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14.0 Initial Test Program

14.1 Specific Information to be Included in Preliminary Safety Analysis Reports

Not applicable.

14.2 Specific Information to be Included in Final Safety Analysis Reports

14.2.1 Summary of Test Programs 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 discussion of preoperational and startup tests described in this section are limited to those systems and components within, or directly related to, the ABWR Standard Plant. Other testing, with respect to site-specific aspects of the plant will be necessary to satisfy certain ABWR requirements. See Subsection 14.2.13.1 for COL license information requirements.

The objectives of the initial test program are to:

(1) Ensure that the construction is complete and acceptable

(2) Demonstrate the capability of structures, components, and systems to meet performance requirements

(3) Effect fuel loading in a safe manner

(4) Demonstrate, where practical, that the plant is capable of withstanding anticipated transients and postulated accidents

(5) 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

(6) 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 will assure that 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:

(1) Ensure that design specification and test acceptance criteria are met

(2) Provide documentation of the performance and safety of equipment and systems

(3) Provide baseline test and operating data on equipment and systems for future reference

(4) Run-in new equipment for a sufficient period so that any design, manufacturing, or installation defects can be detected and corrected

(5) Ensure that plant systems operate together on an integrated basis to the extent possible

(6) Give maximum opportunity to the permanent plant operating staff to obtain practical experience in the operation and maintenance of equipment and systems

(7) Help demonstrate safe and efficient system operating and surveillance testing procedures to the extent possible

(8) 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 from 5 to 100% of rated output

(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 all of which 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 as follows:

(1) Achieve an orderly and safe initial core loading

(2) Accomplish all testing and measurements necessary to assure that the approach to initial criticality and subsequent power ascension is safe and orderly

(3) Conduct a sufficient number of low-power physics tests to ensure that test acceptance criteria have been met

(4) Conduct initial heatup and hot functional testing so that hot integrated operation of all systems is shown to meet test acceptance criteria

(5) Conduct an orderly and safe power ascension program, with requisite physics and systems testing, to ensure that integrated plant operation at power meets test acceptance criteria

(6) Demonstrate, to the extent possible, the adequacy of the various component, system and plant procedures

(7) Conduct a successful warranty demonstration

14.2.2 Organization and Staffing

14.2.2.1 Normal Plant Staff

Normal plant staff responsibilities, authorities, and qualifications are outside the scope of the ABWR Standard Plant and will be provided by the COL applicant, as discussed in Chapter 13. During the construction cycle and the various testing phases, additional staff is supplied by the plant owner/operator, GE, and others.

14.2.2.2 Startup Group

The startup group is an ad hoc organization created for the purpose of ensuring that the initial test program is conducted in an efficient, safe, and timely manner. The startup group is responsible for the planning, executing and documenting of all startup and testing related activities that occur between the completion of the construction phase and commencement of commercial operation of the plant. At completion of the startup program, the startup group is dissolved and the normal plant staff assumes complete responsibility of the plant. Ideally, the startup group will include individuals assigned temporarily from the various departments and disciplines within the normal plant and utility organization. This will assure maximum transfer and retention of experience and knowledge gained during the startup program for the subsequent commercial operation of the plant. It is likely that the startup group will also include an augmented staff of individuals from other concerned parties such as the NSSS vendor (GE), the architect-engineer, and the plant constructor. The normal plant staff will be included in as many aspects of the test programs as is practicable considering their normal duties in the operation and maintenance of the plant.

14.2.2.3 General Electric Company

The General Electric Company (GE) is the supplier of the boiling water reactor (BWR) nuclear steam supply system (NSSS) and is responsible for generic and specific BWR designs. During the construction and testing phases of the plant cycle, GE personnel are onsite to offer consultation and technical direction with regard to GE-supplied systems and equipment. The GE resident site manager is responsible for all GE-supplied equipment disposition and, as the senior NSSS vendor representative onsite, is the official site spokesman for GE. He coordinates with the plant owner’s normal and augmented plant staff for the performance of his duties, which include:

(1) Reviewing and approving all test procedures, changes to test procedures, and test results for equipment and systems within the GE scope of supply

(2) Providing technical direction to the station staff

(3) Managing the activities of the GE site personnel in providing technical direction to shift personnel in the testing and operation of GE-supplied systems

(4) Liaison between the site and the GE San Jose home office to provide rapid and effective solutions for problems which cannot be solved onsite

(5) 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 ABWR Standard Plant design and SCG is used throughout this dicussion for illustrative purposes only.]

14.2.2.4 Others

Other concerned parties, outside the plant staff organization, such as the architect-engineer, the constructor, the turbine-generator supplier, and vendors of other system and equipment, will be 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.

14.2.2.5 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, 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.

14.2.3 Test Procedures

In general, testing during all phases of the initial test program is conducted using detailed, step-by-step written procedures to control the conduct of each test. 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 will be developed and reviewed by personnel with appropriate technical backgrounds and experience. This includes the participation of principal design organizations in the establishment of test performance requirements and acceptance criteria. Specifically, GE will provide the COL applicant with scoping documents (i.e., preoperational and startup test specifications) containing testing objectives and acceptance criteria applicable to its scope of design responsibility. 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, as well as any reconciliation methods needed to account for test conditions, methods or results where testing is performed at conditions other than representative design conditions. Available information on operating and testing experiences of operating power reactors will be factored into test procedures as appropriate. The interfacing support system requirements will be specified by the test procedures. Additionally, the startup administrative manual will delineate how such determinations of operability and availability will be authorized. Test procedures will be reviewed by the SCG and will receive final approval by designated plant management personnel. Approved test procedures for satisfying the commitments of this chapter will be made available to the NRC staff approximately 60 days prior to their intended use for preoperational tests and 60 days prior to scheduled fuel loading for startup tests. See Subsection 14.2.13.2 for COL license information requirements.

14.2.4 Conduct of Test Program

The initial test program is conducted by the startup group 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 interfaces 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 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 hold-points or milestones within a given phase. It also describes the controls in place that will assure the as-tested status of each system is known and that will track modifications, including retest requirements, deemed necessary for systems undergoing or already having completed specified testing. Additionally, the startup manual delineates the qualifications and responsibilities of the different positions within the startup group. The startup administrative procedures are 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 will attempt to be consistent with normal plant procedures, where practical. The plant staff will typically carry out their duties according to normal plant procedures. However, in areas of potential conflict with the goals of the startup program, the startup manual or the individual test procedures will address the required interface. See Subsection 14.2.13.2 for COL license information requirements.

14.2.5 Review, Evaluation, and Approval of Test Results

Individual test results are evaluated and reviewed by cognizant members of the startup group. Test exceptions or acceptance criteria violations are communicated to the affected and responsible organizations who will help resolve the issues by suggesting corrective actions, design modifications, and retests. GE and others outside the plant staff organization, as appropriate, will have the opportunity to review the results for conformance to predictions and expectations. Test results, including final resolutions, are then reviewed and approved by a 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 will 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. See Subsection 14.2.13.2 for COL license information requirements.

14.2.6 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 will be based on consideration of their usefulness in documenting initial plant performance characteristics.

14.2.7 Conformance of Test Program with Regulatory Guides

The NRC Regulatory Guides listed below were used in the development of the initial test program and the applicable tests comply with these guides except as noted. The applicable revisions of the regulatory guides listed below can be found in Table 1.8-20.

(1) Regulatory Guide 1.68—"Initial Test Programs for Water-Cooled Nuclear Power Plants."

(2) Regulatory Guide 1.68.1—"Preoperational and Initial Startup Testing of Feedwater and Condensate Systems for Boiling Water Reactor Power Plants."

(3) Regulatory Guide 1.68.2—"Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants."

(4) Regulatory Guide 1.68.3—"Preoperational Testing of Instrument and Control Air Systems."

(5) Regulatory Guide 1.20—"Comprehensive Vibration Assessment Program for Reactor Internals During Preoperation and Initial Startup Testing."

(6) Regulatory Guide 1.41—"Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments."

(7) Regulatory Guide 1.52—"Design, Testing, and Maintenance Criteria for Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

(8) Regulatory Guide 1.56—"Maintenance of Water Purity in Boiling Water Reactors."

(9) Regulatory Guide 1.95—"Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release."

(10) Regulatory Guide 1.108—"Periodic Testing of Diesel Generators Used as Onsite Electric Power Systems at Nuclear Power Plants."

(11) Regulatory Guide 1.139—"Guidance for Residual Heat Removal."

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

Since every reactor/plant in a GE 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 ABWR plants have the benefits of experience acquired with the successful and safe startup of more than 30 previous BWR/1–6 plants. The operational experience and knowledge gained from these plants and other reactor types has been factored into the design and test specifications of GE-supplied systems and equipment that will be 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 and through other industry sources will be utilized to the extent practicable in developing and carrying out the initial test program.

