear Power Plants;"
- Regulatory Guide 1.68.1 — "Preoperational and Initial Startup Testing of Feedwater and Condensate Systems for Boiling Water Reactor Power Plants;"
- Regulatory Guide 1.68.2 — "Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants;"

- Regulatory Guide 1.68.3 — "Preoperational Testing of Instrument and Control Air Systems;"
- Regulatory Guide 1.20 — "Comprehensive Vibration Assessment Program for Reactor Internals During Preoperation and Initial Startup Testing;"
- Regulatory Guide 1.41 — "Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments;"
- Regulatory Guide 1.56 — "Maintenance of Water Purity in Boiling Water Reactors;"
- Regulatory Guide 1.95 — "Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release," in accordance with SRP Section 14.2;
- Regulatory Guide 1.108 — "Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants" in accordance with SRP Section 14.2;
- Regulatory Guide 1.128 – "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants" in accordance with SRP Section 14.2;
- The application portion (shutdown cooling) of RG 1.139, "Guidance for Residual Heat Removal," in accordance with SRP Section 14.2;
- Regulatory Guide 1.140 — "Design, Testing and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light Water Cooled Nuclear Power Plants."

14.2.4 Utilization of Reactor Operating and Testing Experience in the Development of Test Program

Because every reactor/plant in a GE-NE BWR product line is an evolutionary development of the previous plant in the product line (and each product line is an evolutionary development from the previous product line), it is evident that the ESBWR plants have the benefits of experience acquired with the successful and safe startup of more than 30 previous BWR and ABWR plants. The operational experience and knowledge gained from these plants and other reactor types have been factored into the design and test specifications of ESBWR systems and equipments that are demonstrated during the preoperational and startup test programs. Additionally, reactor operating and testing experience of similar nuclear power plants obtained from NRC Licensee Event Reports, Institute of Nuclear Operations (INPO) correspondence, and through other industry sources are utilized to the extent practicable in developing and carrying out the initial test program.

14.2.5 Use of Plant Operating and Emergency Procedures

To the extent practicable throughout the preoperational and initial startup test program, test procedures utilize operating, surveillance, emergency, and abnormal procedures where applicable in the performance of tests. The use of these procedures is intended to do the following:

- Prove the specific procedure or illustrate changes which may be required;
- Provide training of plant personnel in the use of these procedures; and

- Increase the level of knowledge of plant personnel on the systems being tested.

A testing procedure may use a combination of references to operating, emergency, or abnormal procedure or repeat a series of steps from the procedure in order to accomplish the above goals while efficiently performing the specified testing.

14.2.6 Initial Fuel Loading and Initial Criticality

Fuel loading and initial criticality are conducted in a controlled manner in accordance with specific written procedures as part of the startup test phase (Subsection 14.2.8.2). However, unforeseen circumstances may arise that would prevent the completion of the preoperational testing (including the review and approval of the test results), but that would not necessarily justify the delay of fuel loading. Under such circumstances, the COL licensee may decide to request permission from the NRC to proceed with fuel loading. If portions of any preoperational tests are intended to be conducted, or their results approved, after commencement of fuel loading, then the following shall be documented in such a request:

- List each test;
- State which portions of each test are delayed until after fuel loading;
- Provide technical justification for delaying these portions; and
- State when each test would be completed and the results approved.

Pre-Fuel Load Checks

Once the plant has been declared ready to load fuel, a number of specific checks shall be made prior to proceeding, including a final review of the preoperational test results and the status of any design changes, work packages, and/or retests that were initiated as a result of exceptions noted during this phase. Also, the Technical Specifications surveillance program requirements (Chapter 16) shall be instituted at this time to ensure the operability of systems required for fuel loading. Just prior to the initiation of fuel loading, proper vessel water level and chemistry shall be verified and the calibration and response of nuclear instruments shall be checked.

Initial Fuel Loading

Fuel loading requires the movement of the full core complement of assemblies from the fuel pool to the core, with each assembly being identified by serial number before being placed in the correct coordinate position. The fuel loading procedure ensures safe loading increments by specifying the predetermined intervals to check the shutdown margin and subcriticality. In-vessel neutron monitors provide continuous indication of the core flux level as each assembly is added. A complete check is made of the fully loaded core to ascertain that the assemblies are properly installed, correctly oriented, and occupying their designated positions.

Pre-Criticality Testing

Prior to initial criticality, the shutdown margin shall be verified for the fully loaded core. The control rods shall be function and scram tested with the fuel in place. Additionally, a final verification that the required Technical Specification surveillances have been performed shall be made.

Initial Criticality

During initial criticality, the full core shutdown margin shall be verified as specified in Subsection 14.2.8.2.4. Initial criticality shall be achieved in an orderly, controlled fashion following specific detailed procedures in a prescribed rod withdrawal sequence that has been approved by the plant management. Core neutron flux shall be continuously monitored during the approach to critical and the rod pattern at critical is compared to prediction to allow early detection and evaluation of potential anomalies.

14.2.7 Test Program Schedule and Sequence

The schedule, relative to the initial fuel load date, for conducting each major phase of the initial test program is provided by the COL licensee. This includes the timetable for generation, review, and approval of procedures, as well as the actual testing and analysis of results. As a minimum, at least nine months should be allowed for conducting the preoperational phase prior to the fuel loading date, and at least three months should be allowed for conducting the startup and power ascension testing that commences with fuel loading. To allow for NRC review, test procedure preparation are scheduled such that approved procedures are available approximately 60 days prior to their intended use or 60 days prior to fuel load for power ascension test procedures. Although there is considerable flexibility available in the sequencing of testing within a given phase, there is also a basic order that results in the most efficient schedule.

The design of the ESBWR utilizes a Distributed Control & Information System (DCIS) for instrumentation and control systems. Thus, the DCIS must be functional before many pre-op tests can begin. The DCIS Pre-Op Test (see Subsection 14.2.8.1.7) can begin early and would control scheduling for other tests until they are completed. During the preoperational phase, testing should be performed as system turnover from construction allows. However, the interdependence of systems should also be considered so that common support systems, such as electrical power distribution, DCIS, service and instrument air, and the various makeup water and cooling water systems, are tested as early as possible.

Sequencing of testing during the startup phase depends primarily on specified power conditions and intersystem prerequisites. To the extent practicable, the schedule should establish that, prior to exceeding 25% power, the test requirements are met for those plant structures, systems, and components that are relied on to prevent, limit, or mitigate the consequences of postulated accidents.

Power ascension testing is conducted in essentially three phases:

(1) Initial fuel loading and open vessel testing;

(2) Testing during nuclear heatup to rated temperature and pressure (less than 5% power); and

(3) Power operation testing from 5% to 100% rated power.

The power operation testing plateaus shall consist of low power testing at less than 25% power, mid-power testing up to about 75% power, and high power testing up to rated power. Thus, there are a total of five different testing plateaus designated, Table 14.2-1 indicates in which testing plateaus the various power ascension tests are performed. Although the order of testing within a given plateau is somewhat flexible, the normal recommended sequence of tests would be:

(1) Core performance analysis;

(2) Steady-state tests;

(3) Control system tuning;

(4) System transient tests; and

(5) Major plant transients (including trips).

For a given testing plateau, testing at lower power levels should generally be performed prior to that at higher power levels.

The detailed testing schedule is generated by GE and the COL licensee and is made available to the NRC prior to actual implementation. The schedule may be updated and continually optimized to reflect actual progress and subsequent revised projections.

14.2.8 Individual Test Descriptions

14.2.8.1 Preoperational Test Procedures

The following general descriptions relate the objectives of each preoperational test. During the final construction phase, it may be necessary to modify the preoperational test methods as operating and preoperational test procedures are developed. Consequently, methods in the following descriptions are general, not specific.

Specific testing to be performed and the applicable acceptance criteria for each preoperational test is documented in test procedures to be made available to the NRC approximately 60 days prior to their intended use. Preoperational tests are in accordance with the system specifications and associated equipment specifications for equipment in those systems provided as part of scoping documents to be supplied by GE-NE and others as described in Subsection 14.2.2. The tests demonstrate that the installed equipment and systems perform within the limits of these specifications. To insure the tests are conducted in accordance with established methods and appropriate acceptance criteria, the plant and system preoperational test specifications will also be made available to the NRC.

The preoperational tests anticipated for the ESBWR are described in the following paragraphs. Testing of systems outside the scope of the standard ESBWR design, but which may have related design (and therefore testing) requirements, are discussed in Subsection 14.2.9, along with other information related to the initial test program. Tests and systems that are not applicable to the ESBWR standard design are:

- Electrical switchyard and equipment;
- The site security plan;
- Personnel monitors and radiation survey instruments; and
- The automatic dispatcher control system.

14.2.8.1.1 Nuclear Boiler System Preoperational Test

Purpose

To verify that the valves, actuators, instrumentation, trip logic, alarms, annunciators, and indications associated with the Nuclear Boiler System (NBS) function as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The reactor pressure vessel (RPV) and main steam lines (MSL) can accept water during the test. The nitrogen gas and instrument air are available to support operation of MS valves. Electrical power is available to support main steam (MS) valves, instrumentation, and system operation. To the extent necessary, the interfacing systems are available to support the specific system testing and the appropriate system configurations.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Verification that the sensing devices respond to actual process variables and provide alarms and trips at specified values;
- Proper operation of system instrumentation and any associated logic, including that of the automatic depressurization system (ADS);
- Proper operation of MSIVs and main steamline drain valves, including verification of closure time in the isolation mode;
- Verification of SRV and MSIV accumulator capacity;
- Proper operation of SRV air piston actuators and discharge line vacuum breakers;
- Verification of the acceptable leak tightness and overall integrity of the reactor coolant pressure boundary via the leakage rate and/or hydrostatic testing as described in Section 5.2.
- Proper operation of Depressurization Valves (DPV) and SRV

Other checks shall be performed, as appropriate, to demonstrate that design requirements, such as those for sizing or installation, are met via as-built calculations, visual inspections, review of qualification documentation or other methods. For instance, SRV setpoints and capacities shall be verified from certification or bench tests consistent with applicable requirements.

14.2.8.1.2 Feedwater Control System Preoperational Test

Purpose

This test is to verify proper operation of the Feedwater Control System (FWCS) and meet design requirements..

Prerequisites

The construction tests have been successfully completed, and the Condensate and Feedwater System preoperational test (Subsection 14.2.8.1.44) has been completed. The RWCU/SDC System and Feedwater System low flow control valve are available to support FWCS testing at low power. The SCG has reviewed the test procedures and approved the initiation of testing. FWCS components shall have an initial calibration in accordance with vendor instructions. Required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations.

General Test Methods and Acceptance Criteria

Testing of the FWCS during the preoperational phase may be limited by the absence of an acceptable feedwater recirculation flow path. Comprehensive flow testing is conducted during the startup phase.

Performance shall be observed and recorded during a series of individual component and overall system response tests to demonstrate the following:

- Proper operation of instrumentation and controls in the required combinations of logic and instrument channel trips, including verification of setpoints;
- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Proper operation of system valves, including timing and stroke, in response to control demands (including RWCU/SDC dump valve response to the low flow controller);
- Proper operation of interlocks and equipment protective devices within the FWCS;
- Verification of loss of feedwater heating signal to initiate Selected Control Rod Run-In (SCRRI);
- Verification of feedwater level control level setdown logic on reactor low water level (Level 3) signal;
- Verification of feedwater runback on reactor high level (Level 8) signal;
- Verification of feedwater runback on Anticipated Transient Without Scram (ATWS) trip signal; and
- Proper communication and interface with other control systems and related equipment.
- Proper overall response of the control system including the final control element. This will include control system response to simulated control system malfunctions and simulated plant transients at full flow including MSIV closure and Turbine Trip without bypass capability. (Control system response will be verified, and mechanical / electrical component responses will be tested to the extent possible under preoperational test conditions.)

14.2.8.1.3 Standby Liquid Control System Preoperational Test

Purpose

To verify that the operation of the Standby Liquid Control (SLC) system, including accumulator, tanks, control, logic, and instrumentation, is as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The reactor vessel shall be available for injecting demineralized water. Required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in the required combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper operation of the nitrogen pressurization system;
- Proper system flow paths and discharge (with demineralized water substituted for the neutron absorber mixture);
- Proper operation of interlocks and equipment protective devices in valve controls; and
- Proper operation of the squib type injection valves.

Note: Proper volume and concentration of the neutron absorber solution (refer to Subsection 9.3.5) will be surveilled prior to entry in the Technical Specification mode in which the SLC system is required to be operable.

14.2.8.1.4 Control Rod Drive System Preoperational Test

Purpose

To verify that the Control Rod Drive (CRD) System, including the CRD hydraulic and fine motion control rod subsystems, functions as designed.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The control blades and temporary guides in the RPV shall be installed and the FMCRDs are ready to be stroked and scrammed. Reactor component cooling water, instrument air, and other required interfacing systems shall be available, as needed, to support the specified testing and the corresponding system configurations.

Additionally, the Rod Control and Information System (RC&IS) shall be functional when needed, with the applicable portion of its specified preoperational testing complete.

General Test Methods and Acceptance Criteria

The CRD pumps take suction from the condensate system (preferred source) or the condensate storage tank (backup). This test must include testing both sources and the transfer between sources. Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper functioning of instrumentation and alarms used to monitor system operation and status, including control room video panels designed to display CRD positions, etc.;
- Proper communication with, and response to demands from, the RC&IS and the Reactor Protection System, including that associated with Alternate Rod Insertion (ARI), alternate rod run-in (post-scram), and select control rod run-in functions;
- Proper functioning of system valves, including purge water pressure control valves, under expected operating conditions;
- Proper operation of CRD pumps and motors in all design operating modes;
- Proper operation of CRD makeup to reactor pressure vessel on reactor low level signal;
- Acceptable pump NPSH under the most limiting design flow conditions;
- Proper pump motor start sequence and margin to actuation of protective devices;
- Proper system flow paths and flow rates, including sufficient pump capacity and discharge head;
- Proper operation of interlocks and equipment protective devices in pump, motor, and valve controls;
- Verification of charging water low pressure input to reactor protection system;
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady-state operation;
- Proper operation of fine motion motors and drives and associated control units, including verification of acceptable normal insert and withdraw timing; and
- Proper operation of hydraulic control units and associated valves, including CRD scram timing demonstrations against atmospheric pressure.

14.2.8.1.5 Rod Control and Information System Preoperational Test

Purpose

To verify that the RC&IS functions as designed.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. All electrical connections for rod position

indication and RC&IS have been completed. All RC&IS cabinet power is available and system power supplies calibrated.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of tests to demonstrate the following:

- Proper operation of rod blocks and associated alarms and annunciators in all combinations of logic and instrument channel trip, including all positions of the reactor mode switch;
- Proper system response to control rod run-in logic, including that associated with Alternate Rod Insertion (ARI), Selected Control Rod Run-In (SCRRI) and normal post-SCRAM follow;
- Proper functioning of instrumentation used to monitor fine motion control rod drive (FMCRD) subsystem status such as rod position indication instrumentation and that used to monitor rod/drive separation status;
- Proper operation of RC&IS software including verification of gang and group assignments and Automatic Thermal Limit Monitors (ATLM), Rod Worth Minimizer (RWM) and automatic rod selection and movement functions; and
- Proper communication with plant automation system.

14.2.8.1.6 Safety System Logic and Control Preoperational Test

Purpose

This test is to verify proper operation of the Safety System Logic and Control (SSLC).

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedures and approved the initiation of testing. The required AC and DC electrical power sources shall be operational and the appropriate interfacing systems shall be available as required to support the specified testing.

General Test Methods and Acceptance Criteria

The testing consists of the following:

- Verify the self-test portion of the SSLC, including the proper reporting of all detected failures.
- Verify the non-interaction of the SSLC self-test system to confirm that the self-test system does not cause a false indication.
- Verify the correct activation of the inputs to the SSLC such as pushbutton switches, control operating switches, key-operated switches and analog inputs.
- Verify the local indication devices on the SSLC properly indicate the correct status.
- Verify the proper interface with diverse protection system.

14.2.8.1.7 DCIS System Preoperational Test

Purpose

To verify proper functioning of the plant Distributed Control and Information System (DCIS), including both essential and nonessential subsystems.

Prerequisites

Construction tests have been successfully completed and the SCG has reviewed the test procedures and approved the initiation of testing. The required AC and DC electrical power sources shall be operational and the appropriate interfacing systems shall be available as required to support the specified testing. Interfacing systems shall be tested and operational. Fiber optic cables have been connected.

General Test Methods and Acceptance Criteria

The testing consists of the following:

- Verify the ability to communicate to each nonessential and each essential system. Confirm proper addressing of the nonessential and essential multiplexing networks. Confirm that multiple devices do not answer to or transmit the same address;
- Verify the ability to transmit and receive data from interfacing systems within specified response times and data rate requirements;
- Verify the ability to receive error messages from interfacing systems;
- Verify the synchronization of time signals;
- Verify the multiplexing system failure recovery capabilities;
- Verify the ability of the communications software to identify and locate a problem on the network; and
- Proper Performance Monitoring and Control subsystem function and interfaces to Technical Support Center.

14.2.8.1.8 Leak Detection and Isolation System Preoperational Test

Purpose

This test is to verify proper response and operation of the Leak Detection and Isolation System (LD&IS) logic.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedures and approved the initiation of testing. The required AC and DC electrical power sources shall be operational and the appropriate interfacing systems shall be available as required to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and controls in all combinations of logic and instrument channel trip;
- Proper functioning of indications, annunciators, and alarms used to monitor system operation and status;
- Proper operation of leakoff and drainage measurement functions such as those associated with the reactor vessel head flange and drywell cooler condensate;
- Proper interface with related systems in regard to the input and output of leak detection indications and isolation initiation commands; and
- Proper operation of bypass switches and related logic.

14.2.8.1.9 Reactor Protection System Preoperational Test

Purpose

To verify proper operation of the Reactor Protection System (RPS), including complete channel logic and response time.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedures and approved the initiation of testing. The Control Rod Drive System, Instrument Air System, and the required AC and DC electrical power sources are operational. The other required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and controls in all combinations of logic and instrument channel trip, including those associated with all positions of the reactor mode switch;
- Proper functioning of instrumentation and alarms used to monitor sensor and channel operation and availability;
- Proper calibration of primary sensors;
- Proper operation of bypass switches, including related logic;
- Proper operation of permissive and prohibit interlocks;
- Proper function of the interface to diverse displays and controls;
- Proper system operation while powered from primary and alternate sources, including transfers, and in degraded modes for which the system is expected to remain operational; and
- Acceptability of instrument channel response times, as measured from each applicable process variable (except for neutron sensors and suppression pool temperature sensors) to the deenergization of the scram pilot valve solenoids.

- Final functional testing of proper trip points, logic, operability of scram breakers and valves, and operability of manual scram functions will be conducted during or following initial fuel loading.

14.2.8.1.10 Neutron Monitoring System Preoperational Test

Purpose

To verify the proper operation of the Neutron Monitoring System (NMS), including the startup range neutron monitor, power range neutron monitor, and automated fixed incore probe subsystems and related hardware and software.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. All Startup Range Neutron Monitor (SRNM) subsystem components and Power Range Neutron Monitor (PRNM) subsystem components have been calibrated per vendor instructions. Additionally, required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip, including rod block and scram signals;
- Proper functioning of instrumentation, displays, alarms, and annunciators used to monitor system operation and status;
- Proper operation of detectors and associated cabling, preamplifiers, and power supplies;
- Proper operation of interlocks and equipment protective devices;
- Proper operation of permissive, prohibit, and bypass functions;
- Proper system operation while powered from primary and alternate sources, including transfers, and in degraded modes for which the system is expected to remain operational;
- Proper operation of system and subsystem self-test diagnostic and calibration functions; and
- The ability to communicate and interface between appropriate plant systems and NMS subsystems.

14.2.8.1.11 Plant Automation System Preoperational Test

Purpose

This test is to verify the proper operation of the Plant Automation System (PAS) including the Power Generation Control Subsystem (PGCS) and their related functions.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The PGCS, RC&IS, Turbine Control System, and other required system interfaces shall be available to support the specific system testing. The required input and output devices and various system interfaces shall be connected and available, as needed, for supporting the specified testing configurations.

General Test Methods and Acceptance Criteria

Proper performance of system hardware and software is verified by a series of individual and integral tests that include the following demonstrations:

- Proper connection and calibration of all input signals;
- Proper operation of data logging and transient data recording features, including verification of data rate requirements;
- Verification of computer printouts;
- Verification of operability of control room video display units which are driven by the PAS;
- Proper communication and interface with other plant equipment, computers and control systems; verify that output signals (analog and digital) are correct; and
- Proper operation of operator guidance and prompting functions, including alarms and status messages, in all operating modes for plant startup, shutdown and power maneuvering iterations.

Much of the testing performed during the preoperational phase is done utilizing simulated conditions and inputs via system hardware and software. Final system performance during actual plant conditions is evaluated during the startup phase.

14.2.8.1.12 Remote Shutdown System Preoperational Test

Purpose

Verify the feasibility and operability of intended remote shutdown functions from the remote shutdown panel and other local and remote locations outside the main control room, which are utilized during a safe shutdown from outside the main control room.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Additionally, control power shall be supplied to the remote shutdown panel and the required system and component interfaces shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

The Remote Shutdown System (RSS) consists of the control and instrumentation available at the dedicated remote shutdown panel(s) and other local and remote locations intended to be used during a safe shutdown from outside the control room.

Much of the specified testing can be accomplished in conjunction with, or as part of, the individual system and component preoperational testing. However, the successful results of such testing shall be documented as part of this test, as applicable. Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper functioning of the control and instrumentation associated with the RSS;
- Proper operation of pumps and valves, including establishment of system flow paths using RSS control;
- Proper functioning of RSS transfer switches, including verification of proper override of main control room functions and proper indication in the MCR that these functions have been overridden;
- Proper operation of prohibit and permissive interlocks and bypass functions after transfer of control;
- Proper system operation while powered from primary and alternate electrical sources; and
- The ability to establish and maintain communication among personnel performing the remote shutdown operation.

14.2.8.1.13 Reactor Water Cleanup/Shutdown Cooling System Preoperational Test

The RWCU/SDC system provides both the reactor water cleanup function and the shutdown cooling function.

Purpose

To verify that the operation of the reactor water cleanup and shutdown cooling subsystem, including pumps, valves, heat exchangers and demineralizer equipment, is as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Resin material for filter demineralizers shall be available. Reactor component cooling water, instrument air, CRD purge supply, and other required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and controls in all combinations of logic and instrument channel trip, including those associated with the Leak Detection and Isolation System;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;

- Proper operation of system valves, including timing, under expected operating conditions;
- Proper operation of pumps and motors in all design operating modes;
- Acceptable pump NPSH under the most limiting design flow conditions; this is repeated during startup tests with the reactor hot;
- Proper system flow paths and flow rates, including pump capacity and discharge head;
- Proper pump motor start sequence and margin to actuation of protective devices;
- Proper operation of interlocks and equipment protective devices in pump and valve controls;
- Proper switch over of the RWCU and SDC mode of operation;
- Acceptability of pump/motor vibration levels at all pump speeds and system piping movements during both transient and steady-state operation;
- Proper operation of the RWCU demineralizers and associated support facilities; and
- Proper operation of heatup function.

14.2.8.1.14 Fuel and Auxiliary Pools Cooling System Preoperational Test

Purpose

To verify that the operation of the Fuel and Auxiliary Pools Cooling System (FAPCS), including the pumps, heat exchangers, controls, valves, and instrumentation, is as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip, including isolation and bypass of the non-safety-related fuel pool cleanup filter/demineralizers;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability, including those associated with pool water level;
- Proper operation of system valves, including timing, under expected operating conditions;
- Verification that drywell spray nozzles, headers and piping are free of debris;
- Proper operation of pumps and motors in all design operating modes;

- Acceptable pump NPSH under the most limiting design flow conditions; verify NPSH acceptability when cooling IC pool after testing ICs during startup testing;
- Proper system flow paths and flow rates, including pump capacity and discharge head;
- Proper water levels are maintained in GDCS pools when the system is operating in the GDCS cooling and cleanup mode;
- Proper pump motor start sequence and margin to actuation of protective devices;
- Proper operation of interlocks and equipment protective devices in pump, motor, and valve controls;
- Proper operation of permissive, prohibit, and bypass functions;
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady-state operation;
- Proper functioning of pool anti-siphon devices and acceptable leakage from pool drains, sectionalizing devices, and gaskets or bellows;
- Proper operation of filter/demineralizer units and their associated support facilities; and
- Smooth transfer from one pool to another and acceptable transfer time.

14.2.8.1.15 Process Sampling System Preoperational Test

Purpose

To verify the proper operation and the accuracy of equipment and techniques to be used for on-line and periodic sampling and analysis of overall plant water systems as well as that of individual plant process streams.

Prerequisites

Construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Adequate laboratory facilities and appropriate analytical procedures shall be in place. The systems are available to provide required flow to associated sample panel. Instrument air, and closed cooling water are available to support testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of tests to demonstrate the following:

- Proper calibration of on-line sampling and monitoring equipment, indication and alarm/functions;
- Proper operation of the sample coolers;
- Capability of obtaining grab samples of designated process streams at the desired locations;
- Proper functioning of personnel protective devices at local sampling stations; and
- Adequacy and accuracy of sample analysis methods.

14.2.8.1.16 Process Radiation Monitoring System Preoperational Test

Purpose

To verify the ability of the Process Radiation Monitoring System (PRMS) to indicate and alarm normal and abnormal radiation levels, and to initiate, if appropriate, isolation functions upon detection of high radiation levels in any of the process streams that are monitored.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The various process radiation monitoring subsystems, including the sensors, the digital radiation monitors and associated sampling racks have been calibrated according to instructions. The required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

The PRMS consists of a number of subsystems that monitor various liquid and gaseous process streams, building and area ventilation exhausts, and plant and process effluents. The offgas system and the main steamlines are also monitored.

Performance shall be observed and recorded during a series of individual component and integrated subsystem tests to demonstrate the following:

- Proper calibration of detector assemblies and associated equipment using a standard radiation source or portable calibration unit;
- Proper functioning of radiation monitors and alarms;
- Proper system trips in response to high radiation and downscale/inoperative conditions;
- Proper operation of the isolation functions; and
- Proper operation of the sampling functions.

14.2.8.1.17 Area Radiation Monitoring System Preoperational Test

Purpose

To verify the ability of the Area Radiation Monitoring (ARM) System to indicate and alarm normal and abnormal general area radiation levels throughout the plant.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Sensors and digital radiation monitors have been calibrated according to vendor instructions.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of channel tests to demonstrate the following:

- Proper calibration of detector assemblies and associated equipment using a standard radiation source or portable calibration unit;

- Proper functioning of sensors, monitors, displays, and alarms; and
- Proper system trips in response to high radiation and downscale/inoperative conditions.

14.2.8.1.18 Containment Monitoring System Preoperational Test

Purpose

To verify the ability of the Containment Monitoring System to monitor oxygen, hydrogen, and gross gamma radiation levels in the wetwell and drywell airspace regions of the primary containment and to verify the proper operation of the other functions of the system including drywell-wetwell differential pressure monitoring, suppression pool water level and temperature monitoring, drywell (post LOCA) pool level monitoring and post-accident sampling.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Initial system installation and setup has been accomplished per instructions. The required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations.

General Test Methods and Acceptance Criteria

The Containment Monitoring System consists of radiation, oxygen and hydrogen, suppression pool water level and temperature, drywell-wetwell differential pressure monitoring and post accident sampling subsystems. Performance of each of these subsystems shall be observed and recorded during a series of individual subsystem tests to demonstrate the following:

- Proper calibration of detector assemblies and associated equipment using the standard source or portable calibration unit and gas calibration sources;
- Proper functioning of indications, sampling racks, displays, and alarms including those monitoring system availability;
- Proper system trips in response to high setpoint and downscale/inoperative conditions;
- Proper initiation and operation of detection and sampling functions, including pump start and valve sequencing, if appropriate, in response to a LOCA signal;
- Proper operation of calibration gas supply systems and self-calibration functions;
- Proper operation of the suppression pool temperature to provide signals to initiate scram on high temperature;
- Proper operation of the suppression pool temperature to initiate the shutdown cooling on high temperature; and
- Proper operation of post accident sampling valves.

14.2.8.1.19 Instrument Air and Service Air Systems Preoperational Tests

Purpose

To verify the ability of the Instrument Air System and Service Air Systems (IAS and SAS) to provide the design quantities of clean dry compressed air to user systems and components.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Electrical power, the supplied system and components loads, and component closed cooling water system to provide cooling to the compressor units are available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

The IAS and the SAS are specified as separate systems. However, the preoperational test requirements are essentially the same because they are so closely related.

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of compressors and motors in all design operating modes;
- Ability of compressor(s) to maintain receiver at specified pressure(s) and to recharge within specified time under design loading conditions;
- Proper system flow paths and acceptable flow rates to individual loads at specified air temperatures and pressures under design loading conditions, including a determination that the total air demand at steady-state conditions, including leakage for the system, is in accordance with design;
- Proper operation of interlocks and equipment protective devices in compressor and valve controls;
- Acceptability of compressor/motor vibration levels and system piping movements during both transient and steady-state operation;
- Ability of the air to meet end user cleanliness requirements with respect to oil, water, and particulate matter content;
- Continued operability of supplied loads in response to credible failures that result in an increase in the supply system pressure; and
- Ability of the SAS to act as backup to the IAS.
- Separate from the integrated system Instrument and Service Air Preoperational tests, individual components will be tested for proper "failure" (open, close, or as is) to both instantaneous (pipe break) and slow (plugging or freezing) simulated air losses;

14.2.8.1.20 High Pressure Nitrogen Supply System Preoperational Test

Purpose

To verify the ability of the High Pressure Nitrogen Supply System (HPNSS) to furnish compressed nitrogen to user systems at design quantity and quality.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. User system loads and other required system interfaces shall be available, as needed, to support the specified system testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper system flow paths and acceptable flow rates to individual loads at specified temperatures and pressures under design loading conditions;
- The ability of the nitrogen gas to meet end use cleanliness requirements with respect to oil, water, and particulate matter content;
- Proper "failure" (open, close, or as is) of supplied components to both instantaneous (pipe break) and slow (plugging or freezing) simulated nitrogen gas supply losses; and
- Proper switch over nitrogen supply to bottled nitrogen on low pressure.

14.2.8.1.21 Reactor Component Cooling Water System Preoperational Test

Purpose

To verify proper operation of the Reactor Component Cooling Water System (RCCWS) including its ability to supply design quantities of cooling water, at the specified temperatures, to assigned loads, as appropriate, during normal, abnormal, and accident conditions.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Electrical power, plant service water, instrument air, and other required supporting systems shall be available, as needed, for the specified testing configurations. The cooled components shall be operational and operating to the extent possible during heat exchanger performance evaluation.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;

- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper operation of pumps and motors in all design operating modes;
- Acceptable pump NPSH under the most limiting design flow conditions;
- Proper system and component flow paths, flow rates, and pressure drops, including pump capacity and discharge head;
- Proper operation of interlocks and equipment protective devices in pump and valve controls;
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady-state operation;
- Proper operation of system surge tanks and chemical addition tanks and their associated functions; and
- Acceptable performance of heat exchangers, to the extent practical.

Because of insufficient heat loads during the preoperational phase, the final system flow balancing and heat exchanger performance evaluation is performed during the startup phase.

14.2.8.1.22 Makeup Water System Preoperational Test

Purpose

To verify the ability of the Makeup Water System (MWS) to supply the designated plant systems with design quantity and quality for each system.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Final interconnection with the supplied systems is complete and those systems are ready to accept transfer of design quantities of makeup water.

General Test Methods and Acceptance Criteria

System performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic;
- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Proper operation of pumps, motors, and valves under expected operating conditions;
- Proper functioning of interlocks and equipment protective devices in pump, motor, and valve controls;
- The adequacy of system flow paths and flow rates, including pump and tank capacities;

- Proper functioning of water treatment facilities and equipment;
- Proper functioning of freeze protection methods and devices, if applicable; and
- Acceptability of pumps and motor vibration levels and system piping movements during both transient and steady state operations.

14.2.8.1.23 Hot Water System Preoperational Test

Purpose

Verify the ability of the Hot Water System (HWS) to provide hot water to the appropriate HVAC systems in order to maintain the specified design temperatures within the various building rooms and areas.

Prerequisites

The construction tests have been completed and the SCG has reviewed the test procedure and approved the initiation of testing. Electrical power, the appropriate heating source(s), and the various HVAC systems heating coils shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation;
- Proper operation of system valves under expected operating conditions;
- Proper operation of pumps and motors in all design operating modes;
- Proper system flow paths and flow rates, including pump capacity and discharge head; and
- Proper operation of interlocks and equipment protective devices in pump, motor and valve controls.