14.2.9 Trial Use of Plant Operating and Emergency Procedures

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

(1) Prove the specific procedure or illustrate changes which may be required

(2) Provide training of plant personnel in the use of these procedures

(3) Increase the level of knowledge of plant personnel on the systems being tested

A testing procedure utilizing an operating, emergency, or abnormal procedure will reference the procedure directly, extract a series of steps from the procedure, or both in a way that is optimum to accomplishing the above goals while efficiently performing the specified testing.

14.2.10 Initial Fuel Loading and Initial Criticality

Fuel loading and initial criticality are conducted in a very controlled manner in accordance with specific written procedures as part of the startup test phase (Subsection 14.2.12.2). Approval for commencement of fuel loading is granted by the NRC after it has been verified that all inspections, tests, analyses and acceptance criteria specified in the plant license have been satisfactorily completed. However, unforeseen circumstances may arise that would prevent the completion of all preoperational testing (including the review and approval of the test results) that would not necessarily justify the delay of fuel loading. Under such circumstances, the applicant referencing the ABWR design 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: (1) list each test; (2) state which portions of each test will be delayed until after fuel loading; (3) provide technical justification for delaying these portions; and (4) state when each test will be completed and the results approved. See Subsection 14.2.13.2 for COL license information requirements.

14.2.10.1 Pre-Fuel Load Checks

Once the plant has been declared ready to load fuel, there are a number of specific checks that shall be made prior to proceeding. These include 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, as described in Chapter 16, shall be instituted at this time to assure the operability of systems required for fuel loading. Just prior to the initiation of fuel loading, the proper vessel water level and chemistry shall be verified and the calibration and response of nuclear instruments should be checked.

14.2.10.2 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 number before being placed in the correct coordinate position. The procedure controlling this movement will specify that partial core shutdown margin and subcritical checks be made as described in Subsection 14.2.12.2.3 at predetermined intervals throughout the loading, thus ensuring safe loading increments. 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 all assemblies are properly installed, correctly oriented, and occupying their designated positions.

14.2.10.3 Pre-Criticality Testing

The control rods shall be functional and scram tested with the fuel in place. The post fuel load flow test of the reactor internals vibration assessment program, if applicable, shall be conducted at this time. Additionally, a final verification that the required technical specification surveillances have been performed shall be made.

14.2.10.4 Initial Criticality

During initial criticality, the full core shutdown margin shall be verified as specified in Subsection 14.2.12.2.4 for the fully loaded core. Initial criticality shall be achieved in an orderly, controlled fashion following specific detailed procedures in an approved rod withdrawal sequence. Core neutron flux shall be continuously monitored during the approach to criticality and periodically compared to predictions to allow early detection and evaluation of potential anomalies.

14.2.11 Test Program Schedule

The schedule, relative to the initial fuel load date, for conducting each major phase of the initial test program will be provided by the COL applicant. 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 will be 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 will result in the most efficient schedule.

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, 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 will depend primarily on specified power and flow conditions and intersystem prerequisites. To the extent practicable, the schedule should establish that, prior to exceeding 25% power, the test requirements will be met for those plant structures, systems, and components that are relied on to prevent, limit, or mitigate the consequences of postulated accidents. Additionally, testing shall be sequenced so that the safety of the plant is never totally dependent on untested systems, components, or features.

Power ascension testing will be conducted in essentially three phases: (1) initial fuel loading and open vessel testing; (2) testing during nuclear heatup to rated temperature and pressure; and (3) power operation testing from 5% to 100% rated power. Further, power operation testing will be divided into three sequential testing plateaus (Figure 14.2-1). The testing plateaus consist of low-power testing at less than 25% power, mid-power testing up to about 75% power between approximately the 50% and 75% rod lines, and high-power testing along the 100% rod line up to rated power. Thus, there will be a total of five different testing plateaus designated as described on Figure 14.2-1. Table 14.2-1 indicates in which testing plateaus the various power ascension tests will be performed. A detailed description of the specific test conditions (i.e., power and flow levels) and any special requirements for each listed power ascension tests will be provided in the individual test procedure for each such test as described in Subsection 14.2.3.

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). Also, for a given testing plateau, testing at lower power and flow levels should generally be performed prior to higher power and flow levels. The detailed testing schedule will be generated by the COL applicant and will be made available to the NRC prior to actual implementation. The schedule will then be maintained at the job site so that it may be updated and continually optimized to reflect actual progress and subsequent revised projections. See Subsection 14.2.13.2 for COL license information requirements.

14.2.12 Individual Test Descriptions

14.2.12.1 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 will be documented in detailed test procedures to be made available to the NRC approximately 60 days prior to their intended use. Preoperational testing will be in accordance with the detailed system specifications and associated equipment specifications for equipment in those systems (provided as part of scoping documents to be supplied by GE and others as described in Subsection 14.2.3). The tests demonstrate that the installed equipment and systems perform within the limits of these specifications. To allow verification that the detailed test procedures were developed 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 ABWR Standard Plant are listed and described in the following paragraphs. Testing of systems outside the scope of the ABWR Standard Plant, but that may have related design and therefore testing requirements, are discussed in Subsection 14.2.13, along with other interface requirements related to the initial test program.

14.2.12.1.1 Nuclear Boiler System Preoperational Test

(1) Purpose

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

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Prerequisites of all required interfacing systems, as needed, must be completed to the extent sufficient to support the specified testing and the appropriate system configuration. Additional prerequisites include but are not limited to the following:

(a) All services, including air, nitrogen, water, electricity and communication shall be available and performing at rated design levels (flow, pressure, voltage, cleanliness, etc.).

(b) All system instrumentation and valve position sensors are in accordance with the applicable NBS instrument data sheet, and calibrated per instrument supplier's instructions.

(c) The reactor pressure vessel (RPV) and main steamlines are ready to accept water.

(d) On reactor water level instrumentation, careful inspections have been made on the installation of condensing chambers and piping from the chambers to the instruments to assure compliance with applicable Process Instrumentation Specifications and the P&ID.

(e) On differential pressure-sensing devices, installation has been checked against vendor drawings to assure that hot and cold leg errors due to installations are well within the limits specified in the applicable design document.

(f) Special high accuracy RTDs in the feedwater and steamlines have been verified to meet the accuracy requirements of applicable design document as installed, including effects of noise pickup due to plant and panel wiring.

(g) All system valve packings have been properly adjusted in accordance with applicable vendor instructions.

(h) The nuclear boiler hydrostatic test shall be performed at operating pressure following installation of the SRVs and leaks shall be corrected prior to the operation tests of the safety/relief valves.

(i) During MSIV logic response time testing, all MSIVs have been closed and disabled, since there will be no MSIV actuations during this testing.

(j) Prior to SRV solenoid valve operation testing, flow restrictors have been installed in the pneumatic cylinder exhaust to prevent rapid closure of the SRV and the resulting seat and disk damage during this testing.

(k) Prior to MSIV operations when cold with no fluid in the steamlines, guide surfaces shall have been wetted by flooding the steamlines with water and draining to avoid excessive wear and resultant valve overload.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that all pumps, valves, actuators, instrumentation associated with the NBS properly as specified in Subsections 7.7.1.1, 7.3.1.1.1.2, 5.2.4, and 5.4.5 and appropriate NBS design specifications through the following testing:

(a) Correct response of all sensing devices to actual process variables and provide alarms and trips at specified values (including proper tracking of RPV level instruments in response to actual changes in reactor water level—see Subsection 1A.2.4)

(b) Proper operation of system instrumentation and any associated logic (Subsection 7.7.1.1), including that of the automatic depressurization system (ADS) (Subsection 7.3.1.1.1.2)

(c) Proper operation of MSIVs and main steamline drain valves, including verification of closure time in the isolation mode, and test mode, if applicable

(d) Verification of SRV and MSIV accumulator capacity

(e) Proper operation of SRV solenoid valve, position transmitter, air piston actuators and discharge line vacuum breakers

(f) Acceptable system leaktightness and overall integrity of the reactor coolant pressure boundary (RCPB)via the system leakage and/or hydrostatic pressure testing as described in Subsections 5.2.4.6.1 and 5.2.4.6.2, respectively

(g) Proper system instrumentation and equipment operation while powered from primary and alternate sources, including transfers, and in degraded modes for which the system and/or components are expected to remain operational

(h) Verification of power-operated valves for operability, proper torque switch settings, limit switch settings, and position switch settings

(i) Proper operation of feedwater check valve by verifying its disk swings open and closed freely during system flow test and primary containment leakage test (Subsection 14.2.12.1.40.1)

(j) Proper operation of the feedwater positive acting check valve by verifying that the solenoid valve, pneumatic cylinder piston and piston rod assembly, spring and limit switch function as designed

(k) Proper operation of the feedwater manual operated gate valve, including limit switch function and handwheel rotation

(l) Verification that MSIVs will stroke to the fully closed position upon the loss of pneumatic pressure to the MSIV actuators

(m) Verification that the main steamline drain valves will open when pneumatic pressure to the valve is removed or electric power to the valve actuating solenoid is lost

(n) Verification that the main steamline drain valves will close upon receipt of a simulated containment isolation initiation signal

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 to be consistent with applicable requirements. Additionally, proper installation and setting of supports and restraints for SRV discharge piping will be verified as part of the testing described in Subsection 14.2.12.1.51.