14.2.8.1.24 Chilled Water System Preoperational Test

The Chilled Water System serves the HVAC for Reactor Building, Control Building, Turbine Building, Fuel Building, Radwaste Building, Electrical Building and Drywell Coolers.

Purpose

To verify the ability of the chilled water system to supply the design quantities of chilled water at the specified temperatures to the various cooling coils of the HVAC systems serving rooms and areas require conditioned air.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Electrical power, reactor building and turbine

building closed cooling water systems, the applicable HVAC system cooling coils, and other required system interfaces shall be available, as needed, to support the specified system testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including isolation functions, under expected operating conditions;
- Proper operation of pumps and motors in all design operating modes;
- Proper system flow paths and flow rates to all supplied loads, including pump capacity and discharge head;
- Chiller heat removal capacity with inlet and outlet temperatures and flow data;
- Proper operation of interlocks and equipment protective devices in pump and valve controls;
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady-state operation; and
- Proper functioning of system surge tank and chemical addition features.

14.2.8.1.25 Heating, Ventilation, and Air Conditioning Systems Preoperational Test

There are several Heating, Ventilation and Air Conditioning (HVAC) Systems in the plant, including those serving the following:

- Control Building
- Fuel Building
- Turbine Building
- Reactor Building
- Electrical Building
- Radwaste Building

These systems and the dedicated systems for drywell and main control room will be tested, the preoperational tests will probably be conducted in multiple separate tests.

Purpose

To verify the ability of the various HVAC systems to establish and maintain the specified environment, with regards to temperature, pressure, and airborne particulate level, in the applicable rooms, areas, and buildings throughout the plant, supporting equipment and systems.

Prerequisites

The construction tests, including initial flow balancing, have been successfully completed and the SCG has reviewed the test procedure(s) and approved the initiation of testing. Additionally, the normal and backup electrical power sources, the applicable heating, cooling, and chilled water systems, and any other required system interfaces shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Because the various HVAC systems are similar in design of equipment and function, they are subject to the same basic testing requirements.

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves and dampers, including isolation functions, under expected operating conditions;
- Proper operation of fans and motors in all design operating modes;
- Proper system flow paths and flow rates, including individual component and total system capacities and overall system flow balancing;
- Proper operation of interlocks and equipment protective devices;
- Proper system operation while powered from primary and alternate sources, including transfers, and in degraded modes for which the system is expected to remain operational;
- The ability to maintain the specified positive or negative pressure(s) in the designated rooms and areas and to direct local and total air flow, including any potential leakage, relative to the anticipated contamination levels;
- The ability of exhaust, supply, and recirculation filter units to maintain the specified dust and contamination free environment(s);
- The ability of the control room habitability function to detect the presence of airborne radioactive material, smoke and/or toxic gas and to remove or prevent in-leakage of such;
- Proper operation of HEPA filters and charcoal adsorber sections, if applicable, including relative to the in-place testing requirements of Regulatory Guide 1.140 regarding visual inspections and airflow distribution, DOP penetration and bypass leakage testing;
- The ability of the heating and cooling coils to maintain the specified thermal environment(s) while considering the heat loads present during the preoperational test phase; and
- The ability of HVAC systems to provide sufficient purge, exhaust, and recirculation flows in support of drywell inerting and deinerting operations.

It is not possible to fully evaluate the cooling and heating coil performance of the HVAC during the preoperational phase because of limited heat source. The final system evaluation will be performed in the startup test.

14.2.8.1.26 Containment Inerting System Preoperational Test

Purpose

To verify the ability of the Containment Inerting System (CIS) to establish and maintain the specified inert atmosphere in the primary containment during all expected plant conditions.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The primary containment is intact, the drywell coolers and RB HVAC systems are operational, and the steam evaporator and electric heater in the nitrogen supply are available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper nitrogen/air flow paths and flow rates both into and out of the primary containment;
- Proper operation of interlocks and equipment protective devices; and
- Ability to inert and de-inert containment atmosphere conditions within the designated interval.

14.2.8.1.27 Containment Isolation Valve Leakage Rate Tests

Purpose

The objective of this test is to verify that the leakage rate through each containment isolation valve meets the limit specified in the Containment Leakage Rate Testing Program.

Prerequisites

Required test instrumentation, e.g., pressure and temperature sensors, flowmeters and stopwatch, is installed, calibrated and functionally tested. Each containment isolation valve to be tested is operable. Each valve is closed by normal operation and without any preliminary exercising or adjustments (e.g., no manual tightening of valve after closure by valve actuator). Pneumatic (air or nitrogen) supply to the air operated valves is available. Test connections for pressurizing or venting (or both) the test volume of each valve to be tested are available. Test boxes used for this test are calibrated.

General Test Methods and Acceptance Criteria

The containment isolation valves that require leakage rate testing and acceptance criteria are discussed in Section 6.2. Containment isolation valve leakage rate testing is included in the applicable system preoperational test.

14.2.8.1.28 Containment Penetration Leakage Rate Tests

Purpose

The objective of this test is to verify that the leakage rate through each containment penetration meets the limit specified in the Containment Leakage Rate Testing Program.

Prerequisites

Permanently installed system consisting of a pressurized gas source (air or nitrogen), manifold, and valves may be provided and used as pressurizing equipment. Calibrations of the required test instruments within the scope of this test, e.g., temperature and pressure sensors, flowmeters, are current. Test boxes used for this test are calibrated.

General Test Methods and Acceptance Criteria

Those containment penetrations receiving Containment Penetration Leakage Rate Test (Type B Test) are indicated in Table 6.2-47. Containment penetrations will be leak rate tested by performing the surveillance testing as required in the Containment Leakage Rate Testing Program. Containment penetrations leak rate test and acceptance criteria are performed as described in Section 6.2.

14.2.8.1.29 Containment Airlock Leakage Rate Tests

Purpose

The objective of this test is to verify that the leakage rate through each airlock meets the criteria specified in the Technical Specifications.

Prerequisites

Permanently installed system consisting of a pressurized gas source (air or nitrogen), manifold, and valves may be provided and used as pressurizing equipment. Installation and calibration of required test instrumentation, e.g., temperature and pressure sensors, flowmeters, are complete. Test boxes used for this test are calibrated.

General Test Methods and Acceptance Criteria

Descriptions of and criteria for testing the primary containment air lock leakage rate are given in Section 6.2. Containment air locks leak rate and acceptance criteria are performed as required in the Containment Leakage Rate Testing Program.

14.2.8.1.30 Containment Integrated Leakage Rate Test

Purpose

The objectives of this test are: (a) to demonstrate that the integrated leakage rate of the primary containment at the design basis accident pressure is within the design limits, and (b) to obtain base line data for use during subsequent leak rate tests as described in Section 6.2.

Prerequisites

Construction is completed to the extent necessary to perform this test. Reactor vessel, GDCS Pools, IC/PCCS Pools, reactor cavity, dryer/separator pool, spent fuel pool and suppression pool are filled with water to the normal operating level. Pressurizing and test equipment is checked out and ready for the test. Individual leak rate tests, Type B and C of 10 CFR 50, Appendix J, have been completed. A general inspection of the accessible interior and exterior surfaces of the primary containment structures and components is performed and corrective actions are taken if evidence of structural deterioration exists. Containment isolation valves are functionally tested and aligned in accordance with Containment Leakage Rate Testing Program.

General Test Methods and Acceptance Criteria

Description of the preoperational containment integrated leakage rate tests and acceptance criteria are provided in Section 6.2.

During the Type A test, the drywell to suppression pool gas space differential pressure test will be performed as required by the Technical Specifications.

14.2.8.1.31 Containment Structural Integrity Test

Purpose

The objective of this test is to verify that the design and construction of the primary containment is capable of withstanding specified internal pressure loads as described in Section 3.8.

Prerequisites

The containment construction is complete to the extent necessary to perform this test. Construction turnover of the system is completed. Reactor vessel, GDCS Pools, IC/PCCS Pools, reactor cavity, dryer/separator pool, spent fuel pool and suppression pool are filled with water to the normal operation level. The instruments and controls within the scope of this test are calibrated. The structural integrity measurement and pressurizing equipment is available for use to support the test. Equipments incapable of withstanding the test pressure are removed from containment or otherwise protected.

General Test Methods and Acceptance Criteria

The internal pressure in the containment will be increased from atmospheric pressure to the test pressure in equally spaced pressure increments. The drywell and containment are depressurized in the same increments. During the test, the radial and vertical displacements of the drywell and containment structure are measured, and crack patterns and crack widths of the containment exterior surface at prescribed locations are observed. Pertinent system performance data are recorded and compared with the predicted response. During the analysis, verify that system performance test data satisfy the requirements as specified in Section 3.8.

14.2.8.1.32 Pressure Suppression Containment Bypass Leakage Tests

Purpose

The objectives of this test are:

- To verify that the suppression pool bypass leakage rate is within limits for high pressure and low pressure tests, and

- To obtain the baseline data for use during subsequent leak rate tests.

Prerequisites

After attaining test pressure, the Suppression pool gas space pressure is stabilized for one hour prior to collecting data. Suppression pool gas space closures are in place and the containment ventilation system is operable to support this test. Pressurizing and test equipment is checked out and ready for the test. The wetwell is filled with water to normal operating level.

General Test Methods and Acceptance Criteria

The suppression pool bypass leakage test will be performed at both high and low test pressure conditions to detect potential leakage in the drywell to the suppression pool gas space as described in the following:

With the drywell being pressurized at the specified test pressures, adjust the suppression pool gas space pressure to establish the prescribed test differential pressure. Allow pressure to stabilize for one hour prior to collecting data used to determine the leak rate. Verify that the measured drywell to suppression pool gas space bypass leakage rate is within design limit as specified in Section 6.2.

14.2.8.1.33 Containment Isolation Valve Functional and Closure Timing Tests

Purpose

To verify proper function of the containment isolation valves, including the required closure timing are met.

Prerequisites

Permanently installed equipment and instrumentation shall have been functionally tested and calibrated.

General Test Methods and Acceptance Criteria

The Containment Isolation System is discussed in Section 6.2 with characteristics of and requirements for individual valves listed in Tables 6.2-16 through 6.2-42. Preoperational functional and closure timing tests of valves performing containment isolation functions will be done as part of the testing of the systems to which such valves belong (see Tables 6.2-16 through 6.2-42 for system affiliation of individual valves). Overall containment isolation initiation logic is a function of the leak detection and isolation system testing that is described in Subsection 14.2.8.1.

14.2.8.1.34 Wetwell-to-Drywell Vacuum Breaker System Preoperational Test

Purpose

This test is to verify proper functioning of the wetwell-to-drywell vacuum breakers. The leakage rate test of the vacuum breakers are performed in conjunction with suppression pool bypass described in Subsection 14.2.8.1.

Prerequisites

The visual inspections of the mechanical components on the vacuum breakers have been completed and the SCG has reviewed the test procedure and approved the initiation of testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of vacuum breaker valves, including verification of opening and closing;
- Proper functioning of valve positive closure, including verification of adequate valve leak tightness;
- Proper functioning of vacuum breaker open; and
- Proper operation of instrumentation and alarms used to monitor valve position indication.

14.2.8.1.35 DC Power Supply System Preoperational Test

Purpose

To verify the ability of DC power supply systems to supply reliable, uninterruptible power for instrumentation, logic, control, lighting and other normal and emergency loads that must remain operational during and after a loss of AC power.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedures and approved the initiation of testing. Permanently installed and test instrumentation are properly calibrated and operational. The power supply and battery charger are available. Additionally, a test load is available for the performance of battery capacity test. Adequate ventilation to battery rooms is available and operational. All interfacing systems and equipment required to support system operation shall be available, as needed, for the specified testing configurations.

General Test Methods and Acceptance Criteria

The DC power supply systems consist of safety-related and nonsafety-related equipment, including batteries, battery chargers, inverters, static transfer switches, and associated instrumentation and alarms, that is used to supply both normal and emergency loads. Performance shall be observed and recorded during a series of individual component and integrated systems tests to demonstrate the following:

- Capability of each battery bank to supply its design load for the specified time without the voltage dropping below minimum battery or cell limits;
- Capability of each battery charger to fully recharge its associated battery (or bank), from the discharged state, within the specified time while simultaneously supplying the specified loads;
- Verification that actual loading of each DC bus is consistent with battery sizing assumptions;
- Verification that each DC bus meets the specified level of redundancy and electrical independence for its particular application;

- Proper functioning of transfer devices, breakers, cables and inverters (including load capability);
- Verify that safety-related batteries have the capacity to support essential loads for a period of 72 hours;
- Proper calibration and trip settings of protective devices, including relaying, and proper operation of permissive and prohibit interlocks;
- Voltage spikes between rails and rails to ground in the loaded system are within design parameters assumed for connected electronics;
- Proper operation of instrumentation and alarms associated with undervoltage, overvoltage, and ground conditions; and
- Proper operation of emergency DC lighting, including capacity of self-contained batteries.

14.2.8.1.36 AC Power Distribution System Preoperational Test

Purpose

To verify the ability of the AC power distribution system to provide a means for supplying AC power to plant auxiliary equipment, from both offsite and onsite sources, via independent distribution subsystems for each redundant load group.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. All the necessary permanently installed and test instrumentation shall have been calibrated and operational. Adequate ventilation to both switchgear and battery rooms are available and operational. All interfacing systems and equipment required to support system operation shall be available, as needed, for the specified testing configurations.

General Test Methods and Acceptance Criteria

The AC power distribution system is comprised of the equipment required for transformation, conversion, and regulation of voltage to the buses, the switchgear and motor control centers required for the individual loads served, and the coordinated system protective relaying. Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of initiating, transfer, and trip devices;
- Proper operation of relaying and logic;
- Proper operation of equipment protective devices, including permissive and prohibit interlocks;
- Proper operation of instrumentation and alarms used to monitor system and equipment status;
- Proper operation and load carrying capability of breakers, motor controllers, switchgear, transformers, and cables;

- The capability to transfer between onsite and offsite power sources as per design;
- The ability of emergency and vital loads to start in the proper sequence and to operate properly under simulated accident conditions; and
- The adequacy of the plant emergency lighting system.

14.2.8.1.37 Standby Diesel Generator & AC Power System Preoperational Test

Purpose

To demonstrate the capability of the standby diesel generators to provide electrical power to plant nonsafety-related loads when the normal offsite power sources are unavailable.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The diesel generator auxiliary systems (e.g., diesel fuel oil transfer, diesel-generator starting air supply, jacket cooling water, and lube oil) are operable to support continuous diesel operation. Appropriate electrical power sources, cooling water supply, diesel generator room HVAC and equipment required to support system operation shall be available, as needed, for the specified testing configuration. Additionally, sufficient diesel fuel shall be available onsite to perform the scheduled tests.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper automatic startup and operation of the diesel generators upon simulated loss of preferred power (LOPP) and attainment of the required frequency and voltage within the specified time limits;
- Proper operation of the diesel generators during load shedding, load sequencing, and load rejection, including a test of the loss of the largest single load and of the complete loss of load, verifying that voltage and frequency are maintained within design limits and that overspeed limits are not exceeded;
- That a LOPP signal initiates termination of parallel operations (test or manual transfer) and that the diesel generator continues to run and assume load as required;
- That the engine speed governor and the generator voltage regulator automatically return to an isochronous (constant speed) mode of operation upon initiation of a LOPP signal;
- Full-load carrying capability of the diesel generators for a period of not less than 24 hours, of which 22 hours are at a load equivalent to the continuous rating of the diesel generator and 2 hours are at the manufacturer's 2-hour load rating, including verification that the diesel cooling systems function within design limits, and that the HVAC System maintains the DG room within design limits;
- The ability to synchronize the diesel generators with offsite power while connected to the standby load, transfer the load from the diesel generators to the offsite power, isolate the diesel generators, and restore them to standby status;

- The rate of fuel consumption and the operation of the fuel oil transfer pumps, while operating at the design-basis load, meets the requirements for 7-day storage inventory for each diesel generator;
- The proper function of the diesel generator protective devices;
- That all permissive and prohibit interlocks, controls, and alarms (both local and remote) operate in accordance with design specifications;
- Proper operation of auxiliary systems such as those used for starting, cooling, heating, ventilating, lubricating, and fueling the diesel generators;
- Proper operation of the isolation breakers in the Class 1E motor control centers which act as isolation devices between the non-Class 1E power sources and the Class 1E loads; for Class 1E battery chargers only; and
- Capability of the system to allow a portable generator to supply power to the 1E AC Motor Control Centers.