14.2.12.1.2 Reactor Recirculation System Preoperational Test

(1) Purpose

To verify the proper operation of the Reactor Recirculation System (RRS) at conditions approaching rated volumetric flow, including the reactor internal pumps (RIPs) and motors, and the equipment associated with the motor cooling, inflatable shaft seal, and seal purge subsystems.

(2) Prerequisites

The RRS construction tests and flushing have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Cooling water from the Reactor Building Cooling Water (RCW)System and seal purge flow from the CRD Hydraulic System shall be available. The Recirculation Flow Control System(RFCS) shall be sufficiently tested to support RIP operation. Other interfacing systems (such as RIP adjustable speed drives, electric power medium and low voltage systems, radioactive drain transfer system, makeup water-purified distribution system) shall be available, as needed, to support the specified testing and the corresponding system configurations. Reactor vessel internals shall be capable of being subjected to rated volumetric core flow. Temporary equipment for starting the RRS preoperational testing must be installed and properly documented.

(3) General Test Methods and Acceptance Criteria

Testing of the recirculation system shall be coordinated closely with that of the Recirculation Flow Control System (Subsection 14.2.12.1.3) in order to adequately demonstrate proper integrated system response and operation. Also, the preoperational phase of the reactor internals vibration assessment program (Subsection 14.2.12.1.52) involves extended operation of the RRS and should be scheduled accordingly so as to optimize overall plant integrated testing.

The scope and intensity of the preoperational testing of the RRS and associated support subsystems will be limited by the unavailability of nuclear heating. Comprehensive testing of the system at rated temperature and pressure will be performed during the startup phase.

Performance shall be observed and recorded during a series of individual component and integration system tests. This test shall demonstrate that the RRS operates properly as specified in Subsection 5.4.1 and applicable RRS design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms used to monitor system operation and availability for correct alarm actuation and reset.

(c) Proper operation of system valves, including operability and position indication.

(d) Proper operation of pumps and motors in all normal design operating modes, as well as any specified special testing configurations.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper system flow rates, including individual pump capacity and discharge head.

(g) Proper manual and automatic system operation and actuation of protective devices.

(h) Proper operation of interlocks and equipment protective devices in pump and motor controls.

(i) Proper operation of permissive, prohibit and bypass functions.

(j) 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.

(k) Proper operation of the recirculation motor seal purge subsystem over the full range of RPV pressures, including the proper functioning of the main header pressure control valve and proper distribution of seal purge flow to individual pumps and motors.

(l) Proper operation of the RCW flow and temperature instrumentation of the recirculation motor cooling subsystem.

(m) Acceptable RIP steady-state performance data at several intermediate speed steps and the maximum permissible speed while RIPs are at separate and ganged mode of operation prior to fuel loading. This same set of RIP performance data will also be recorded at the maximum permissible speed after fuel loading and prior to initial reactor startup with RIPs at separate mode of operation.

(n) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(o) Acceptable reactor vessel internals flow-induced vibration levels per the requirements of Subsection 14.2.12.1.52.

(p) Proper operation of the Reactor Recirculation System at various flow steps under rated temperature and pressure conditions during the schedule RRS/RPV internal hot functional test prior to fuel loading.

(q) Proper operation of reactor recirculation system in response to the designed Recirculation Pump Trips (RPTs) required during integrated ECCS/LOPP testing (Subsection 14.2.12.1.46) prior to fuel loading.

(r) Proper operation of the recirculation motor inflatable shaft seal system (RMISS) to prevent reactor water leakage through the inflated secondary seal and primary seal from exceeding the limit specified in the RRS design specification. This test shall be done after the removable secondary seal installed, the RIP impeller normally backseated, and the reactor cavity filled to normal refueling level prior to fuel loading.

14.2.12.1.3 Recirculation Flow Control System Preoperational Test

(1) Purpose

To verify that the operation of the Recirculation Flow Control (RFC) System, including that of the Adjustable Speed Drives, RIP trip and runback logic, and the core flow measurement subsystem, is as specified.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The following systems shall be available, as needed, to support the specified testing and the corresponding system configurations: Reactor Recirculation System, Feedwater Control System, Steam Bypass and Pressure Control System, Electric Power Distribution System/instrumentation and control power supply, Process Computer System, Reactor Water Cleanup System, CRD System, RCIS, Neutron Monitoring System, Automatic Power Regulator System, Condensate and Feedwater System and Reactor Protection System.

(3) General Test Methods and Acceptance Criteria

Some portions of the RFC System testing described below may be performed in conjunction with that of the Recirculation System, as described in Subsection 14.2.12.1.2. In any case, close coordination of the testing specified for the two systems is required in order to demonstrate the proper integrated system response and operation.

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the RFC System operates properly as specified in Subsection 7.7.1.3 and applicable RFC System design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip, including stability control and protection (SCP), alternate rod insertion (ARI), recirculation flow block, recirculation pump trip (RPT) and runback circuity (RPT testing will specifically include its related ATWS function)

(b) Proper functioning of instrumentation, including calibration of process sensors, operator displays and alarm annunciation, confirmation of signal continuity, scaling and validation logic; and operator/technician interfaces and services

(c) Proper functioning of the core flow measurement subsystem

(d) Proper operation of the RFC System control algorithm in all design operating modes and all levels of controls

(e) Proper operation of the adjustable speed drives, recirculation pump and pump motor component

(f) Fault-tolerant capability of the redundant RFC digital controller upon a simulated single processor channel failure

(g) Capability of the self-test and online diagnostic features of the FTDC in identifying the presence of a fault and determining the location of a failure

(h) Proper operation of interlocks and trip logic and all control functions

(i) Proper operation of the technical interface unit (TIU) in the various provided operational modes as defined by the RFC design specification

(j) Proper steady-state and coastdown performance of M-G sets

(k) Capabilities of the FTDC cold and warm start features (i.e., self-starting following a power interruption to the full system and bringing a processing channel online with the other channels in operation without the need for operator or technician action)

(l) Proper operation of the RIPs trip function by verifying that RIPs trip in response to simulated high dome pressure, low water level, and both signals as specified by the appropriate RFC System design specification

14.2.12.1.4 Feedwater Control System Preoperational Test

(1) Purpose

To verify proper operation of the Feedwater Control System (FWCS), including individual components such as controllers, indicators, and controller software settings such as gains and function generator curves.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedures and approved the initiation of testing. Preoperational tests must be completed on lower level controllers that do not strictly belong to the FWCS but that may affect system response. All FWCS components shall have an initial calibration in accordance with vendor instructions. Appropriate instrumentation and control power supply, Turbine Control System, Reactor Recirculation Flow Control System, Condensate and Feedwater System, Process Computer System, Reactor Water Cleanup System, RCIC System, Nuclear Boiler System and Multiplexing System shall be available and operational to support the performance of this test.

(3) 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 will be conducted during startup phase.

Performance shall be observed and recorded during a series of individual component and overall system response tests. These tests shall demonstrate that the FWCS operates as specified in Subsection 7.7.1.4, applicable FWCS design specification, and manufacturer's technical instruction manual through the following testing:

(a) Verification of dynamic characteristics of level controllers, flow controllers, dynamic compensators, signal filters, level setpoint modification and bumpless gain logic for correct functions

(b) Correct functioning of instrumentation, including signal continuity checking, scaling and interface mating, calibration of process sensors, operator displays and alarm annunciation functions

(c) Proper operation of system valves, including timing and stroke, in response to control demands during test mode and operational mode (including the Reactor Water Cleanup System dump valve response to the low flow controller)

(d) Proper operation of interlocks, trips and all control functions

(e) Preliminary adjustments of controllers and actuators for prescribed open-loop frequency response or step response

(f) Capability of the self-test and online diagnostic features of the FTDC in identifying the presence of a fault and determining the location of the failure

(g) Capabilities of the FTDC cold and warm start features (i.e., self-starting following a power interruption to the full system and bringing a processing channel online with the other channels in operation, without the need for operator or technician action)

(h) Proper operation of the technician interface unit (TIU) in the various operational modes as defined by the FWCS design specification

(i) Correct functioning of all control logic and FWCS services provided to other systems as specified by the appropriate FWCS design specification

(j) Proper operation of redundant controller upon simulated single channel controller failures

(k) Proper operation of level setpoint step test functions

14.2.12.1.5 Standby Liquid Control System Preoperational Test

(1) Purpose

To verify that the operation of the Standby Liquid Control System (SLCS), including pumps, tanks, control, logic, and instrumentation, is as specified.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Valves should be previously bench tested and other precautions relative to positive displacement pumps taken. A sufficient quantity of chemically acceptable water is available to conduct the test. The reactor vessel shall be available for injecting demineralized water. All required interfacing systems, such as the service air system and makeup water-purified distribution system, shall be available, as needed, to support the specified testing and the appropriate system configurations.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the SLCS operates properly as specified in Subsections 9.3.5 and 7.4.1.2 and applicable SLCS design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms used to monitor system operation and availability for correct alarm actuation and reset.