14.2.8.1.38 Plant Communications System Preoperational Test

Purpose

To verify the proper operation and adequacy of plant communications systems and methods that are used during normal and abnormal operations, including those needed to carry out the plant emergency plan.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Initial system and component settings (gains, volumes, etc.) shall be adjusted based on expectations of the acoustic environment and background noise levels for each location and for all modes of operation.

General Test Methods and Acceptance Criteria

The communications systems to be tested include the plant paging system, telephone systems, portable radio systems, and the plant emergency alarms. Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper functioning of transmitters and receivers without excessive interference levels;
- Proper operation of controls, switches, and interfaces, including silencing and muting features;
- Proper isolation and independence of various channels and systems;
- Proper operation of systems under multiple user and fully loaded conditions as per design;
- Proper operation of plant emergency alarms;
- Audibility of speakers and receivers under anticipated background noise levels;
- The ability to establish the required communications with outside agencies; and

- Proper functioning of dedicated use systems and of those systems expected to function under abnormal conditions such as loss of electrical power or shutdown from outside the control room scenarios.

14.2.8.1.39 Fire Protection System Preoperational Test

Purpose

This test is to verify the ability of the Fire Protection System to detect and alarm the presence of combustion, smoke or fire within the plant and to initiate the appropriate suppression systems or devices. The test purpose is also to provide the required volume of water to fill the IC/PCCS and Spent Fuel Pool up to seven days.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The required electrical power and makeup water sources, diesel fuel oil system for the diesel driven fire pump, and other appropriate interfaces and support systems, are available as needed for the specified testing.

General Test Methods and Acceptance Criteria

The Fire Protection System is but one part of the overall fire protection program. This program is an integrated effort involving components, procedures, and personnel utilized in carrying out all activities of fire protection, in accordance with Criterion 3 of 10 CFR 50 Appendix A. It includes systems and components, facility design, fire prevention, detection, annunciation, confinement, suppression, administrative controls, fire brigade organization, training, quality assurance, inspection, testing, and maintenance. Fire Protection System in accordance with the criteria in codes and standards listed in Table 9.5-1 testing demonstrates the equipment and facilities designed for the detection, annunciation, and suppression of fires operate properly and meet all functional requirements described in subsection 9.5.1.1. This testing shall include the following demonstrations:

- Proper operation of instrumentation and equipment in all combinations of logic and control;
- Proper operation of system valves, pumps, motors and pump-driving diesel under expected operating conditions;
- Proper system and component flow paths, flow rates and capacities;
- Verification of proper installation of all fire protection equipment, including sprinkler heads, spray nozzles, fire detectors, annunciators, hose stations, and portable fire extinguishers;
- Proper operation of water-based suppression systems such as sprinkler, deluge, and hose stations and other suppression systems such as foams and dry chemicals;
- Proper operation of freeze protection methods and devices, if applicable;
- Proper functioning of all fire detection devices;
- Proper operation of both local and remote alarms, including those interfacing with outside agencies;

- Proper operation of primary and secondary electrical power sources;
- Verification of proper installation and integrity of all fire barriers, including penetration seals, fire doors and fire dampers;
- Proper installation and operation of HVAC systems used for smoke control and exhaust.

14.2.8.1.40 Radioactive Liquid Drainage and Transfer Systems Preoperational Tests

Purpose

This test is to verify the proper operation of the various equipment and pathways of the radioactive liquid drainage and transfer system.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. An adequate supply of demineralized water, the necessary electrical power, and other required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

The performance of the radioactive liquid drain system is observed and recorded during the individual component and system test that characterizes the various modes of system operation. Also included are dedicated systems for the handling of liquids that require special collection and disposal considerations such as detergents.

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of automatic isolation function of radwaste system containment isolation valves;
- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Acceptable system and component flow paths and flow rates, including pump capacities and sump or tank volumes;
- Proper operation of filter and demineralizer regeneration cycles of the liquid radwaste system and the associated support facilities; and
- Proper functioning of drains and sumps, including those dedicated for handling of specific agents such as detergents.

14.2.8.1.41 Fuel-Handling and Reactor Servicing Equipment Preoperational Test

Purpose

This test is to verify proper operation of the fuel-handling and reactor component servicing equipment. This includes cranes, hoists, grapples, trolleys, platforms, hand tools, viewing aids, and other equipment used to lift, transport, or otherwise manipulate fuel, control rods, neutron instrumentation, and other in-vessel and undervessel components. Also included is equipment

needed to lift and relocate structures and components necessary to provide access to fuel, vessel internals, and reactor components during the refueling and servicing operations.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The required electrical power sources and sufficient lighting shall be available undervessel, and on the refueling floor. The refueling floor (including the fuel storage pool and reactor cavity), and drywell and undervessel areas shall be capable of supporting load and travel testing of the various cranes, bridges, and hoists. Other interfacing systems shall be available as required to support the specified testing.

General Test Methods and Acceptance Criteria

Fuel-handling and reactor component servicing equipment testing described herein includes that of the reactor building crane, the refueling machine, fuel-handling platform and the fuel transfer system, the auxiliary platform, and the associated hoists and grapples, as well as other lifting and rigging devices. Also included are specialized hand tools and viewing aids. Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation for each crane, bridge, trolley, or platform through its full travel and up to its maximum speed, including verification of braking action and overspeed or overtravel protection devices;
- Proper operation of the various cables, grapples, and hoists, including brakes, limit switches, load cells, and other equipment protective devices;
- Proper functioning of all control, instrumentation, logic, interlocks and alarms;
- Proper operation of reactor servicing equipment, including reactor vessel servicing tools, main steam line plugs, shroud head stud wrench, RPV head tensioning and de-tensioning, dryer and separator strongback, and reactor head strongback;
- Proper functioning of fuel handling servicing equipment such as fuel preparation machine, new fuel inspection stand, channel handling tools, refueling platform and inclined fuel transfer system;
- Proper operation of under-vessel servicing equipment, including FMCRD servicing tools and handling equipment, in-core flange seal test plugs;
- Proper operation of various servicing aids such as underwater lights and viewing tubes, viewing aids;
- Proficiency in fuel movement operations using dummy fuel (prior to actual fuel loading); and
- Dynamic and static load testing of all cranes, hoists, and associated lifting and rigging equipment, including static load testing at 125% of rated load and full operational testing at 100% of rated load.

14.2.8.1.42 Expansion, Vibration and Dynamic Effects Preoperational Test

Purpose

To verify that critical components and piping runs are properly installed and supported such that expected steady-state and transient vibration and movement due to thermal expansion does not result in excessive stress or fatigue to safety-related plant systems and equipment.

Prerequisites

Hydro testing and flushing of the piping systems have been completed. The SCG has reviewed the test procedure and approved the initiation of testing. Inspect and determined that piping and components and their associated supports and restraints are installed per design. Additionally, verify that support devices such as snubbers and spring cans are in their expected cold, static positions, and observe that temporary restraining devices such as hanger locking pins are removed.

General Test Methods and Acceptance Criteria

Vibration and thermal expansion testing is conducted on plant systems and components of the following classifications:

- ASME Code Class 1,2 and 3 systems;
- High energy piping systems inside Seismic Category I structures;
- High energy portions of systems whose failure could reduce the functioning of any Seismic Category I plant features to an unacceptable level; and
- Seismic Category I portions of moderate energy piping systems located outside containment.

Thermal expansion testing during the preoperational phase is limited to those systems that are expected to be heated up significantly above their normal ambient temperatures. The testing is in conformance with ANSI/ASME-OM7 as discussed in Subsection 3.9.2.1.2, and consists of a combination of visual inspections and local and remote displacement measurements. Visual inspections are performed to identify actual or potential constraints to free thermal growth. Displacement measurements are made utilizing specially installed instruments and also using the position of supports such as snubbers. Results of the thermal expansion testing are acceptable when all systems move as predicted and there are no observed restraints to free thermal growth or when additional analysis shows that any unexpected results would not produce unacceptable stress values.

Vibration testing is performed on system components and piping during preoperational function and flow testing. This testing is in accordance with ANSI/ASME-OM3 as discussed in Subsection 3.9.2.1.1, and includes visual observation and local and remote monitoring in critical steady-state operating modes and during transients such as pump starts and stops, valve stroking, and significant process flow changes. Results are acceptable when visual observations show no signs of excessive vibration and when measured vibration amplitudes are within acceptable levels to assure no failures from fatigue over the life of the plant as calculated based on expected steady-state and transient operation.

14.2.8.1.43 Reactor Vessel Flow-Induced Vibration Preoperational Test

The ESBWR is a natural circulation reactor in which core flow can only be achieved with core power; thus, a preoperational test to measure the flow-induced vibration of reactor internals is not possible (refer to the discussion of the initial startup testing and measurement of flow induced vibration in Subsection 14.2.8.2.11).

The pre-operational testing is to verify the test instruments have been installed and calibrated. The internals, test instrumentation, and instrumentation lead wires are installed in the reactor vessel head and it is water leak tight. The proper operation and calibration of the test instrumentation and recording equipment is verified during the leak testing of the reactor pressure vessel.

14.2.8.1.44 Condensate and Feedwater Systems Preoperational Test

Purpose

To verify proper operation of the various components that comprise the Condensate and Feedwater System and their capability to deliver the required flow from the condenser hotwell to the Nuclear Boiler System.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure(s) and approved the initiation of testing. The required interfacing systems shall be available, as needed, to support the specified testing. For flow testing there shall be an adequate suction source available and an appropriate flow path established. The main condenser shall be intact and the hotwell water level is in the normal range.

General Test Methods and Acceptance Criteria

Preoperational testing of the Condensate and Feedwater System includes the piping, components, and instrumentation between the condenser and the nuclear boiler, but not the condensate filters or demineralizers nor the feedwater heaters, which are tested separately per the specific discussions provided for those features.

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions and proper response of flow control valves for the design operating range and correct operation of protective features;
- Proper operation of pumps and motors in all design operating modes(Condensate and Reactor Feed Pumps);
- Acceptable pump NPSH under the most limiting design flow conditions;

- Proper system flow paths and flow rates, including pump capacity and discharge head;
- Proper pump motor start sequence and margin to actuation of protective devices;
- Proper operation of interlocks and equipment protective devices in pump, motor, and valve controls;
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady-state operation; and
- Proper operation of controllers for pump drivers and flow control valves, including those in minimum flow recirculation lines.

14.2.8.1.45 Condensate Cleanup System Preoperational Test

Purpose

To verify proper operation of the condensate filters and demineralizers, and the associated support facilities.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The condensate system shall be operational with an established flow path capable of supporting condensate filter and demineralizer flow. Adequate supplies of ion exchange resin should be available, and the Radwaste System shall be capable of processing the expected quantities of water and spent resins. Other required interfacing systems shall also be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper individual vessel and overall system flow rates and pressure drops, including bypass capabilities (for both filter and demineralizer units);
- Proper operation of interlocks and equipment protective devices;
- The ability to perform on-line exchange of standby and spent filter units and demineralizer vessels;
- Proper operation of filter/demineralizer support facilities such as those used for regeneration of resins or for handling of wastes; and
- Regeneration times and spent resin discharge volumes.

14.2.8.1.46 Reactor Water Chemistry Control Systems Preoperational Test

Purpose

This test is to verify proper operation of the Oxygen Injection System .

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure(s) and approved the initiation of testing. The required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Preoperational testing concentrates on verifying proper operation of the equipment skids and the various individual components. Actual oxygen injection demonstrations and/or simulations shall be limited to only those cases where it is deemed practicable or appropriate with regards to the aforementioned precautions.

Performance shall be observed and recorded during a series of individual component and integrated system tests (to the extent possible) to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing and sequencing, under expected operating conditions;
- Proper system flow paths, flow rates and pressures; and
- Proper operation of system interlocks and equipment protective devices.

14.2.8.1.47 Condenser Air Removal System Preoperational Test

Purpose

To verify the ability of the mechanical vacuum pumps and steam jet air ejectors to establish and maintain vacuum in the main condenser as designed. The test of the steam jet air ejectors is performed in conjunction with offgas system described in Subsection 14.2.8.1.48.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Additionally, instrument air, electrical power, cooling water, turbine gland sealing steam, and other required system interfaces shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. The test demonstrate the mechanical vacuum pump operates as designed through the following testing:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of the mechanical vacuum pumps, including the ability to establish the required vacuum within the design time frame;
- Proper operation of all remote-operated valves, including position indications; and
- Proper operation of the mechanical vacuum pump trip function and its discharge valve closure on simulated main steam line radiation signal.

14.2.8.1.48 Offgas System Preoperational Test

Purpose

To verify proper operation of the Offgas System, including steam jet air ejectors, valves, recombiner, condensers, coolers, filters, and hydrogen analyzers.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Additionally, instrument air, electrical power, cooling water, turbine gland sealing steam, auxiliary boiler system and other required system interfaces shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of the steam jet air ejectors, including their ability to maintain the specified vacuum in the main condenser (while accounting for the source of the driving steam used);
- Proper operation of system valves, including isolation features, under expected operating conditions;
- Proper operation of components in all design operating modes;
- Proper system and component flow paths and flow rates;

- Proper operation of interlocks and equipment protective devices;
- Proper operation of permissive, prohibit, and bypass functions; and
- Proper operation of the isolation valve closure of the offgas system on the simulated low steam flow signal.

14.2.8.1.49 Condensate Storage and Transfer System Preoperational Test

Purpose

To verify the ability of the Condensate Storage and Transfer System to provide an adequate reserve of condensate quality water for makeup to the condenser, CRD, RWCU/SDC system, Fuel Pool system and for other uses as designed.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic;
- Proper functioning of permissive and prohibit interlocks;
- Proper operation of the condensate storage and transfer pumps;
- Proper functioning of instrumentation and alarms used to monitor system operation and status, including CST volume and/or level;
- Proper operation of main condenser water level control;
- Proper operation of the freeze protection and flood protection, if applicable; and
- Ability of the system to provide desired flow rates and volumes to the applicable systems and/or components.

14.2.8.1.50 Circulating Water System Preoperational Test

Purpose

To verify the proper operation of the Circulating Water System and its ability to circulate cooling water through the tubes of the main condenser in sufficient quantities to condense the steam exhausted from the main turbine under all expected operating conditions.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The main condenser, the cooling water source, pump bearing lubricating and shaft sealing water, vacuum priming for the water boxes, electrical power source and other required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Because of insufficient heat loads during the preoperational test phase, condenser and cooling water source performance evaluation are performed during the startup phase with the turbine-generator on line.

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper operation of pumps and motors in all design operating modes;
- Proper system flow paths and flow rates, including pump capacity and discharge head;
- Proper pump motor start sequence and margin to actuation of protective devices;
- Proper operation of interlocks and equipment protective devices in pump and valve controls;
- Proper operation of permissive, prohibit, and bypass functions;
- Proper operation of freeze protection methods and devices, if applicable; and
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady state operation.

14.2.8.1.51 Plant Service Water System Preoperational Test

Purpose

To verify proper operation of the Plant Service Water System (PSWS) and its ability to supply design quantities of cooling water to the Reactor Component Cooling Water System (RCCWS) and Turbine Component Cooling Water System (TCCWS) heat exchangers.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Electrical power, the RCCWS and TCCWS (including heat exchangers), instrument air, cooling towers, and other required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;

- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper operation of pumps and motors in all design operating modes;
- Acceptable pump NPSH under the most limiting design flow conditions;
- Proper operation of motorized self cleaning strainers;
- Proper system flow paths and flow rates, including pump capacity and discharge head;
- Proper pump motor start sequence and margin to actuation of protective devices;
- Proper operation of interlocks and equipment protective devices in pump, motor and valve controls;
- Proper operation of freeze protection methods and devices, if applicable; and
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady state operation.

The heat exchangers, which serve as interface with the RCCWS and TCCWS, are considered part of those systems and are tested as such. However, due to insufficient heat loads during the preoperational test phase, the heat exchanger performance verification is deferred until the startup phase.

14.2.8.1.52 Turbine Component Cooling Water System Preoperational Test

Purpose

To verify proper operation of the Turbine Component Cooling Water System (TCCWS) and its ability to supply design quantities of cooling water, at the specified temperatures, to designated plant loads.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Electric power, Plant Service Water (PSWS), instrument air, and other required supporting systems shall be available, as needed, for the specified testing configurations. The cooled components shall be operating to the extent possible during heat exchanger performance evaluation.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;

- Proper operation of system valves, including timing, under expected operating conditions;
- Proper operation of pumps and motors in all design operating modes;
- Acceptable pump NPSH under the most limiting design flow conditions;
- Proper system and component flow paths, flow rates, and pressure drops, including pump capacity and discharge head;
- Proper pump motor start sequence and margin to actuation of protective devices;
- Proper operation of interlocks and equipment protective devices in pump and valve controls;
- Acceptability of pump/motor vibration levels and system piping movements during both transient and steady-state operation;
- Proper operation of system surge tanks and chemical addition tanks and their associated functions; and
- Acceptable performance of TCCWS heat exchangers, to the extent practical.