(c) Proper operation of system valves, including timing under expected operating conditions, position indication and isolation function, as appropriate, and backflow seal on each pump check valve while the other pump is running.

(d) Proper operation of SLCS pumps and motors during continuous run tests.

(e) Proper operation of the tank heaters to heat SLC tank water volume above the low water level and to maintain defined temperature in the SLC tank and proper mixing of the neutron absorber solution.

(f) Proper system flow rates while operating from SLC tank to test tank including pump capacity and discharge head (with demineralized water substituted for the neutron absorber mixture).

(g) Proper pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks and equipment protective devices in pump, heater and valve to follow IBD when initiated.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) 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.

(k) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(l) Proper operation of the lubricant pump at the defined pumping pressure on the flow path between the lubricant pump and the SLC injection pump for verifying normal operating conditions.

(m) Proper operation of the SLC pump with designed flow rate and pumping pressure on the flow path between the SLC test tank and the SLC pump for verifying normal operating conditions.

(n) Proper operation of pump discharge line relief valve by operating SLC pump to circulate from test tank to test tank, close the test return valve gradually for verifying correct operating points (i.e., opening and reclosing pressure).

(o) Proper operation of the SLCS in the following flow path and mode of operation:

    (i) Test mode (test tank to test tank)
    (ii) Accident mode (SLC tank to RPV)
    (iii) Injection test mode (test tank to RPV)

(p) Adequate NPSH verification by injecting demineralized water using both SLCS pumps and flow path from the storage tank to the RPV with conditions in the storage tank of low level (down to pump trip level) and temperature greater than or equal to 43°C.

14.2.12.1.6 Control Rod Drive System Preoperational Test

(1) Purpose

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

(2) 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 shall be installed and ready to be stroked and scrammed. Temporary test equipment for the conduct of FMCRD ball check valve testing and drive line friction testing shall be available and connected to the HCU test port prior to the test. Reactor Building 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 RCIS shall be functional when needed, with the applicable portion of its specified preoperational testing complete.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the CRD System operates properly as specified in Subsections 4.6 and 7.7.1.2.1 and applicable CRD System design specification through the following testing:

(a) Verification of various component alarms used to monitor system operation and status for correct alarm actuation and reset.

(b) Proper communication with, and response to demands from, the ATWS and the Reactor Protection System(RPS).

(c) Proper functioning of system valves, including purge water pressure control valves, under expected operating conditions.

(d) Proper operation of the CRD Hydraulic Subsystem (CRDHS) to deliver water in accordance with the PFD at the design flow rate, at the flow control station, and at the design differential pressure over reactor pressure in the purge water header.

(e) Proper performance of CRD System pump suction and drive water filters.

(f) Proper pump motor start sequence and actuation of protective devices.

(g) Proper CRD pump performance over the full range of flow conditions from minimum flow to pump runout.

(h) Proper operation of interlocks and equipment protective devices in pump, motor, and valve controls.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) 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.

(k) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(l) Proper operation of fine motion motors and drives and associated control units, including verification of the following:

(i) Satisfactory insert/withdraw performance of the FMCRD at various RCIS operating modes (i.e., step driving, notch driving and continuous driving)

(ii) Satisfactory performance of the FMCRD separation switch probes at the overtravel position and the integrity of the coupling between the control blade and the FMCRD hollow piston

(iii) Satisfactory scram system functional performance, including the requirements of scram timing, automatic scram follow function, scram accumulator charging pressure, scram solenoid pilot valve and scram valve operations, FMCRD failed buffer detection and backup scram function

(iv) Proper operation in response to the initiation of alternate rod insertion (ARI), select control rod run-in (SCRRI), and scram follow functions

(v) Capability of the FMCRD brake to hold the FMCRD in position

(vi) Proper actuation of the ball check valve in the drive housing flange when subject to a reverse flow through the scram insert line

(vii) Acceptable drive line friction measured at cold conditions for each FMCRD

14.2.12.1.7 Rod Control and Information System Preoperational Test

(1) Purpose

To verify that the Rod Control and Information System (RCIS) functions as described.

(2) Prerequisites

The construction tests, including initial operation and checkout of RCIS software, have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Additional prerequisites, include but are not limited to the following:

(a) All electrical connections have been completed and verified in accordance with the RCIS IED and IBD.

(b) All RCIS cabinet power is available and system power supplies calibrated.

(c) All site-installed interconnecting cables associated with the RCIS have been properly installed for the performance of this test.

(d) A control rod synchro simulator for both RCIS channels has been fabricated to facilitate verification testing of rod position displays and alarms.

(e) Simulated inputs shall be provided, as required, for the following interfacing systems associated with the RCIS functions:

(i) Feedwater Control System
(ii) Recirculation Flow Control System
(iii) Reactor Protection System
(iv) Performance Monitoring and Control System
(v) Automatic Power Regulator System
(vi) Refueling Platform Control Computer System
(vii) Scram time recording and analysis panel
(viii) Neutron Monitoring System
(ix) Control Rod Drive System

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of tests. These tests shall demonstrate that the RCIS functions properly as specified in Subsection 7.7.1.2 and applicable RCIS design specifications through the following testing:

(a) 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

(b) Proper operation of Rod Server Module in processing control rod run-in logic, including that associated with ARI, SCRRI and normal post-SCRAM run-in

(c) Proper functioning of Rod Action and Position Information Subsystem used to monitor CRD System status such as rod position indication instrumentation and that used to monitor continuous full-in and rod/drive separation status

(d) Proper operation of RCIS software, including verification of gang rod selection and verification logic, rod withdrawal sequence restrictions, rod worth minimizer, and banked position reference rod pull sequence functions

(e) Proper communication with interfacing systems such as the power generation control system, the automatic power regulator, and the automatic rod block monitor

(f) Proper operation of automated thermal limit monitor (ATLM) to generate a rod block signal based on LPRM and control rod position input data that simulate a condition of fuel operating thermal limits violation

(g) Capability of RCIS continued operation under the condition with different subsystems of RCIS being bypassed

(h) Proper functioning of the RCIS bypass interlock logic to preclude a bypass state that could render the RCIS inoperational as specified in the appropriate design documents

(i) Proper operation of single-failure design feature of the RCIS by verifying that the RCIS is capable of continued operation with one channel disabled, that one channel can cause a rod block, and that two channels must be in agreement to cause normal RCIS functioning of control rod movements

14.2.12.1.8 Residual Heat Removal System Preoperational Test

(1) Purpose

To verify the proper operation of the Residual Heat Removal (RHR) System under its various modes of operation: core cooling, shutdown cooling, wetwell and drywell spray, suppression pool cooling, and supplemental fuel pool cooling.

(2) 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 intact and capable of receiving injection flow from the various modes of RHR. Reactor Building Cooling Water System, Instrument Air System, Fuel Pool Cooling and Cleanup System, Leak Detection System, RCIC System, Suppression Pool Water System, Nuclear Boiler System, Process Computer System, Electric Power Distribution System, Process Computer System and other required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations. Additionally, RHR pump suctionline shall be installed with a 50% plugged temporary strainer throughout the test. Also, the suppression pool water shall be of a quality acceptable prior to injection testing with flow from the suppression pool to the reactor.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests that includes all modes of RHR System operation. This test shall demonstrate that the RHR System operates properly as specified in Subsections 5.4.7, 7.3.1.1.1.4, 7.3.1.1.3, 7.3.1.1.4 and 7.4.1.3 and applicable RHR System design specifications through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms used to monitor system operation and availability, including those intended to alert high-pressure/low-pressure interface valves not fully closed with the reactor coolant system at high pressure (per Regulatory Guide 1.139).

(c) Proper operation of system valves including timing, position indication, controller function (if any for air operated valve), and verification of proper capacity and setpoint of system relief valves per ASME Code requirements. This test shall include those intended to meet the requirements of Regulatory Guide 1.139. The results of vendor tests and the appropriate documentation of such may be used to confirm that each system relief valve has been tested for proper relief pressure.

(d) Proper operating conditions of RHR water leg pump with flow through a bypass loop around the water leg pumps. The water leg pump discharges to the RHR main line to keep it and all its branches filled with water. Any makeup water needed is drawn from the RHR pump's suction line's open path to the suppression pool. The ability to keep the RHR line filled with water prevents damaging waterhammer during system transient. Tests shall confirm the RHR water leg pump trip on startup of the RHR pump.

(e) Proper operating conditions of each RHR pump during continuous operation at design rated flow with flow path from suppression pool through RHR heat exchanger and return to suppression pool.

(f) Proper operation of RHR System in each design mode. The modes to be tested are test mode, shutdown cooling mode, wetwell and drywell spray cooling mode, suppression pool cooling mode, LPFL mode, minimum flow mode, and fuel pool cooling mode. Adequate NPSH shall be verified in this test.

(g) Verification that wetwell and drywell spray nozzles, headers and piping are clear of obstructions.

(h) Proper RHR pump motor start sequence and actuation of protective devices.

(i) Proper operation of interlocks and equipment protective devices in pump and valve controls including those designed to protect low pressure portions of the system from the reactor coolant system at high pressure (per Regulatory Guide 1.139).

(j) Proper operation of permissive, prohibit, and bypass functions.

(k) Proper system operation while powered from primary and alternate sources, including transfers, automatic startup, timing and sequencing. This test can be performed in conjunction with integrated ECCS LOPP/LOCA preoperational test (Subsection 14.2.12.1.46).

(l) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational tests (Subsection 14.2.12.1.51).

(m) Proper operation of each RHR pump with the flow path from RHR System to the following radwaste treatment system collector pool and tank:

    (i) Low conductivity waste collector pool
    (ii) High conductivity waste collector tank

(n) Acceptable performance capability of RHR heat exchanger to the extent practical. Otherwise, RHR heat exchanger confirmatory tests can be performed in startup test stage.

(o) Verification that the RHR System is capable of placing into the AC-independent water addition mode of operation.

14.2.12.1.9 Reactor Core Isolation Cooling System Preoperational Test

(1) Purpose

Verify that the operation of the Reactor Core Isolation Cooling (RCIC) System, including the turbine, pump, valves, instrumentation, and control, is as specified.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. A temporary steam (low pressure) supply shall be available for driving the RCIC turbine. A temporary strainer shall also be installed in the pump suction throughout the test. The turbine instruction manual shall be reviewed in detail in order that precautions relative to turbine operation are followed. All required interfacing systems such as reactor pressure vessel, suppression pool, condensate storage pool, instrument air system, condensate makeup water system, Reactor Building Cooling Water System and communication shall be available, as needed, to support the specified testing and the corresponding system configurations. Additionally, appropriate measures shall be taken so that other systems will not be affected when signals involving other systems are used throughout the test. The signals to automatically startup this system at low reactor water level or high drywell pressure and the signal for automatic isolation of this system at low pressure of the steam supply shall be blocked prior to the test.

(3) General Test Methods and Acceptance Criteria

The RCIC turbine shall be tested in accordance with the manufacturer's recommendations. Usually this involves the turbine first being tested while disconnected from and then while coupled to the pump. The intent of this preoperational test is to test the RCIC System to the extent possible. However, since preoperational testing is performed utilizing a temporary steam supply, the attainable RCIC pump flow may be limited. Should this prevent any specified testing from being completed successfully, such cases will be documented and scheduled for completion during the power ascension test phase.

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the RCIC System operates properly as specified in Subsections 5.4.6 and

7.3.1.1.1.3 and applicable RCIC System design specification through the following testing:

(a) Correct implementation and operation of the RCIC System software-based controls and instrumentation. This test shall check the system behavior against the functional, performance and interface requirements as specified by the appropriate design documents and hardware/software system specification (HSSS).

(b) Verification of various component alarms for correct alarm initiation at the established value and reset when the operating signal is removed.

(c) Proper operation of all motor-operated and air-operated valves, including operability, position indicators, and timing, if applicable.

(d) Proper operation of RCIC turbine accessories.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Satisfactory performance of the RCIC System during the following modes of operation. This test shall be performed using temporary steam supply, equipment, piping and instrumentation as necessary for the test:

(i) At minimum flow mode with suction from the suppression pool or from the condensate storage pool and return to the suppression pool.

(ii) At test mode with required pump flow rate and head and through the system test line with suction from the suppression pool and return to the suppression pool.

(iii) At injection mode with suction from the condensate storage pool and inject water into the reactor through the reactor feedwater line with the reactor at atmospheric pressure condition.

(iv) Turbine quick start in response to the simulated automatic initiation signal with suction from the condensate storage pool and discharge via test return line to the condensate storage pool. This test shall demonstrate proper system flow rate and time to rated flow and no malfunction in the system.

(g) Proper operation of interlocks and equipment protective devices in turbine, pump, and valve controls.

(h) Proper operation of permissive, prohibit, and bypass functions.

(i) 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. Included shall be (1) a demonstration of RCIC System ability to start without the aid of AC power, except for RCIC DC/AC inverters, and (2) an evaluation of RCIC operation beyond its design basis during an extended loss of AC power to it and its support systems and verification of RCIC DC component operability when the non-RCIC station batteries are disconnected (Subsection 1A.2.4).

(j) Acceptable pump/turbine vibration levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(k) Proper operation of the barometric condenser condensate pump and vacuum pump.

(l) Ability of the system to swap pump suction source from the condensate storage tank to the suppression pool without interrupting system operation.

(m) Proper operation of the pump discharge line keep-fill system and its ability to prevent damaging water hammer during system transients.

14.2.12.1.10 High Pressure Core Flooder System Preoperational Test

(1) Purpose

To verify the operation of the High Pressure Core Flooder (HPCF) System, including related auxiliary equipment, pumps, valves, instrumentation and control, is as specified.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. A temporary strainer shall be installed with 50% plugged in the pump suction throughout this test. The suppression pool and condensate storage tank shall be available as HPCF pump suction sources and the reactor vessel shall be sufficiently intact to receive HPCF injection flow. The Instrument Air System, Makeup Water Condensate System, Residual Heat Removal System, Remote Shutdown System, Reactor Building Cooling Water System, and appropriate electrical power sources shall be available as needed, to support the specified testing and the appropriate system configurations.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the HPCF System operates properly as specified by Subsections 6.3.2.2.1 and

7.3.1.1.1.1 and applicable HPCF System design specification through the following testing:

(a) Correct implementation and operation of the HPCF System software-based controls and instrumentation. This test shall check the system behavior against the functional, performance and interface requirements as specified by the appropriate design documents and the Hardware/Software System Specification (HSSS).

(b) Verification of various component alarms for proper alarm actuation by practically operating the detector of the alarm generating source or using the simulated signal and alarm reset.

(c) Proper operation of all motor-operated valves including opening and closing with the operating switch, valve status indication and travel timing, if applicable.

(d) Proper operation of HPCF pumps and motors during continuous run tests.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Verification that the of HPCF System can be operated normally at each mode and satisfy the NPSH requirement by combining all components, piping and instruments constituting this system through the following testing:

  (i) Minimum flow operational test—operate the HPCF pump manually using flow path from suppression pool to suppression pool through the minimum flow line until the temperature of each pump and motor bearing is stabilized.

  (ii) Rated core flooding operational test—operate the HPCF System at rated core flooding made using test line for flooding the suppression pool. This test shall be performed continuously from the pump motor start sequence and the minimum flow operating condition.

  (iii) High pressure flooding operation test—operate the HPCF System at the high pressure flooding mode using test lines from suppression pool (or condensate storage tank) to suppression pool. This test shall also be performed continuously from the pump motor start sequence and the minimum flow condition.

  (iv) Reactor injection test —operate the HPCF System using core flooding line to confirm that the core flooding runout operation can be performed normally.

(v) Alternate source verification test —confirm that water source can be transferred satisfactorily from the condensate storage pool to the suppression pool.

(vi) Automatic starting test—confirm that the HPCF System starting time is within the safety requirement and waterhammer does not occur.

(g) Proper HPCF pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks including operation of all components subject to interlocking.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) 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.

(k) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(l) Acceptable HPCF sparger flooding pattern.

(m) Proper operation of the pump discharge line keep-fill system and its ability to prevent damaging water hammer during system transients.