Because of insufficient heat loads during the preoperational phase, the final system flow balancing and heat exchanger performance evaluation is performed during the startup phase.

14.2.8.1.53 Main Turbine Control System Preoperational Test

Purpose

To verify the proper operation of the Main Turbine Control System that operates the turbine stop valves, control valves, combined intermediate valves (CIVs) and bypass valves through their associated actuators and hydraulic control to the extent that it can be done without steam.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Electrical power supply to motors, control circuits, and instrumentation are available, the steam bypass and pressure control system shall be operational and other required interfacing systems are available, as needed, to support the specific testing. The Turbine Instruction Manual (TIM) is available to identify the necessary supporting systems and to define the test steps.

General Test Methods and Acceptance Criteria

This test and those other turbine tests detailed in Subsection 14.2.8.1.57 are probably performed as a set. The TIM shall be used to prepare a detailed procedure for testing the hydraulic system in manual and automatic modes, all turbine trip paths, stop and control valves, combined intermediate valves, extraction nonreturn valves, local instrumentation and control room instrumentation.

This test demonstrates main turbine control system functions properly through the following testing:

- Proper operation of the hydraulic control subsystem, including hydraulic fluid pumps and accumulators, and power supplies;
- Proper operation of the main stop and control valves, CIVs in response to simulated signals related to turbine speed, load, and pressure;
- Proper operation of the main stop and control valves, CIVs upon loss of the control system electrical power or hydraulic system pressure;
- Capability of manual operation of the turbine valves, including position indications and stroke rate adjustments;
- Proper interface with steam bypass and pressure control system; and
- Verification that various component alarms used to monitor system operation.

14.2.8.1.54 Main Turbine Bypass System Preoperational Test

Purpose

To verify the proper operation of the Main Turbine Bypass System (MTBS) to the extent that it can be done without steam.

Prerequisite

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The Turbine Instruction Manual (TIM) is available to identify the necessary supporting systems and to define the test steps.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of component and system tests. This test shall demonstrate that the turbine bypass system operates properly through the following testing:

- Proper functioning of instrumentation and system controls in all combinations of logic and instrument channel trip;
- Capability of manual bypass operation, including stroke rate adjustments and position indications;
- Proper operation of the bypass valve closure in response to loss of condenser vacuum, control system electrical signal or hydraulic power;
- Proper bypass valve response following a simulated turbine and generator trip initiation signal, including the fast opening timing to avoid the reactor trip; and
- Proper interface with the steam bypass and pressure control system.

14.2.8.1.55 Steam Bypass and Pressure Control (SB&PC) System Preoperational Test

Purpose

To verify the proper operation of the SB&PC System, including turbine valves and turbine bypass valve control and the plant automation system.

Prerequisite

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The preoperational tests of the turbine valves and bypass valves have been completed to the extent necessary to support integrated system testing. All SB&PC system components have been calibrated. The TIM is available to identify the necessary supporting systems and to define the test steps.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and overall system response tests to demonstrate the following:

- Preliminary adjustments of controllers for prescribed open-loop frequency response or step response;
- Proper operation of redundant controller upon simulated operating controller failure;
- Proper calibration of redundant pressure sensors to within the prescribed limits as specified in the system design specification;
- Proper operation of permissive, prohibit, and bypass functions; and
- Proper communication and interface with other control systems and related equipment.

14.2.8.1.56 Heater, Drain and Vent System Preoperational Test

Purpose

To verify proper operation of the feedwater heaters and their associated drains and vents, including heater level control capabilities.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Appropriate power sources that supply power to the control circuits and instrumentation are available to support testing. Required interfacing systems shall be available, as needed, to support the specified testing.

General Test Method and Acceptance Criteria

The Feedwater Heater and Drain System includes the feedwater heaters, internal and external drain coolers, normal and emergency dump valves, shell and tube side isolation valves, shell side vents and safety/relief valves, and associated instrumentation, control and logic.

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;

- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Proper operation of system valves and actuators under expected operating conditions;
- Proper operation of interlocks and equipment protective devices; and
- Proper operation of heater level controls, including response of the associated drain/dump valves.

14.2.8.1.57 Extraction Steam System Preoperational Test

Purpose

To verify proper operation of the components which comprise the extraction steam system.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Appropriate power sources that supply power to the control circuits and instrumentation are available to support testing. Required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Comprehensive testing of the extraction steam system requires the turbine generator to be on-line with a substantial amount of steam flow available. The preoperational testing of the extraction steam system without main turbine generator on-line is limited.

Performance shall be observed and recorded during a series of component and system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Proper operation of system valves under expected operating conditions, including response of air-assisted nonreturn check valves to a turbine trip signal; and
- Proper operation of interlocks and equipment protective devices.

14.2.8.1.58 Moisture Separator Reheater System Preoperational Test

Purpose

To verify proper operation of the turbine Moisture Separator Reheater (MSR) and the associated drain pathways, steam extraction lines, and isolation and non-return check valves.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Appropriate power sources that supply power to the control circuits and instrumentation are available to support testing. Required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

Comprehensive testing of the extraction steam system require the turbine generator to be on-line with a substantial amount of steam flow available. The preoperational testing of the moisture separator system without main turbine generator on-line is limited.

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip including turbine trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Proper operation of system valves and actuators (including isolation and nonreturn check valves) under expected operating conditions;
- Proper operation of interlocks and equipment protective devices; and
- Proper operation of moisture separator drain pathways.

14.2.8.1.59 Main Turbine and Auxiliaries Preoperational Test

Purpose

To verify that the operation of the main turbine and its auxiliary systems, including the gland sealing system, lube oil system, turning gear, supervisory instrumentation, and turbine protection system (including overspeed protection), is as specified. Testing of the turbine valves and associated control systems is included.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. Appropriate power sources that supply power to the control circuits and instrumentation are available to support testing. Required interfacing systems shall be available, as needed, to support the specified testing and the corresponding system configurations.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component, subsystem and integrated system tests (to the extent possible) to demonstrate the following, with regard to both the turbine and its auxiliaries:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability, including the turbine supervisory instrumentation;
- Proper operation of system pumps and valves in all design operating modes;
- Proper system flow paths, flow rates, temperatures and pressures (particularly with regard to the lube oil and gland sealing steam systems);

- Proper operation of valve auxiliaries such as hydraulic fluid systems, including pumps and accumulators, and power supplies;
- Verification that automatic starting of motor driven lube oil pumps, the alarm functions of lube oil level and the pressure drop of lube oil filters;
- Proper operation of interlocks and equipment protective devices in various turbine, pump, and valve controls; and
- Proper operation of the turbine turning gear including proper turning gear engagement and disengagement functions.
- Proper operation of the turbine overspeed protection system to provide mechanical overspeed trip and electrical backup overspeed trip as specified in subsection 10.2.2.4 and the manufacturer's technical instruction manual. This test can be performed in the startup test stage in conjunction with the major transient testing. (During the preoperational test phase, simulated speed signals will be used for these tests.)

14.2.8.1.60 Main Generator and Auxiliary Systems Preoperational Test

Purpose

Verify that the operation of the main generator and its auxiliary systems, including the generator hydrogen system and its associated seal oil and cooling systems, those subsystems and/or components that provide cooling to the generator exciter, stator, circuit breakers and isophase bus duct, and the generator protection system, is as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure(s) and approved the initiation of testing. Appropriate power sources that supply power to the control circuits and instrumentation are available to support testing. The generator instruction manual shall be reviewed in detail in order that precautions relative to generator operation are followed. Required interfacing systems shall be available, as needed, to support the specified testing and the corresponding system configurations.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component, subsystem and integrated system tests (to the extent possible) to demonstrate the following, with regard to both the generator and its auxiliaries:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system pumps, valves, fans, and piping or ducting in all design operating modes;
- Proper system flow paths, flow rates and pressures (particularly with regard to the generator hydrogen system and its associated seal oil and cooling systems);

- Proper operation of the generator purge system;
- Proper operation of interlocks and equipment protective devices in the various generator and auxiliary system controls; and
- Proper operation of the field excitation.

14.2.8.1.61 Seismic Monitoring System Preoperational Test

Purpose

To verify that the Seismic Monitoring System operates as designed in response to a seismic event.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The required electrical power shall be available and system-recording devices should have sufficient storage medium available. Instrument calibration and instrument loop checks have been completed.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of tests, as recommended by the manufacturer, to demonstrate the following:

- Proper calibration and response of seismic instrumentation, including verification of alarm and initiation setpoints;
- Proper operation of internal calibration or test features; and
- Proper operation of recording and playback devices.

14.2.8.1.62 Liquid and Solid Radwaste Systems Preoperational Tests

Purpose

To verify the proper operation of the various equipment and processes which make up the liquid and solid radwaste systems.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure(s) and approved the initiation of testing. There shall be access to appropriate laboratory facilities and an acceptable effluent discharge path shall be established. Additionally, an adequate supply of demineralized water, the electrical power, and other required interfacing systems shall be available, as needed, to support the specified testing.

General Test Methods and Acceptance Criteria

The testing described below includes that of equipment and processes for the handling, treating, storing, and preparation for the disposal or discharge of liquid and solid radwaste.

The liquid and solid radwaste systems performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate to the extent possible for the following:

- Proper operation of equipment controls and logic, including prohibit and permissive interlocks;
- Proper operation of equipment protective features and automatic isolation functions, including those for ventilation systems and liquid effluent pathways;
- Proper functioning of instrumentation and alarms used to monitor system operation and status;
- Acceptable system and component flow paths and flow rates, including pump capacities and tank volumes;
- Proper operation of system pumps, valves, and motors under expected operating conditions;
- Proper operation of phase separators;
- Proper operation of concentrating and packaging functions, including verification of the absence of free liquids in packaged waste;
- Proper operation of filter and demineralizer units and their associated support facilities; and
- Proper functioning of drains and sumps, including those dedicated for handling of specific agents such as detergents.

14.2.8.1.63 Isolation Condenser System Preoperational Test

Purpose

To verify that the operation of the Isolation Condenser (IC) system loops, including valves, logic and instrumentation is as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. High-pressure nitrogen must be available to operate the spring-loaded condensate return valves, and nitrogen operated pneumatic rotary motor isolation valves. Electrical power is also required to operate valves and controls.

General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing;
- Verification that the steam flow paths from the IC/PCCS pools to the atmosphere are unobstructed;

- Verification that IC steam and condensate-return piping flow passages are unobstructed;
- Verification that IC system valves are in their operational readiness positions as required by design, and the IC pool is filled to normal level;
- Proper operation of IC/PCCS pool level control;
- Verification that the IC Pool subcompartment valves are locked open; and
- Proper isolation of IC containment isolation valves upon receipt of simulated isolation signals.

14.2.8.1.64 Passive Containment Cooling System Preoperational Test

Purpose

To verify the operation of Passive Containment Cooling Systems (PCCS) is as specified.

Prerequisites

The construction tests have been successfully completed and the integrated containment leak rate test has been completed successfully. Makeup Water System is available to support the proper level control of IC/PCCS pool. The SCG has reviewed the test procedure and approved this visual inspection.

General Test Methods and Acceptance Criteria Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Verification that PCCS steam supply, drain and vent piping is unobstructed;
- Verification that PCCS condenser air flow versus differential pressure is within acceptable test limits;
- Verification that PCCS pool subcompartment valves are locked open;
- Proper operation of IC/PCCS pool level control; and
- Verification of the system interface with Fuel and Auxiliary Pools Cooling System for IC/PCCS pool cooling.

14.2.8.1.65 Gravity-Driven Cooling System Preoperational Test

Purpose

To verify that the operation of the four divisions of the Gravity-Driven Cooling System (GDCS), including valves, logic and instrumentation, is as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The reactor vessel shall be ready to accept GDCS flow. The required electrical power shall be available for squib type valve power supply. Instrument calibration and instrument loop checks have been completed.

General Test Method and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing;
- Verification that the flow passages from GDCS and Suppression Pool to reactor vessel are unobstructed;
- Verification that the flow passages to upper drywell are unobstructed; and
- Adequacy to provide required design flow rate.

14.2.8.1.66 Deleted

14.2.8.2 General Discussion of Startup Tests

Those tests proposed and expected to comprise the startup test phase are discussed in this subsection. For each test, a general description is provided for test purpose, test prerequisites, test description and test acceptance criteria, where applicable.

Because additions, deletions, and changes to these discussions are expected to occur as the test program is developed and implemented, the descriptions remain general in scope. In describing a test, however, an attempt is made to identify those operating and safety-oriented characteristics of the plant, which are to be explored and evaluated.

The ESBWR, because it is a natural circulation reactor, has unique characteristic during startups and especially during the initial startup. The control rod drive (CRD) cooling flow provides a steady supply of cold water into the bottom of the RPV and core heat warms the upper part of the RPV (i.e., there is a designed-in tendency for temperature stratification until natural circulation is established). This can be overcome with the RWCU/SDC system (See Subsection 14.2.8.2.17).

Where applicable, the relevant acceptance criteria for the test are discussed. Some of the criteria relate to the value of process variables assigned in the design or analysis of the plant, component systems, and associated equipment. Other criteria may be associated with expectations relating to the performance of systems. The startup administrative manual shall describe the various categories of acceptance criteria and shall designate how differentiation between them is accomplished in the test procedures. Specific actions for dealing with criteria failures and other testing exceptions or anomalies are also described in the startup administrative manual.

The specifics of the startup tests relating to test methodology, plant prerequisites, initial conditions, acceptance criteria, analysis techniques, and the like, is incorporated into the detailed test procedures to be utilized, based on the scoping documents to be supplied by the appropriate

design and engineering organizations in the form of plant, system and component performance and testing specifications. The power ascension test phase procedures are made available to the NRC 60 days prior to the scheduled date for fuel loading. Furthermore, to insure that the tests are conducted in accordance with established methods and appropriate acceptance criteria, the associated plant testing specification(s) is made available to the NRC.

14.2.8.2.1 Chemical and Radiochemical Measurement Tests

Purpose

To secure information on the chemistry and radiochemistry of the reactor coolant while verifying that the sampling equipment, procedures and analytic techniques are adequate to supply the data required to demonstrate that the chemistry of all parts of the entire reactor system meet specifications and process requirements.

Prerequisites

The preoperational tests have been completed and plant management has reviewed the test procedures and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with prerequisite testing completed. Instrumentation has been checked or calibrated as appropriate.

Description

Specific objectives of the test program include evaluation of fuel performance, evaluations of demineralizer operations by direct and indirect methods, measurements of filter performance, confirmation of condenser integrity, and evaluation and calibration of certain process instrumentation (including that used to monitor reactor water conductivity). Data for these purposes is secured from a variety of sources such as plant operating records, regular routine coolant analysis, radiochemical measurements of specific nuclides, and special chemical tests.

Prior to fuel loading, a complete set of chemical and radiochemical samples is taken to ensure that all sample stations are functioning properly, if not demonstrated during the preoperational testing, and to determine initial concentrations. Subsequent to fuel loading, during reactor heatup, and at each major power level change, samples are taken and measurements made to determine the chemical and radiochemical quality of reactor water and incoming feedwater, amount of radiolytic gas in the steam, gaseous activities leaving the air ejectors, decay times in the offgas lines, and performance of filters and demineralizers.

Calibrations are made of monitors in effluent release paths, waste handling systems, and process lines. Proper functioning of such monitors is verified, as appropriate, including via comparison with independent laboratory or other analyses. In particular, the proper operation of failed fuel detection functions of the main steamline and offgas pretreatment process radiation monitors is verified. In this regard, sufficient data is taken to assure proper setting of, or to make needed adjustments to, the alarm and trip settings of the applicable instrumentation.

Criteria

Chemical factors defined in the Fuel Warranty Operating Limits must be maintained within the limits specified.

The activity of gaseous and liquid effluents must conform to license limitations.

Water quality must be known at all times and shall remain within the guidelines of the water quality specifications and the requirements of the Fuel Warranty document.

14.2.8.2.2 Radiation Measurement Tests

Purpose

To determine the background radiation levels in the plant environs prior to operation for base data on activity buildup and to monitor radiation at selected power levels to assure the protection of personnel during plant operation.

Prerequisites

The preoperational tests have been completed and plant management has reviewed the test procedures and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. Instrumentation has been checked or calibrated as appropriate.

Description

A survey of natural background radiation throughout the plant site is made prior to fuel loading, and repeated periodically during startup testing, subsequent to fuel loading, during reactor heatup, and at several power levels up to and including rated power, gamma dose rate measurements and, where appropriate, neutron dose rate measurements are made at specific locations throughout the plant. All potentially high radiation areas are surveyed, including:

- Containment penetrations;
- All accessible areas where intermittent activities have the potential to produce transient high radiation conditions before, during, and after such operations; and
- A complete survey of all accessible floor areas within the plant prior to fuel loading, at intermediate powers, and at full power.

Criteria

The radiation doses of plant origin and the occupancy times of personnel in radiation zones shall be controlled consistent with the guidelines outlined in 10 CFR 20, "Standards for Protection Against Radiation."

14.2.8.2.3 Fuel Loading Test

Purpose

This test is to load fuel safely and efficiently to the full core size.

Prerequisites

The plant has received the proper authorization from the NRC to proceed with fuel loading and plant management has reviewed the applicable procedures and the overall plant readiness, and approved the initiation of loading.

Additionally, the following requirements are met prior to commencing fuel loading to assure that this operation is performed in a safe manner:

- The status of all systems required for fuel loading is specified and the systems are in the required status;
- Fuel and control rod inspections are complete. Control rods are fully inserted and functionally tested;
- For the initial core, neutron sources are installed;
- The required number of SRNM channels are operable and calibrated with high flux scram and rod block trips being set conservatively low in the non-coincident mode;
- Nuclear instruments are source checked with a neutron source prior to loading;
- Reactor vessel status is specified relative to internal component placement and this placement established to make the vessel ready to receive fuel;
- Reactor vessel water level is established above the minimum level prescribed; and
- Other required systems shall be operable as defined by the plant Technical Specifications and as demonstrated by the applicable surveillance tests.

Description

Fuel loading commences and proceeds according to written procedures in a predetermined sequence that assure a safe and efficient loading, with each fuel assembly by serial number in its specified location. The neutron count rates shall be monitored as the core loading progresses to ensure continuous subcriticality, and shutdown margin demonstrations are performed at specified loading intervals. Criteria for and actions required to address any deviations from expected results will be delineated in the fuel loading procedures as described in Subsection 14.2.2.

Criteria

The partially loaded core, at the applicable intervals, must be subcritical by at least the specified amount, in terms of reactivity, with the analytically determined highest worth rod pair fully withdrawn (a rod pair is defined as having a shared accumulator).

14.2.8.2.4 Full Core Shutdown Margin Demonstration Test

Purpose

To demonstrate that the reactor is subcritical throughout the first fuel cycle with the highest worth control rod pair (two CRDs with a shared accumulator) fully withdrawn and all other control rods fully inserted.

Prerequisites

The plant management has reviewed the test procedure and approved the initiation of the testing. The following prerequisites are satisfied prior to performing the full core shutdown margin tests:

- The predicted rod position for the criticality has been determined;
- The Standby Liquid Control System is operable;
- Nuclear instrumentation is operable with the minimum neutron count rate and signal-to-noise ratio as specified by the Technical Specifications; and

- High-flux scram trips are set conservatively low on SRNMs.

Description

This test is performed in the fully loaded core in the xenon free condition. This test is performed by withdrawing the control rods from the all-rods-in configuration in the specified withdrawal sequence until criticality is reached. The difference between the measured K_{eff} and the calculated K_{eff} for the in-sequence critical is applied to the calculated value to obtain the true shutdown margin.

Criteria

The shutdown margin of the fully loaded, cold (20°C/68°F), xenon-free core occurring at the most reactive time during the cycle must be at least that amount required by Technical Specifications, with the analytically strongest rod pair (or the reactivity equivalent) fully withdrawn. If the core reactivity is calculated to increase during the fuel cycle, compliance with the above criterion is shown by demonstrating that the shutdown margin is the specified amount plus an exposure-dependent increment which adjusts for the difference in core reactivity between the most reactive exposure and the time at which the shutdown margin is demonstrated. Additionally, criticality shall occur within the specified tolerance of the predicted critical.

14.2.8.2.5 Control Rod Drive System Performance Test

Purpose

To demonstrate that the control rods operate properly over the full range of primary coolant temperatures and pressures from ambient to operating conditions, in both the scram and fine motion control modes, in conjunction with the Rod Control and Information System (RC&IS).

Prerequisites

The preoperational tests have been completed and plant management has reviewed the test procedures and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. The applicable instrumentation shall be checked or calibrated as appropriate. In addition, a special test fixture containing a small pump and associated hydraulic control shall be available for performing driveline friction testing.

Description

The control rod drive (CRD) testing performed during the heatup and power ascension phases of the startup test program is designed as an extension of the testing performed during the preoperational phase. The continuous-insert friction test is performed after completion of fuel loading for each drive with the reactor at cold, atmospheric pressure condition. The underside of each Fine Motion Control Rod Drive (FMCRD) hollow piston will be pressurized using a portable friction test cart connected to the hydraulic control unit. The pressure acting on the bottom surface of the FMCRD hollow piston is measured by the friction test device as the control rod drive moves towards insertion. The variation in water pressure under the hollow piston is then compared against the acceptable limit for indication of abnormal driveline resistance that would adversely affect drive operation.

After it is verified that all CRDs operate properly when installed, tests are performed periodically during heatup to assure that there is no significant binding caused by thermal expansion of the core components and no significant effect on performance due to increased pressure, power or flow. Additionally, software functions such as those associated with the RC&IS are tested to the extent that they could not be checked during preoperational testing.

Coupling tests will be performed by withdrawing each drive from full-out to overtravel-out position (i.e., uncoupling check position) using Coupling Check Test Mode. The coupling test is performed to:

- Demonstrate actuation of the separation switches
- Confirm synchro position indication as the drive is withdrawn to the overtravel-out position, and
- Confirm the integrity of the coupling between the control blade and the hollow piston.

Gang rod operation in response to commands from the RC&IS and the Plant Automation System during automatic rod movement will be demonstrated during reactor heatup and at reactor rated temperature and pressure conditions. This test will also verify that a rod withdrawal block is activated as a result of rod gang misalignment during normal gang rod movement.

The scram performance tests will be demonstrated at atmospheric and rated reactor pressure conditions by using Scram Test Switches on the test panel. The accumulator charging line valve in the associated hydraulic control unit (HCU) shall be closed so that the CRDs do not ride the CRD pump head during the paired (two-CRD per HCU) and unpaired (one-CRD per HCU) CRD scram performance test. Four CRDs will be selected based on slow normal accumulator pressure scram times as determined from preoperational or atmospheric scram performance testing, or unusual operating characteristics. During reactor heatup with reactor pressure at 4.14 and 5.51±0.34 MpaG (800±50 psig), scram performance tests of these four selected CRDs with the CRD accumulators normally charged will be conducted for continuous monitoring purposes.

Additionally, the full core scram tests will be performed in conjunction with the various planned scram tests. The scram insertion time of each fully withdrawn rod will be measured during each scram test. The scram follow function will be confirmed to actuate automatically and go to completion. The intermediate position reed switches will be verified to actuate momentarily at the end of scram. The separation switches will be verified to actuate at the start of scram and return to their normal state at the completion of the scram follow function.

Criteria

Each CRD shall have a measured scram time that is less than or equal to the Technical Specifications requirements and consistent with safety analysis assumptions during both individual rod pair and full core scrams, as applicable. Each CRD shall have a measured insert/withdrawal speed consistent with specified design requirements, including those associated with group or gang movement. The CRDs shall meet friction test requirements. For each control rod, the scram-follow function shall actuate automatically to insert the scrammed control rod(s) to the full-in position within the time limit specified as per design. The separation switches for each control rod shall operate normally from scram occurrence to scram-follow completion during both paired/unpaired rod and full core scram performance tests.

14.2.8.2.6 Neutron Monitoring System Performance Test

Purpose

To verify response, calibration and operation of Startup Range Neutron Monitors (SRNMs), Local Power Range Monitors (LPRMs), Average Power Range Monitors (APRMs), and other hardware and software of the Neutron Monitoring System during fuel loading, control rod withdrawal, heatup and power ascension.

Prerequisites

The applicable preoperational phase testing is complete and the plant management has reviewed the test procedure(s) and approved the initiation of testing. For each scheduled test iteration the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. The applicable instrumentation shall be checked or calibrated, as appropriate.

Description

Testing of the Neutron Monitoring System commences prior to fuel loading and continues at intervals up to and including rated power. The SRNMs and operational sources are tested during fuel loading and during rod withdrawal on the approach to criticality and heatup to rated temperature and pressure and low power operation. The LPRMs and APRMs are tested as soon as sufficient flux levels exist and at specified intervals during the ascension to rated power. Testing includes response checks, calibrations and verification of system software calculations using actual core flux levels and other plant inputs.

Criteria

The SRNMs, in conjunction with the installed neutron sources, shall have count rates that meet Technical Specifications and design requirements, as applicable. The respective range functions of the SRNMs and APRMs shall provide for overlapping neutron flux indication as required by plant Technical Specifications and the applicable design specifications. The APRMs shall be calibrated against core thermal power by means of a heat balance. The accuracy of this calibration shall be consistent with the Technical Specifications. The LPRMs shall be calibrated consistent with design calibration and accuracy requirements. Additionally, all system hardware and software shall function properly in response to actual core flux levels.

14.2.8.2.7 Core Performance Test

Purpose

To demonstrate that the various core and reactor performance characteristics such as power and flow, core power distributions, and those parameters used to demonstrate compliance with core thermal limits and plant license conditions are in accordance with design limits and expectations.

Prerequisites

The applicable preoperational tests have been completed and plant management has reviewed the test procedure(s) and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. Applicable instrumentation shall have been checked and calibrated, as appropriate.

Description

This test collects data sufficient to demonstrate that reactor and core performance characteristics remain within design limits and expectations for the operational conditions the plant is normally expected to encounter. Beginning with rod withdrawal and continuing through initial criticality, plant heatup, and the ascension to rated power, pertinent data is collected at various rod patterns and powers sufficient to determine the axial and radial core power distributions, compliance with core thermal limits, and the level of consistency with predicted core reactivity and core flow versus core power. Core flow is calculated from a heat and mass-flow balance on the downcomer. Core power is calculated from a heat and mass-flow balance on the nuclear boiler.

Criteria

Technical Specification and license condition requirements involving core thermal limits, maximum power level, and any observed reactivity anomalies or core instabilities shall be met.

14.2.8.2.8 Nuclear Boiler Process Monitoring Test

Purpose

To verify proper operation of various nuclear boiler process instrumentation and to collect pertinent data from such instrumentation at various plant operating conditions in order to validate design assumptions and identify any operational limitations that may exist.

Prerequisites

The applicable preoperational testing has been completed and plant management has reviewed the test procedure(s) and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. Additionally, system and test instrumentation shall have been installed and calibrated.

Description

After all in-vessel work has been completed and the RPV head has been secured, a hydrostatic pressure test is required before nuclear heatup. The RPV must be heated to a minimum temperature before it can be hydrotested; refer to the pressure-temperature curve for the RPV. The Feedwater System in conjunction with the RWCU/SDC System shall be used to meet this temperature requirement and demonstrate their capability.

During plant heatup and power ascension, pertinent parameters such as reactor coolant temperature, vessel bottom head temperature, vessel dome pressure, vessel water level, and water-level reference column temperature distribution are monitored at selected intervals and plant conditions. This data is used to verify proper instrument response to changing plant conditions and to document the relationships among these parameters and with other important parameters such as reactor power, feedwater flow and steam flow. The data are also used to validate design assumptions such as those used in the calibration of vessel level indication and to identify potential operational condition limitations such as excessive coolant temperature stratification in the vessel bottom head region.

Criteria

The various nuclear boiler process instrumentations shall operate as designed in response to changes in plant conditions. The observed process characteristics shall be conservative relative to applicable safety analysis assumptions and shall be consistent with design expectations.

14.2.8.2.9 System Expansion Test

Purpose

The purpose of the thermal expansion test is to confirm that the pipe suspension system is working as designed, and the piping is free of obstructions during power changes. The measured and observed pipe expansion is in accordance with design, the piping returns to its approximate cold condition after cooldown.

Prerequisites

The preoperational tests have been completed and plant management has reviewed the test procedures and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. The applicable instrumentation shall be checked or calibrated as is appropriate.

Description

The thermal expansion tests consist of measuring displacements and temperatures of piping during various operating modes. The power levels used to heat and hold the system at a constant temperature shall be as low as practicable. The Plant Automation System can be used to control the rate of heatup and hold the temperature constant. Thermal movement and temperature measurements shall be recorded for at least the following test points (following a suitable hold period to assure steady-state temperatures):

- During reactor pressure vessel heatup at least one intermediate temperature (between 121°C/250°F and 177°C/350°F) prior to reaching normal operating temperature, including an inspection of the piping and its suspension for obstructions or inoperable supports;
- Following reactor pressure vessel heatup to normal operating temperature;
- Following heatup of other piping systems to normal operating temperature (those systems whose heatup cycles differ from the reactor pressure vessel); and
- Subsequent heatup/cooldown cycles, as specified, at the applicable operating and shutdown temperatures, to measure possible shakedown effects.

Thermal expansion shall be conducted on plant systems of the following systems:

- Main Steam Piping: Steam lines between the RPV nozzles and the outboard main steam isolation valves (MSIVs), and steam lines downstream of the outboard MSIVs shall be tested;
- Relief Valve Discharge Piping: The piping attached to the main steam lines and bounded by the SRV discharge flange and the quencher in the wetwell shall be within the scope of the test;

- Feedwater Piping: The feedwater discharge piping downstream of the butt welds, located nominally one meter of piping outside of the reactor building boundary up to the RPV feedwater nozzles, shall be within the scope of this test;
- Isolation Condenser Piping: The steam supply and condensate return piping shall be within the scope of this test;
- RWCU/SDC Piping: The RWCU pumps suction and discharge piping is within the scope of the test;
- RPV Head Vent Piping: RPV Head Vent piping shall be tested; and
- Piping Inside Drywell: Major piping systems inside the drywell including the GDCS and SLC discharge piping are within the scope of the test and subject to inspection.

The system expansion test consists of measuring displacements and temperatures of piping systems using installed instruments or local measurements during various system and plant operating modes. A visual examination for evidence of obstruction or interference will be performed on the above mentioned system piping inside containment at appropriate hold points during reactor heatup to rated temperature and pressure conditions and after three heatup and cooldown cycles. In addition, visual observation will also be made by a system walkdown at accessible locations to determine acceptability of the system outside containment under the conditions existing during each specified system testing.

Thermal movement and temperature measurements shall be recorded inside the drywell and wetwell on the following piping: main steam, selected SRV discharge lines, IC steam piping, feedwater lines, and RWCU/SDC, at least at the following points during the power ascension phase of startup testing:

- Ambient temperature (for baseline data);
- 1.05 MPaG (150psig) reactor pressure;
- 4.14 MPaG (600 psig) reactor pressure;
- Approximately 7.07 MpaG (1025 psig); and
- 20-25%, 50%, 75% and 100% of rated thermal power.

Thermal movements will also be recorded at appropriate temperature increments up to the required test temperature for the feedwater, RWCU/SDC system piping when each system is placed in service during normal plant operation.

For applicable BOP system piping, cold baseline data will be initially recorded. During initial reactor heatup, measurement data will be obtained at specified temperature plateaus. Stop the heatup if any excessive movement is encountered. On completion of cooldown to ambient temperature, measurement data will again be collected.

Additionally, a special test will be performed to monitor the conditions and effects of temperature stratification that may exist on the feedwater discharge piping inside and outside of containment. This special test will be conducted during heatup, hot standby, post scram, during IC operation, and during reactor shutdown. During the performance of this test, thermal displacements, strains, and temperature measurements will be taken on at least one of the main

feedwater headers inside and outside the containment, at selected feedwater riser piping, and at selected feedwater RPV nozzles to measure thermal cycling.

Criteria

The thermal expansion acceptance criteria are based upon the actual movements being within a prescribed tolerance of the movements predicted by analysis. Measured movements are not expected to precisely correspond with those mathematically predicted. Therefore, a tolerance is specified for differences between measured and predicted movement. The tolerances are based on consideration of measurement accuracy, suspension free play, and piping temperature distributions. If the measured movement does not vary from the predictions by more than the specified tolerance, the piping is expanding in a manner consistent with predictions and is therefore acceptable. Tolerances shall be the same for all operating test conditions. The locations to be monitored and the predicted displacements for the monitored locations in each plant are provided by the applicable testing specification.