14.2.12.1.11 Safety System Logic and Control Preoperational Test

(1) Purpose

To verify proper operation of the plant safety system logic and control (SSLC).

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The required 120 VAC and 125 VDC electrical power systems shall be in operation and available to the SSLC cabinets as required. The control logic associated with those systems resident in the SSLC cabinets shall have been verified to be operable. Annunciators, indicators, and displays as part of the SSLC cabinets are operable. All instrumentation (including bypasses where applicable) associated with the SSLC shall have been installed with permanent wiring connections made and adjusted to the values specified in the plant Technical Specifications. The process computer shall be available for displaying and logging, as required, the SSLC supplied parameters and fault identification and bypass status signals. Additionally, a dedicated diagnostic instrument surveillance test controller (STC) shall be available and used as an aid in performing SSLC functional logic testing, including trip, initiation, and interlock logic.

(3) General Test Methods and Acceptance Criteria

The SSLC integrates the automatic decision making and trip logic functions associated with the safety action of several of the plants' safety-related systems. Such systems include the RPS, HPCF, RHR, RCIC, LDIS, and ADS. The SSLC is not so much a system itself, but is instead an assembly of the above mentioned safety-related systems signal processors designed and grouped for optimum reliability, availability and operability. The SSLC, therefore, shall be adequately tested during the preoperational phase testing of the associated systems, including the integrated LOPP/LOCA test. Provided the construction testing and the associated system preoperational testing has been successfully completed, as it related to proper operation of the SSLC, no specific additional testing should be necessary.

Operability of the SSLC functional logic from sensor input to driven equipment actuation shall be demonstrated during a series of overlap testing. This test shall demonstrate that the SSLC operates correctly as specified in Subsection 7.1.2.1.6 and applicable SSLC design and testing specification through the following testing:

(a) Reactor Protection System (RPS)/MSIV Tests

(i) Setpoint validation (RMU to DTM), using input simulation and automatic self-test feature

(ii) Trip logic test of TLU, using input simulation and automatic self-test feature

(iii) Divisional RPS trip test, by manually actuating divisional trip test switch

(iv) Manual Scram Test (RPS), by actuating manual scram switches

(v) MSIV test close, by manually operating test close switches

(vi) Divisional MSIV isolation test, by manually actuating divisional isolation test switches

(b) Engineered Safety Features (ESF) Actuation System Tests

(i) Setpoint validation, using input simulation and automatic self-test feature

(ii) Trip logic test of SLU, using input simulation and automatic self-test feature

(iii) Equipment operation, using input simulation or manual

(c) Acceptability of the SSLC bypass functions, including division-of-sensor bypass and division-out-of-service bypass as specified by the appropriate SSLC system design specifications

(d) Capability of the automatic self-test feature in verifying proper operation of the functional logic of each SSLC logic processor

(e) Proper operation of fail-safe (de-energize-to-operate) design feature of SSLC upon loss of AC or DC power as described by the appropriate design specification

(f) Correct functioning of the digital trip module (DTM), trip logic unit (TLU) or safety system logic unit (SLU) in SSLC signal processing as described by the appropriate design-specification.

(g) Proper annunciator action for trip of any channel, including annunciation display and reset functions.

14.2.12.1.12 Multiplexing System Preoperational Test

(1) Purpose

To verify proper functioning of the plant multiplexing system, including both essential and nonessential (EMS and NEMS) subsystems.

(2) Prerequisites

The construction test have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The power supply, logic units (SSLC), and other component (MCU, RMU, CMU) associated with the essential and non-essential multiplexing systems shall be operable. The interfacing systems' actuators, alarms, and displays which receive the processed control signals from the essential and non-essential multiplexing systems shall be operational. The data acquisition and communication software required to support the essential and non-essential multiplexing system functions shall be available. Simulated sensor input signals shall be provided for the performance of this test. Additionally, special test instrumentation for simulated inputs, data reductions and analysis shall be available.

(3) General Test Method and Acceptance Criteria

Since this system is the primary communication interface between the various plant systems, it shall be adequately tested during the preoperational phase testing performed on those interconnected systems. The integrated hardware/software testing shall check the system functional performance and interface requirements as specified in the non-essential multiplexing system (NEMS) and essential multiplexing system (EMS) design specifications. The verification and validation (V&V) tests are performed to check the input signal coming from appropriately assigned input point and the output signal to the appropriately assigned signal points. This testing shall also check the function of the redundant multiplexing system and the fail-safe function of both systems. The capability of both warm and cold starts upon power interruption and automatic self-test function of the systems shall also be demonstrated to meet the design requirements. Additionally, after the above verification, the validated essential multiplexing system shall be checked for final validation during integrated EMS/SSLC testing as part of the SSLC preoperational test (Subsection 14.2.12.1.11). Testing shall include confirmation of every multiplexed sensor signal for accuracy, and functional requirements of control, interlock or display as specified in the documents of the system integrated within the SSLC.

14.2.12.1.13 Leak Detection and Isolation System Preoperational Test

(1) Purpose

To verify proper response and operation of the Leak Detection and Isolation System (LDS) logic.

(2) Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedures and approved the initiation testing. All system instrumentation shall have been properly calibrated per instrument supplier's instructions. Appropriate simulation of LDS response and sensors shall be provided for each LDS division. Special test instrumentation for simulated test inputs, data reduction and analysis shall be available for use. Systems which may be tripped by the input process variables that are not intended to function during a specified test shall be blocked out before the test. Applicable power sources to supply electrical power to motors, control circuits, and instrumentation shall be available and operational. Auxiliary calibration sources shall be provided to support the specified calibration tests. Additionally, the following nuclear and plant auxiliary systems shall be operational for verifying the leak detection and isolation functions as indicated in the parenthesis:

(a) Neutron Monitoring System (ATIP isolation)

(b) Containment System (drywell coolant leakage)

(c) Standby Gas Treatment System (system initiation)

(d) Reactor Protection System (isolation bypass)

(e) Standby Liquid Control System (system initiation)

(f) Nuclear Boiler System (MSIV, MSL drain valves)

(g) RHR System (shutdown cooling suction isolation)

(h) CUW System (containment isolation valve)

(i) RCIC System (system isolation)

(j) SSLC (LDS logic processing)

(k) Other auxiliary systems (e.g., PRM, RD, RCW, HNCW, HVAC, ACS, FCS, SPCU, etc.) associated with the LDS functions

(3) General Test Methods and Acceptance Criteria

Since the LDS is comprised mostly of logic, the checks of valve response and timing and the testing of sensors will be performed as part of, or in conjunction with, the various systems with which they are associated.

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the LDS operates properly as specified in Subsection 7.3.1.1.2 and applicable LDS design specification through the following testing:

(a) Correct implementation and operation of the LDS software-based controls and instrumentation. This test shall check the system behavior against the functional, performance and interface requirements as specified by the appropriate design documents and the Hardware/Software System Specification (HSSS).

(b) Verification of various indicators, annunciators, and alarms used to monitor system operation and status for correct functions.

(c) Proper operation of leakoff and drainage measurement functions such as those associated with the reactor vessel head flange, drywell cooler condensate, and various primary system valves.

(d) Proper response of related system valves, including open/close cycling, position indication verification and travel timing, if applicable.

(e) Proper interface with related systems in regards to the input and output of leak detection indications and isolation initiation commands.

(f) Proper operation of bypass switches and related logic, including capability of manual reset from the main control room.

(g) 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.

(h) Proper operation of the LDS functions such as equipment-area leak detection for RHR and RCIC Systems and area leak detection for main steamline tunnel in Reactor Building and Turbine Building and CUW System.

(i) Proper operation of drywell coolers condensate flow monitoring, including flow indicator and alarm actuation.

(j) Correct functioning of flow transmitter and differential flow switch on the CUW flow leak detection system.

(k) Correct functioning of RCIC steamline high flow and main steamline high flow detection and the associated trip initiations.

(l) Proper operation of the fission product monitoring system, including calibration of each detector and control functions of all associated equipment.

(m) Capability of the LDS to perform MSIV isolation function as designed with diverse manual isolation switches from the main control room.

(n) That loss of electrical power to one LDS divisional logic channel will initiate a channel trip.

14.2.12.1.14 Reactor Protection System Preoperational Test

(1) Purpose

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

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedures and approved the initiation of testing. The Rod Control and Information System, Instrument Air System, and the required AC and DC electrical power sources are operational. All other required interfacing systems shall be available, as needed, to support the specified testing. Additionally, appropriate simulated RPS multiplexed input signals shall be provided for each of the four RPS divisions. Special test instrumentation for simulated inputs, data reduction, and analysis shall be available for use. Systems which may be tripped by the input process variables that are not intended to function during a specified test shall be blocked out before the test.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the RPS functions properly as specified in Subsection 7.2.1 and applicable RPS design specification through the following testing:

(a) Correct implementation and operation of the RPS software-based controls and instrumentation. This test shall check the system behavior against the functional, performance and interface requirements as specified by the appropriate design documents and the HSSS.