14.2.8.2.10 System Vibration Test

Purpose

To verify that the vibration of critical plant system components and piping is within acceptable limits during normal steady-state power operation and during expected anticipated operational occurrences (AOOs).

Prerequisites

The applicable preoperational phase testing is complete and plant management has reviewed the test procedure(s) and approved the initiation of testing. Applicable systems have been walked through and verified complete to the extent required to conduct this test. Temporary hangers have been removed and replaced with permanently installed hangers for the systems involved, prior to starting the test on the particular system. For each scheduled test iteration the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. The required remote monitoring instrumentation shall be calibrated and operational.

Description

Vibration testing during the power ascension phase is limited to those systems that could not be adequately tested during the preoperational phase. Systems within the scope of this testing are therefore the same as mentioned in Subsection 14.2.8.1.42. However, the systems that remain to be tested are primarily of those exposed to and affected by steam flow and high rates of core flow. Because of the potentially high levels of radiation present during power operation, the testing is performed using remote monitoring instrumentation. Displacement, acceleration, and strain data is collected at various critical steady-state operating conditions and during significant anticipated operational occurrences (AOOs) such as turbine or generator trip, main steamline isolation, and SRV actuation.

Criteria

Criteria are calculated for those points monitored for vibration for both steady state and AOO cases. Two levels of criteria are generated, one level for predicted vibration and one level based on acceptable values of displacement and acceleration and the associated stress to assure that there are no failures from fatigue over the life of the plant. Failure to remain within the predicted

levels of vibration shall be investigated but do not necessarily preclude the continuation of further testing. However, failure to meet the criteria based on stress limits requires prompt investigation and resolution while the plant or affected system is placed in a safe condition.

14.2.8.2.11 Reactor Internals Vibration Test(Initial Startup Flow-Induced Vibration Testing)

Purpose

To collect information needed to verify the adequacy of the design, manufacture, and assembly of reactor vessel internals with respect to the potential affects of flow-induced vibration. Instrumentation of major components and the flow tests and remote inspections provide assurance that excessive vibration amplitudes, if they exist, are detected at the earliest possible time. The data collected also helps establish the margin to safety associated with steady state and AOO conditions and helps confirm the pretest analytical vibration calculations. This testing fulfills the initial startup test requirements of Regulatory Guide 1.20 for a vibration measurement and inspection program for prototype reactor internals.

Prerequisites

The applicable preoperational phase testing is complete and plant management has reviewed the test procedure(s) and approved the initiation of testing. The initial vibration analysis computations and specifications of acceptance criteria shall be complete. These results shall be utilized to define final inspection and measurement programs. All reactor vessel components and structures shall be installed and secured as designed in expectation of being subjected to rated volumetric core flow. This includes the steam separator and dryer assembly and reactor vessel head. The assembly and disassembly of vessel internals shall be choreographed such that structures and components requiring remote inspections are accessible at the proper times. The required sensors shall be installed and calibrated prior to the flow testing. All other systems, components and structures shall be available, as required, to support the reactor internals vibration assessment program. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with all specified testing complete.

Description

The reactor internals vibration testing subsequent to fuel loading is performed during the power ascension phase and includes intermediate and high power and flow conditions during steady-state operation. AOOs that are expected to result in limiting or significant levels of reactor internals vibration are also included.

The reactor internals vibration assessment program consists of two parts: a vibration analysis program, and an inspection and measurement program. The vibration analysis portion is performed on the final design, prior to the initial startup test, and the results are used to develop the measurement and inspection portions of the program. The initial startup test therefore consists of an instrumented flow test and pre- and post-test inspections as described in the following paragraphs:

Pre-flow Vessel Inspection — The pre-flow inspection is performed primarily to establish and document the status of vessel internal structures and components. Some of the inspection requirements may be met by normal visual fabrication inspections. The majority of the inspection requirements are met by visual and remote observations of the installed reactor

internals in a flushed and drained vessel. The following types of structures and components shall be included in the vessel internals inspection program:

- Major load bearing elements, including lateral, vertical and torsional supports;
- Locking and bolting components whose failure could adversely affect structural integrity;
- Known or potential contact surfaces;
- Critical locations as identified by the vibration analysis program; and
- Interior surfaces for evidence of loose parts or foreign material.

Flow Testing — The initial startup flow test are performed at low, mid and high core powers leading to rated volumetric core flow with the vessel internals completely assembled, including the fuel bundles, the control blades and the steam dryer assembly. The internals vibration is measured during individual component or system startup testing where operation may result in significant vibrational excitation of reactor internals, such as Isolation Condenser testing. The duration of the startup testing at the various flow configurations shall ensure that each critical component vibration is within design limitations.

Post-Flow Vessel Inspection — The post-flow inspection shall be performed after the resultant vibration from the startup flow testing described above. This is done at the first refueling outage unless there are compelling reasons--based on the data obtained during testing--to investigate earlier. The structures and components inspected shall be the same as specified for the pre-flow inspection. Remote observations are performed after the vessel has been depressurized and the head removed. The schedule for this step is determined by analysis of the measured data obtained during flow testing.

Criteria

The acceptance criteria are generated as part of the analytical portion of the program in terms of maximum vibrational response levels of overall structures and components and translated to specific sensor locations.

Reactor vessel internals vibration is considered acceptable when results of the measurement program correlate and compare favorably with those of the analysis program, and when the results of inspections show no signs of defects, loose parts, extraneous material, or excessive wear due to flow testing, and are consistent with the results obtained from the analysis and measurement programs.

14.2.8.2.12 Feedwater Control Test

Purpose

To demonstrate that the stability and response characteristics of the Feedwater Control System are in accordance with design requirements for applicable system configurations and operational conditions.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the

appropriate operational configuration with all specified prerequisite testing complete. This includes preliminary adjustments and optimization of control system components, as appropriate.

Description

Startup phase testing of the Feedwater Control System is intended to demonstrate that the overall response and stability of the system meets design requirements subsequent to controller optimization. Testing begins during plant heatup for any special configurations designed for very low feedwater or condensate flow rates and continues up through the normal full power lineup. Testing shall include all modes of control and encompass all expected plant power levels and operational conditions. Testing is accomplished by manual manipulation of controllers and/or by direct input of demand changes at various levels of control. System response shall also be evaluated under AOO conditions such as an unexpected loss of a feedwater pump or a rapid reduction in core power level and after plant trips such as turbine trip or main steamline isolation. Proper setup of control system components or features designed to handle the nonlinearities or dissimilarities in system response at various conditions shall also be demonstrated. The above testing also serves to demonstrate overall core stability to subcooling changes.

Criteria

Above all else, the Feedwater Control System performance shall be stable such that any type of divergent response is avoided. The response shall be sufficiently fast but with any oscillatory modes of response well damped, usually with decay ratios less than 0.25.

14.2.8.2.13 Pressure Control Test

Purpose

To demonstrate that the stability and response characteristics of the pressure regulation system are in accordance with the design requirements for all modes of control under expected operating conditions.

Prerequisites

The preoperational tests have been completed and plant management has reviewed the test procedure and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate. This includes preliminary adjustment and optimization of control system components, as appropriate.

Description

Startup phase testing of the Pressure Control System is intended to demonstrate that the overall response and stability of the system meets design requirements, subsequent to control system optimization. Performance shall be evaluated across the spectrum of anticipated steam flows for both the pressure regulation and load-following modes of control, as applicable. Testing shall demonstrate acceptable response with either the turbine control valves or bypass control valves in control and for the transition between the two. Testing is accomplished by manual manipulation of controllers and/or direct input of demand changes at various levels of control. It shall also be demonstrated that other affected parameters remain within acceptable limits during

such pressure regulator-induced maneuvers. Overall system response is evaluated during other plant AOOs as well. Additionally, proper setup of components or features designed to deal with the nonlinearities or dissimilarities in system response that may exist under various conditions shall be demonstrated.

Criteria

System performance shall be stable such that any type of divergent response is avoided. The response shall be sufficiently fast but with any oscillatory modes of response well damped, usually with decay ratios less than 0.25.

14.2.8.2.14 Plant Automation and Control Test

Purpose

To verify proper plant performance in automatic modes of control such as during automatic plant startup or automatic load following under the direction of the Plant Automation System (PAS). To verify the ability of the Plant Automation System (PAS) to collect, process, and display plant data, execute plant performance calculations, support main control room display functions, and interface with various plant control systems during actual plant operating conditions.

Prerequisites

The applicable preoperational tests have been completed and plant management has reviewed the testing procedure and approved the initiation of testing. Affected systems and equipment, including lower level control systems such as RC&IS, feedwater control and turbine control, as well as monitoring and predicting functions of the Plant Automation System and/or automation computer, shall have been adequately tested under actual operating conditions.

Description

A comprehensive series of tests is performed in order to demonstrate proper functioning of the various plant automation and control features. This testing shall include or bound all expected plant operating conditions under all permissible modes of control and shall also verify, to the extent possible, avoidance of prohibited or undesirable conditions or control modes. Auto load following capabilities are demonstrated under control of the PAS for control rod movements, including anticipated transition regions. Such testing includes demonstration(s) that the dynamic response of the plant (including BOP signals) to design load swings for the facility, including limiting step and ramp changes as appropriate, is in accordance with design. The ability of the PAS to properly orchestrate automated plant startup, shutdown and power maneuvering is shown. Also to be tested are system components or interfaces that perform monitoring, prediction, processing, validation, alarm, protection or control functions.

Criteria

The PAS and other features and functions of plant automation and control shall perform in accordance with the applicable design and testing specifications. Automatic maneuvering characteristics of plant and systems shall meet the appropriate response and stability requirements. Safety and protection features shall perform consistent with safety analysis assumptions and predictions.

14.2.8.2.15 Feedwater System Performance Test

Purpose

This test is to verify that the overall feedwater system performance characteristics are in accordance with the design requirements.

Prerequisites

The preoperational testing is complete and plant management has reviewed the test procedure and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. Applicable instrumentation has been checked or calibrated, as appropriate.

Description

Pertinent parameters are monitored throughout the feedwater system, and condensate system if appropriate, across the spectrum of system flow and plant operating conditions in order to demonstrate that system operation is in accordance with design. Parameters to be monitored may include temperatures, pressures, flow rates, pressure drops, pump speeds and developed heads, and general equipment status. Of special interest is data that serves to verify design assumptions used in plant AOO performance and safety analysis calculations (e.g., maximum feedwater runout capabilities and feedwater temperature versus power level relationships). Steady-state and AOO testing are conducted, as necessary, to assure that adequate margins exist between system variables and setpoints of instruments monitoring these variables to prevent spurious actuations or loss of system pumps and motor-operated valves.

Criteria

When applicable, measured parameters shall compare conservatively with safety analysis design assumptions. Additionally, test data shall demonstrate that system steady state and AOO performance meets design requirements.

14.2.8.2.16 Main Steam System Performance Test

Purpose

To verify that main steam system related performance characteristics are in accordance with design requirements.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with prerequisite testing complete. Applicable instrumentation shall be checked or calibrated, as appropriate.

Description

Pertinent system parameters, such as temperatures, pressures, and flows, are monitored at various steam flow rates in order to demonstrate that system operation is in accordance with design. The steam flow measuring devices that provide input to feedwater control and/or leak detection logic shall be crosschecked to verify the accuracy of design calibration assumptions. If appropriate, the pressure drop developed across critical components shall be compared with design values.

The quality of the steam leaving the reactor shall also be determined to be within design requirements.

Criteria

When applicable, measured parameters shall compare conservatively with safety analysis design assumptions. Additionally, test data shall demonstrate that system steady state and AOO performance meets design requirements.

14.2.8.2.17 Reactor Water Cleanup/Shutdown Cooling System Performance Test

Purpose

To verify that RWCU/SDC System performance, in all modes of operation, is in accordance with design requirements at rated reactor temperature and pressure conditions.

Prerequisites

The preoperational testing is complete and plant management has reviewed the test procedure and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. Instrumentation has been checked or calibrated as appropriate.

Description

To prevent thermal stratification in the RPV during RPV heatup for reactor startup and hot standby conditions, both trains of the RWCU/SDC System shall be aligned to take suction from only the bottom drain lines to preclude vessel thermal stratification.. The normal shutdown cooling suction line shall be shut during this mode of operation.

Startup phase testing of the RWCU/SDC System is an extension of the preoperational tests for rated temperature and pressure conditions. System parameters are monitored in the various modes of operation at critical temperature, pressure and flow conditions. Acceptable NPSH for the pumps must be demonstrated.

The performance of system heat exchangers and demineralizer units are evaluated at hot operating conditions. The ability of the system to reject excess vessel inventory during plant heatup is verified. Other system features shall be demonstrated as appropriate.

Criteria

The RWCU/SDC System shall maintain the temperature difference between the reactor steam dome and the bottom head drain to less than 80.6°C (145°F) during reactor startup and hot standby conditions. System performance shall meet other specified design requirements in required operating modes.

14.2.8.2.18 Plant Service Water System Performance Test

Purpose

To verify performance of the Plant Service Water System, including the Reactor Component Cooling Water System (RCCWS), and the Turbine Component Cooling Water System (TCCWS) under expected reactor power operation load conditions.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. All applicable instrumentation shall be checked or calibrated as is appropriate

Description

Power ascension phase testing of plant cooling water systems is necessary only to the extent that fully loaded conditions could not be approached during the preoperational phase. Pertinent parameters shall be monitored in order to provide a verification of proper system flow balancing and heat exchanger performance under near design or special conditions, as appropriate. This includes extrapolation of results obtained under normal or test conditions as needed to demonstrate required performance at limiting or accident conditions.

Criteria

System performance shall be consistent with design requirements.

14.2.8.2.19 HVAC System Performance Test

Purpose

To verify ability various HVAC systems to maintain area temperatures and humidity within the specified limits during reactor power operation.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure(s) and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. All applicable instrumentation shall be checked or calibrated as is appropriate.

Description

Power ascension phase testing of plant HVAC systems is necessary only to the extent that fully loaded conditions could not be approached during the preoperational phase. Pertinent parameters shall be monitored in order to provide a final verification of proper system flow balancing and cooler performance under near design or special situation conditions, as appropriate. For some sites it may be necessary to perform this test at the most limiting time of the year.

Criteria

System performance shall be consistent with design requirements. For systems that are taken credit for in the plant safety analysis, performance shall meet the minimum requirements assumed in such analysis.

14.2.8.2.20 Turbine Valve Performance Test

Purpose

To demonstrate proper functioning of the main turbine control, stop, and bypass valves during reactor power operation.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure(s) and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. All applicable instrumentation shall be checked or calibrated as is appropriate.

Description

Early in the startup test phase with the reactor at a moderate power level and with the turbine generator on-line, the operability of the control, stop, and bypass valves are demonstrated. This testing is similar to the individual valve testing required by the Technical Specification surveillances. In addition to valve operability, the overall plant response is observed. Because turbine valve testing is required routinely during power operation, the maximum power level at which such tests can safely be performed is determined by observing plant response during such tests at successively higher power levels.

Criteria

Turbine valves shall operate properly and in accordance with applicable Technical Specification requirements. Valve performance and plant response shall be consistent with design requirements. During high power testing, adequate scram avoidance margins shall be maintained.

14.2.8.2.21 MSIV Performance Test

Purpose

To demonstrate proper operation of and to verify closure times for Main Steamline Isolation Valves (MSIVs), including branch steamline isolation valves, during power operation.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure(s) and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. All applicable instrumentation shall be checked or calibrated as is appropriate.

Description

At rated temperature and pressure (hot standby), and then again at an intermediate power level, each MSIV is individually stroked in the fast closure mode. Valve operability and closure time are verified and overall plant response observed. Closure times are evaluated consistent with Technical Specification and safety analysis requirements. If appropriate, the maximum power level at which such tests can safely be performed is determined by observing plant response during such tests at successively higher power levels. In addition, at rated temperature and pressure, proper functioning and stroke timing of branch steamline isolation valves (e.g., on the common drain line) are demonstrated.

Criteria

MSIV closure times shall be within the limits required by plant Technical Specifications and those assumed in the plant safety analysis. Overall valve performance shall be in accordance

with design requirements. During higher power level tests, adequate scram avoidance margins shall be maintained.