(b) Verification of various system alarms used to monitor sensor and channel operation and availability for correct alarm actuation and reset.

(c) Proper calibration of primary sensors, including signal error checking and signal conditioning functions.

(d) Proper operation of each RPS output scram signals, CRD motor run-in signals from RPS and RPS backup scram signal initiations at the prescribed trip setpoints.

(e) Capabilities of automatic and manual bypass functions, including related logic.

(f) Proper operation of manual trip mode switch functions.

(g) 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. This test shall include verification of RPS fail-safe and single-failure-proof design features.

(h) Acceptable instrument channel response times, as measured from each applicable process variable (except for neutron sensors) to the de-energized of the scram pilot valve solenoids.

(i) Correct functioning of test and calibration hardware/software.

(j) Correct functioning of all RPS isolated output signals during individual or combinations of input conditions such as automatic system trip initiation, manual trip initiation, and channel sensor bypass operations.

(k) Acceptable timing established within which manual reset is automatically inhibited following a full reactor scram initiation condition.

14.2.12.1.15 Neutron Monitoring System Preoperational Test

(1) Purpose

To verify the proper operation of the Neutron Monitoring System (NMS) including fixed incore Startup Range Neutron Monitoring (SRNM) subsystems, Power Range Neutron Monitoring (PRNM) subsystems, Automated Traversing Incore Probes (ATIP) and related hardware and software, Oscillation Power Range Monitor (OPRM), and Multi-channel Rod Block Monitoring (MRBM) subsystem.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All subsystem components have been calibrated per vendor instructions. Additionally, instrument air, electrical power system, and RCIS are available and operational. All other required interfacing systems shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the NMS operates properly as specified in Subsections 7.6.1.1 and 7.7.1.6 and applicable NMS design specification through the following testing:

(a) Correct implementation and operation of the NMS software-based controls and instrumentation. This test shall check the system behavior against the functional, performance and interface requirements as specified by the appropriate design documents and the HSSS.

(b) Verification of various displays, alarms, and annunciators used to monitor system operation and status for correct functions.

(c) Proper operation of detectors and associated cabling, preamplifiers, and power supplies and signal conditioning equipment.

(d) Proper operation of ATIP drive mechanisms, indexers, ATIP control unit and ATIP automatic control system in all modes of operation.

(e) Proper operation of interlocks and equipment protective devices including those associated with the ATIP indexers and drive control units.

(f) Proper operation of trip and bypass functions including the APRM rapid core flow coastdown trip unit.

(g) 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.

(h) Proper operation of system and subsystem self-test diagnostic and calibration functions.

(i) Ability to communicate and interface with appropriate plant systems and between NMS subsystems.

(j) Ability of the APRM flow rate unit to generate core flow signal from core plate differential pressure measurements.

(k) Proper operation of ATIP purging system and valve control monitor unit.

(l) Verification of MRBM input matrix and trip output for correct functions.

(m) Verification of OPRM instrumentation for correct trip, alarm, and bypass functions.

14.2.12.1.16 Process Computer System Preoperational Test

(1) Purpose

To verify the proper operation of the Process Computer System (PCS), including the Performance Monitoring and Control System (PMCS) and the Power Generation Control System (PGCS) and their related functions.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All programming shall be complete and initial software diagnostic checks determined acceptable. The required input and output devices and various system interfaces shall be connected and available, as needed, for supporting the specified testing configurations.

(3) General Test Methods and Acceptance Criteria

Proper performance of system hardware and software will be verified by a series of individual and integral tests. These tests shall demonstrate that the PCS, including PMCS and PGCS, operates properly as specified in Subsection 7.7.1.5 and applicable PCS design specifications through the following testing:

(a) Verification of continuity checking, scaling, interface matching, and calibration of all analog and digital signals for correct functions.

(b) Proper operation of data logging and plotting, alarm monitoring, processing and display features.

(c) Verification of computer printouts and CRT displays and touch operation including the capability of locking out selected equipment indications.

(d) Proper data transmission and interface with other plant equipment such as the multiplexing system, neutron monitoring system, ATLM, site host computer and emergency operation facility.

(e) Verification of proper data flow and processing and of calculational accuracy.

(f) Verification of surveillance test guide for correct function.

(g) Proper operation of operator guidance and prompting functions, including voice announcement and status messages, in all operating modes for plant startup, shutdown and power maneuvering iterations.

(h) Proper operation of redundant controller functions in response to a simulated controller failure.

(i) Proper operation of system self-checking function.

(j) Capability of the PGCS to automatically decouple from the plant control circuits and revert the plant operation to manual mode upon receipt of a simulated failure signal.

Much of the testing performed during the operational phase is done utilizing simulated conditions and inputs via system hardware and software. Final system performance during live conditions and reactor core and plant performance calculation programs will be evaluated during the startup phase of testing (Subsection 14.2.12.2.7). The capability of the PGCS to operate with the APR in supporting automation of the normal plant startup, shutdown, and power operation will also be verified by this subsection.

14.2.12.1.17 Automatic Power Regulator Preoperational Test

(1) Purpose

To verify proper operation of the automatic power regulator (APR) over the range of required operating modes.

(2) Prerequisites

The software programming and initial diagnostic testing has been completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The Process Computer System, RCIS, RFC System, Turbine Control System, SB&PC System, and other required system interfaces shall be available to support the specified system testing.

(3) General Test Methods and Acceptance Criteria

The APR is a top level controller that interfaces with various lower level controllers and systems. APR testing, therefore, shall be closely coordinated with testing of related interfacing and affected systems. This test shall demonstrate that the APR System operates properly as specified in Subsection 7.7.1.7 and applicable APR System design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic for all modes of operation including transfers.

(b) Proper functioning of annunciators, alarms, and displays used to monitor system operation and status.

(c) Verification of proper data flow and processing, including the accuracy of calculations and control algorithms.

(d) Proper communication and interface with other control systems and related supporting and monitoring functions.

(e) Verification of the dynamic characteristics of load rate limiter and reactor power compensator for correct functions.

(f) Capability of the APR System to identify and isolate failure of process input signals.

(g) Proper operation of the redundant controller function upon a simulated controller failure.

(h) Proper operation of the APR system upon loss of any one power supply.

14.2.12.1.18 Remote Shutdown System Preoperational Test

(1) Purpose

Verify the feasibility and operability of intended remote shutdown functions from the Remote Shutdown System (RSS) panel and other local and remote locations outside the main control room which will be utilized during the remote shutdown scenario.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Communication shall be established between the RSS panel, main control room, and each system associated with the RSS. Additionally, the 480 VAC and 6.9 kVAC electrical power system shall be in operation and available and 125 VAC/125 VDC control power shall be supplied to the remote shutdown panel. The applicable portions of the RHR, HPCF, RCW, RSW, NBS, ACS, FCS and MUWC shall be available, as needed, to support the specified testing.

(3) 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 the remote shutdown scenario.

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. This test shall demonstrate that the RSS operates properly as specified in Subsection 7.4.1.4 and applicable RSS design specification through the following testing:

(a) Proper functioning of the system controls and instrumentation associated with the RSS after transfer of control to the RSS panel.

(b) Proper operation of remote shutdown system pumps and valves including establishment of system flow paths using RSS control.

(c) Proper functioning of RSS transfer switches including verification of proper override of main control room functions.

(d) Proper operation of prohibit and permissive interlocks and bypass functions after transfer of control. The instrument setpoints shall be according to the acceptance criteria for the respective system.

14.2.12.1.19 Reactor Water Cleanup System Preoperational Test

(1) Purpose

To verify that the operation of the Reactor Water Cleanup System (CUW), including pumps, valves, and filter/demineralizer equipment, is as specified.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Filter aid and resin material shall be available. The filter influent and effluent strainers must be installed prior to cleanup system operations to protect against gross resin injection to the RPV. Reactor Building Cooling Water, Instrument Air, CRD purge supply, Makeup Water System, and other required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations. Additionally, the reactor vessel, main condenser and Radwaste System shall be available and ready to receive water from the system. The reactor vessel shall be filled to its normal operation level. During any drainage operations, the reactor vessel water level shall be maintained high enough to provide adequate NPSH for the pump. Special provisions may be required for testing the CUW System in the vessel head spray mode.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the CUW System operates properly as specified in Subsection 5.4.8 and applicable CUW System design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip, including those associated with the leak detection and isolation system.

(b) Verification of various component alarms used to monitor system operation and availability for correct alarm actuation and reset.