14.2.8.2.22 SRV Performance Test

Purpose

To demonstrate that each ADS safety/relief valve (SRV) can be manually opened and closed properly during reactor power operation.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure(s) and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. All applicable instrumentation shall be checked or calibrated as is appropriate.

Description

A functional test of each SRV shall be performed during plant heatup and at the 50% power plateau by manually opening/closing each valve. Opening and closing of each valve, as well as evidence of steam flow, are verified by response of SRV discharge tailpipe temperature sensors and by observed changes in turbine bypass valve positions or generator load. Tailpipe temperature indication is also used to confirm valve closure and no significant leakage. Downstream indications of SRV operation could be changes in such parameters as turbine valve positions or generator output. Such changes are also evaluated for anomalies that may indicate a restriction or blockage in a particular SRV tailpipe by making valve-to-valve comparisons.

Criteria

There shall be a positive indication of steam discharge during each manual valve opening. SRV open/close indications, and tailpipe temperature sensor, shall function as designed. For manual openings, the apparent steam flow through each SRV shall not vary significantly from the average for all valves. Each SRV shall be properly reseated after testing.

14.2.8.2.23 Loss of Feedwater Heating Test

Purpose

To demonstrate proper integrated plant response to a loss of feedwater heating event and verify the adequacy of the modeling and associated assumptions used for this AOO in the plant licensing analysis.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. All applicable instrumentation shall be checked or calibrated as is appropriate.

Description

The credible single failure or operator error that has been identified as resulting in the largest feedwater temperature reduction is initiated at a significantly high power level, while considering

the event analyzed and the predicted results. The ESBWR design provides automatic SCRRI (Selected Control Rods Run-In) when a loss of feedwater heating is greater than or equal to 18.8°C (30°F). This feature is checked and verified in this test. Core performance and overall plant response are observed in order to demonstrate proper integrated response and to compare actual results with those predicted. This comparison takes into account the differences between actual initial conditions and observed results and the assumptions used for the analytical predictions.

Criteria

Resultant MCPR (Minimum Critical Power Ratio) shall remain greater than the MCPR safety limit, and measured results shall compare conservatively with design assumptions and predictions. The overall plant response shall be according to design and test specifications. Proper SCRRI operation shall be verified.

14.2.8.2.24 Feedwater Pump Trip Test

Purpose

To demonstrate the ability of the plant to respond and continue power operation following the loss of an operating feedwater pump from near rated power conditions.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. Applicable instrumentation shall be checked or calibrated, as appropriate.

Description From an initial reactor power level near rated, one of the normally operating feedwater pumps is tripped to demonstrate that the overall plant response is such that a reactor scram is avoided. Specifically, it shall be verified that the Feedwater Control System is sufficiently responsive, in conjunction with specified mitigating features, to prevent a reactor scram due to the reactor water level change. Separate tests may be required to demonstrate auto start of a standby pump.

Criteria

From normal operating conditions, the reactor shall avoid low water level scram with adequate margin to the low water level trip setpoint.

14.2.8.2.25 Shutdown From Outside the Main Control Room Test

Purpose

To demonstrate that the reactor can be shut down from normal power operation to the point where a controlled cooldown has been established, via decay heat rejection to the environment, with vessel pressure and water level under control, all using means entirely outside the main control room.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration

with the specified prerequisite testing complete. The applicable instrumentation shall be checked or calibrated, as appropriate. An adequate number of qualified personnel shall be on site to perform the specified testing as well as their normal plant operational duties.

Description

This test shall be performed from a low initial power level but from one that is sufficiently high that a majority of plant systems are in their normal configurations for power operation. This test is as much a test of normal and emergency plant procedures and the ability of plant personnel to carry them out, as it is a test of plant systems and equipment. Therefore, the test shall be performed using the minimum shift crew that would be available during an actual event. Additional qualified personnel is available in the control room to monitor the progress of the test and to re-establish control of the plant should an unsafe condition develop. The personnel also perform predefined nonsafety-related activities to protect plant equipment, where such activities would not be required during an actual emergency situation. The test is initiated by simulating a control room evacuation and then tripping and isolating the reactor by means outside of the main control room. Achievement and maintenance of the hot standby condition and subsequent reactor cool down is then demonstrated through control of vessel pressure and water level from the remote shutdown panel. The cold shutdown capability does not necessarily have to be demonstrated immediately following the shutdown and hot standby demonstration as long as the total integrated capability is adequately demonstrated. Also, additional personnel, over and above the minimum shift crew, may be utilized for the cold shutdown portion of the test consistent with plant procedure and management's ability to assemble extra help at the plant site in emergency situations.

Criteria

The remote shutdown test shall, as a minimum, demonstrate the capability of plant personnel, equipment, and procedures to initiate a reactor trip, to achieve and maintain hot standby conditions for at least 30 minutes, and to initiate decay heat removal such that coolant temperature is reduced by at least 28°C (44.9°F) at a rate within Technical Specification limit, all from outside the main control room. Additionally, system and plant performance shall be consistent with design and testing specification requirements.

14.2.8.2.26 Loss of Turbine Generator and Offsite Power Test

Purpose

To verify proper electrical equipment response and reactor system transient performance during and subsequent to a turbine generator trip with coincident loss of all offsite power sources.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. Applicable instrumentation shall be checked or calibrated, as appropriate. A sufficient number of qualified personnel shall be available to handle the needs of this test, as well as those associated with normal plant operation.

Description

This test shall be performed at a relatively low power level early in the power ascension phase, but with the generator on-line at greater than 10% load. The test is initiated in a way such that the turbine generator is tripped and the plant is completely disconnected from all offsite power sources. The plant shall then be maintained isolated from offsite power for a minimum of 30 minutes. During this time, appropriate parameters are monitored in order to verify the proper response of plant systems and equipment, including the proper switching of electrical equipment and the proper starting and sequencing of onsite power sources and their respective loads.

Criteria

Reactor protection system actions shall prevent violation of fuel thermal limits. Diesel generator and plant systems shall function properly without manual assistance to maintain reactor level above the initiation level of ADS and GDCS. Other systems and equipment shall perform consistent with applicable design and testing specifications.

14.2.8.2.27 Turbine Trip and Generator Load Rejection Test

Purpose

To verify that the dynamic response of the reactor and applicable systems and equipment is in accordance with design for protective trips of the turbine and generator during power operation.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. Applicable instrumentation shall be checked or calibrated, as appropriate, including steamline expansion/vibration sensors.

Description

In the ESBWR design, there is no direct scram because of turbine trip or generator load rejection. From an initial power level near rated, the main generator is tripped in order to verify the proper reactor and integrated plant response. The method for initiating the trip should be chosen so that the turbine is subjected to maximum overspeed potential. Reactor parameters such as vessel dome pressure and simulated fuel surface heat flux are monitored and compared with predictions so that the adequacy and conservatism of the analytical models and assumptions used to license the plant can be verified. Proper response of systems and equipment such as the turbine stop, control, and bypass valves, steamline vibration, the reactor protection system, and the feedwater system are also demonstrated. The ability of the feedwater system to control vessel level after a reactor trip shall also be verified. Overspeed of the main turbine shall also be evaluated because the generator is unloaded prior to complete shutoff of steam to the turbine.

For a turbine trip, the generator remains loaded and there is no overspeed. However, the dynamic response of the reactor may be different if the steam shutoff rate is different. If there is expected to be a significant difference, it may be necessary to perform a separate demonstration and evaluation (similar to that discussed above), but initiated by a direct trip of the main turbine.

A turbine or generator trip should also be performed at a lower power level. Reactor dynamic response is not as important for this AOO except for the ability to remain operating as designed. More important is the demonstration of proper integrated plant and system performance.

Criteria

The reactor shall not scram during turbine or generator trips. For high power turbine or generator trips, reactor dynamic response shall be consistent with predictions based on expected system characteristics and shall be conservative relative to analysis results based on design assumptions. Feedwater control shall prevent flooding of the steamline following generator or turbine trip. After generator load rejection, the generator shall continue to supply the station house load. The positive change in reactor dome pressure and fuel surface heat flux shall not exceed limits assumed in the transient analysis. Other plant systems and equipment shall perform in accordance with the appropriate design and testing specifications.

14.2.8.2.28 Reactor Full Isolation Test

Purpose

To verify that the dynamic response of the reactor and applicable systems and equipment is in accordance with design for a simultaneous full closure of all MSIVs from near rated reactor power.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. All applicable instrumentation shall be checked or calibrated, as appropriate.

Description

A simultaneous full closure of all MSIVs is initiated from near rated power in order to verify proper reactor and integrated plant response. Reactor dynamic response, as determined by such parameters as vessel dome pressure and simulated fuel surface heat flux, is compared with analytical predictions in order to verify the adequacy and conservatism of the models and assumptions used in the plant safety and licensing analysis. Proper response of systems and equipment such as the MSIVs, ICs, the Reactor Protection System, and the Feedwater System is also demonstrated.

Criteria

The reactor must scram to limit the severity of the neutron flux and simulated fuel surface heat flux transients.

Feedwater system settings must prevent flooding of the main steam lines following the full reactor isolation transient event.

The recorded MSIV full closure times must meet the limits specified in the Technical Specifications.

The positive change in vessel dome pressure and simulated fuel surface heat flux shall not exceed the limits assumed in transient analysis.

Initiation of Isolation Condenser and system performance shall be within specification.

14.2.8.2.29 Offgas System Test

Purpose

To verify proper operation of the various components of the Offgas System over the expected operating range of the system.

Prerequisites

The preoperational tests have been completed and plant management has reviewed the test procedure and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. Applicable instrumentation shall be checked or calibrated as is appropriate.

Description

Proper operation of the Offgas System is demonstrated by monitoring pertinent parameters such as temperature, pressure, flow rate, humidity, hydrogen content, and effluent radioactivity. Data shall be collected at selected operating points such that each critical component of the system is evaluated over its particular expected operating range. Performance shall be demonstrated for specific components such as catalytic recombiners, and activated carbon adsorbers, as well as the various heaters, coolers, dryers and filters. Also to be evaluated are the piping, valving, instrumentation and control that comprise the overall system.

Criteria

Hydrogen concentration and radioactivity effluents shall not exceed Technical Specification limits. Steam supply to the non-condensing stage of steam jet air ejector must be maintained above the required flow. All applicable system and component parameters shall be consistent with design and testing specification requirements.

14.2.8.2.30 Deleted

14.2.8.2.31 Concrete Penetration Temperature Surveys Test

Purpose

To demonstrate the acceptability of concrete wall temperatures in the vicinity of selected high temperature penetrations under normal plant operational conditions.

Prerequisites

The plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration for the scheduled testing. Applicable instrumentation shall be installed and checked or calibrated as is appropriate.

Description

Concrete temperature data is collected, around selected high temperature penetrations, at various power levels and system configurations in order to verify acceptable performance under expected

plant operational conditions. Penetrations and measurement locations selected for monitoring, as well as the test conditions at which data is to be collected, shall be sufficiently comprehensive so as to include the expected limiting thermal loading conditions on critical concrete walls and structures within the plant.

Criteria

The temperature(s) of the concrete at the monitored locations shall be consistent with design predictions and shall not exceed design basis requirements or assumptions critical to associated design basis analyses.

14.2.8.2.32 Liquid Radwaste System Performance Test

Purpose

To demonstrate acceptable performance of liquid radioactive waste processing, storage and release systems under normal plant operational conditions.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration for the scheduled testing. The necessary instrumentation shall be checked or calibrated. Appropriate precautions shall be taken relative to activities conducted in the vicinity of radioactive material or potential radiation areas.

Description

Radwaste System operation is monitored, and appropriate data collected, during the power ascension test phase to demonstrate that system operation is in accordance with design requirements. Operation of liquid Radwaste Systems is discussed in detail in Sections 11.2. Performance shall be demonstrated periodically throughout the startup test program to evaluate acceptable operation of piping, valving, and instrumentation and control that comprise the overall system.

Criteria

The liquid radwaste system shall be capable of collecting, process, and controlling the liquid radwaste as designed. Handling and release of radioactive wastes shall be in conformance with all applicable regulations.

14.2.8.2.33 Steam and Power Conversion System Performance Test

Purpose

To demonstrate acceptable performance of the power conversion systems under expected operational conditions, particularly those equipments that could not be fully tested during the preoperational phase due to inadequate steam flow conditions.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration for the scheduled testing. The necessary instrumentation shall be checked or calibrated.

Description

Operation of the main turbine-generator power conversion system with related auxiliaries is monitored, and appropriate data collected, during the power ascension test phase to demonstrate that system operation is in accordance with design requirements. Systems to be monitored include the main turbine and generator and their auxiliaries, the feedwater heaters and moisture separator, the main condenser and condenser air removal system, and the main circulating water system. At each major power level change, data is taken to determine reactor power, core flow and generator output. Operation and testing of power conversion systems is discussed in detail in Chapter 10. The main turbine generator and related auxiliaries are discussed in Section 10.2 and other power conversion equipment and systems are discussed in Section 10.4. Testing specific to turbine valves is described in Subsection 14.2.8.2.20 and plant AOO testing involving the main turbine generator is also described in Subsection 14.2.8.2.27.

Criteria

Performance characteristics (such as pressures, flows, temperatures, voltage, amps) of the various systems in the power conversion systems and related subsystems will be monitored and the data obtained will be evaluated aginst the systems process flow diagrams or equivalent design basis information. Any deviations observed will be evaluated to determine the cause and significance of the deviation.

14.2.8.2.34 Isolation Condenser Performance Test

Purpose

To demonstrate acceptable performance of the four isolation condensers when supplied with reactor steam at rated pressure. Heat balances on the reactor to determine the IC capacity.

Prerequisites

The preoperational tests are complete and plant management has reviewed the test procedure and approved the initiation of testing. The plant shall be in the appropriate operational configuration for the scheduled testing. The necessary instrumentation shall be checked or calibrated. Any required expansion/vibration instrumentation for the IC piping must be in place.

Description

With the plant operating at steady state mid-power, perform a heat balance on the reactor, and recording the main generator electrical output, APRMs and turbine control valve position. Initiate operation of one IC by opening the condensate drain valves and record the generator output, APRMs, and turbine control valve position. Perform a heat balance on the reactor with IC in operation. Determine the IC capacity by the difference in heat input before and after IC operation. Operate the FAPCS to cool the IC/PCCS pools during the test.

Criteria

Performance characteristics of the ICs shall be in accordance with the design and test specifications.

14.2.9 COL Information

The preceding discussion of preoperational and startup tests was limited to those systems and components within, or directly related to, the ESBWR. Other testing, with respect to site-specific aspects of the plant, is necessary. Testing of such systems and components should be adequate to demonstrate conformance to such requirements as defined throughout the specific chapters of the SSAR. Below are systems that may require such testing:

- Electrical switchyard and equipment;
- The site security plan;
- Personnel monitors and radiation survey instruments; and
- The automatic dispatcher control system (if applicable).

The COL holder will make available 60 days prior to use, the startup administration manual described in Subsection 14.2.2, which describes, among other things, what specific permissions are required for the approval of test results and the permission to proceed to the next testing plateau.

Regulatory Guide 1.68 specifies criteria (see Regulatory Position C.1) for determining what structures, systems, components and design features are required to be tested during the power ascension test phase in accordance with the requirements therein. Testing of such structures, systems, components and design features is then subject to license conditions requiring NRC prior approval for major test changes. The COL applicant shall also provide a list of those tests to be performed as part of the power ascension test phase that are proposed to be exempt from operating license conditions requiring NRC prior approval for major test changes, and the basis for the exemption.

14.2.9.1 Test Procedures/Test Program/Startup Administrative Manual

The COL holder will make a startup administrative manual available to the NRC 60 days prior to use that:

(1) The responsibilities of the organization that will carry out the test program, methods and plans for providing the necessary manpower, and a description of the staff responsibilities, authorities and personnel qualifications for conducting the initial test program.
(2) Delineates the development, review and approval of test procedures per Appendix C of RG 1.68. The site approved test procedures will be made available approximately 60 days before their intended use.
(3) Delineates utilization of reactor operating and testing experience in the development of the test procedures.
(4) Requires the development of plant operating and emergency procedures prior to fuel loading, and their application during the test program, consistent with section C.7 of RG 1.68.
(5) Defines requirements for the test program schedule consistent with section C.5 of RG 1.68 and the test sequence, consistent with sections 1 through 5 in Appendix A of . RG 1.68.

(6) Defines requirements for the test methodology, prerequisites, initial conditions, acceptance criteria, and analysis techniques consistent with RG 1.68.

14.2.10 References

See Subsection 14.2.3 for a list of applicable Regulatory Guides.