(c) Proper operation of system valves, including timing, and position indication verification, if applicable.

(d) Proper operation of CUW pumps and motors during continuous run tests.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Satisfactory system performance capability based on ambient reactor pressure and temperature with all components, piping and instruments that constitute the entire system in the below listed mode of operation:

  (i) Rated operation (with 2 pumps and 2 filter-demineralizers)

  (ii) 50% flow rate operation (with 1 pump and 1 filter-demineralizer)

  (iii) RPV head spray operation

  (iv) Pump runout operation (with 1 pump in operation until operating conditions stabilized by using filter-demineralizer bypass line and setting flow rate to the established runout flow rate)

  Additionally, the RPV bottom drain flow rate shall be adjusted if necessary to the established value during rated operation.

(g) Proper CUW pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks and equipment protective devices in pump and valve controls.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) 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.

(k) Acceptable pump/motor vibrating levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(l) Proper operation of the CUW filter/demineralizers and associated support facilities.

(m) Proper operation of sampling stations and displays. This test is demonstrated per plant process sampling system preoperational test (Subsection 14.2.12.1.22).

(n) Acceptable performance capability of CUW heat exchangers to the extent practical. Otherwise, CUW heat exchanger confirmatory test can be performed in startup test stage.

14.2.12.1.20 Suppression Pool Cleanup System Preoperational Test

(1) Purpose

To verify that the operation of the Suppression Pool Cleanup System (SPCU) is as specified in all required operating modes.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The Instrument Air System, Makeup Water System and Electrical Power System shall be in operation and available for use during this test. The fuel pool and suppression pool shall be adequately filled and the appropriate filter/demineralizer support facilities and other system interfaces available, as needed, to support the specified testing.

(3) General Test Method and Acceptance Criteria

The suppression pool and fuel pool share common water treatment facilities. The SPCU System has a dedicated pump for circulating water to and from the suppression pool and through the common filter/demineralizer. However, the shared filter/demineralizer facilities are considered part of the FPCU System. Therefore, this preoperational test shall be closely coordinated with that of Subsection 14.2.12.1.21.

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the SPCU System operates properly as specified in Subsection 9.5.9 and applicable SPCU System design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms used to monitor system operation and availability for correct alarm actuation and reset

(c) Proper operation of system motor-operated and air-operated valves, including operability, position indication verification, timing and isolation function, if applicable

(d) Proper operation of SPCU pump and motor during continuous run tests

(e) Acceptable pump NPSH under the most limiting design flow conditions

(f) Proper system operation while placing and removing filter/demineralizer into and from service respectively

(g) Proper SPCU pump motor start sequence and actuation of protective devices

(h) Proper operation of all components subject to interlock signals

(i) Proper operation of permissive, prohibit, and bypass functions

(j) Proper system operation while providing filling water to the reactor well using the suppression pool as water source

(k) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation

(l) Proper system operation while supplying water to the RCW surge tanks and fuel pool (for FPCU system) using the condensate storage tank and suppression pool (backup) as the water source

14.2.12.1.21 Fuel Pool Cooling and Cleanup System Preoperational Test

(1) Purpose

To verify that the operation of the FPCU System, including the pumps, heat exchangers, controls, valves and instrumentation, is as specified.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. A sufficient quantity of chemically acceptable water is available for the performance of this test. All applicable electrical power to motors, control circuits, and instrumentation shall be available for use during this test. The spent fuel storage pool and dryer/separator storage pool are filled with demineralized water prior to the test. The portions of RHR and SPCU System required by the performance of this test shall be available. The Instrument Air System, Makeup Water Condensate System and Reactor Building Cooling Water System shall be in operation and available for use throughout this test. Additionally, all other required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the

FPCU System operates properly as specified in Subsections 9.1.3 and 7.6.1.4 and applicable design specifications through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip, including isolation and bypass of the non-safety-related FPCU filter/demineralizers.

(b) Verification of various component alarms used to monitor system operation and availability, including those associated with pool water level, for correct alarm actuation and reset.

(c) Proper operation of motor-operated and air-operated valves in the FPCU filter demineralizers, including valve operability for the main control room, valve position indicator and timing, if applicable.

(d) Proper operation of the FPCU pumps at various system flow rates. This test shall be verified by bypassing the filter/demineralizers on the flow path between the skimmer surge tanks and the fuel pool.

(e) Acceptable pump NPSH under the most limiting flow conditions during FPCU pump operation test in Item (d) above.

(f) Proper system operating conditions on various flow paths and operation modes in accordance with the applicable system design specification:

(i) Normal Heat Load Mode: with one subsystem and two subsystems in parallel and with the filter demineralizer inline or bypassed.

(ii) Earthquake Cooling Operating Mode: with the pumps in cleanup bypass mode of operation and the flow path begin with the skimmer surge tanks, through FPC pump, heat exchanger and supply water to fuel pool.

(iii) Draining Operating Mode (LCW collector pool): operate the system to drain water directly between reactor well pool/dryer-separator storage pool and LCW collector pool through installed draining piping.

(iv) Draining Operating Mode (suppression pool): operate the system to drain water directly between reactor well pool/dryer-separator storage pool and suppression pool through using FPCU pumps, filter/demineralizers and the SPCU returning piping to the suppression pool. This test can be performed in conjunction with the SPCU preoperational test (Subsection 14.2.12.1.20).

(g) Proper pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks function of FPCU pumps, including ability of pump start above the low level in skimmer surge tanks, pump

ON-OFF operation using switch in the main control room, and the pump into trip initiation on low-low surge tank level, low discharge flow and low pump suction pressure.

(i) Proper operation of permissive, prohibit and bypass functions.

(j) 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.

(k) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation.

(l) Proper functioning of pool antisiphon devices and acceptable nonleakage from pool drains, sectionalizing devices, and gaskets or bellows.

(m) Proper functioning of the system in conjunction with the RHR System in the supplement fuel pool cooling mode.

(n) Proper operation of filter/demineralizer units and their associated support facilities.

14.2.12.1.22 Plant Process Sampling System Preoperational Test

(1) Purpose

To verify the proper operation of the plant Process Sampling System (PSS) and the accuracy of equipment and techniques to be used for online and periodic sampling and analysis of overall reactor water chemistry (including that required to show compliance with Regulatory Guide 1.56), as well as that individual plant process streams, including the Post-Accident Sampling System (PASS).

(2) 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. Additional prerequisites include but are not limited to the following:

(a) All instrumentation provided for alarm, recording and analyzing functions shall be available and operational and properly calibrated.

(b) All applicable power sources to supply electric power to motors, control circuits, and instrumentation shall be available, as required, for test use.

(c) The system valve and electrical lineups shall be completed in accordance with the applicable plant operation procedures prior to the test.

(d) The following sampling panels shall be available and operational:

(i) Reactor Building sample station (CUW, CRD, PASS)

(ii) Feedwater corrosion product monitoring system panel

(iii) RHR, fuel pool and suppression pool sampling station

(iv) Turbine Building condensate system sampling

(v) Radwaste System sampling station

(e) All sample lines and components are operable.

(f) Instrument Air System, Makeup Water-Purified Distribution System, Turbine and Reactor Building Cooling Water (TCW and RCW) Systems are available to support testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of tests. This test shall demonstrate that the PSS, including PASS, operated properly as specified in Subsection 9.3.2 and applicable PSS design specification and manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of online sampling and monitoring equipment, considering required calibration, indication, and alarm/functions, including reactor water conductivity instrumentation and other equipment or instrumentation required to show compliance with Regulatory Guide 1.56.

(b) Capability of obtaining grab samples of designated process streams at the desired locations.

(c) Proper functioning of personnel protective devices at local sampling stations.

(d) Adequacy and accuracy of sample analysis methods.

(e) Proper operation of all motor-operated and air-operated valves, including operability from local control panel, open/closure indicators and timing, if applicable.

(f) Proper operative conditions and operative/stop indicators of all equipment except for valves from PASS local panel.

(g) Proper operation of interlock functions in conformity with IBD by detector practical operation or simulated signal operation.

(h) Proper operating condition without any abnormalities in the pump during continuous operation.

(i) Proper equipment functions in automatic mode of system operation during sampling, sample transportation and flushing of PASS.

(j) Correct operation of temperature baths, relief, sensors, and indicators specified by the P&ID.

(k) Capability of opening PASS isolation valve under simulated LOCA conditions.

14.2.12.1.23 Process Radiation Monitoring System Preoperational Test

(1) 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 and/or cleanup systems upon detection of high radiation levels in any of the process streams that are monitored.

(2) 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 preamplifiers, power supplies, indicator and trip units, and sensors and converters, have been calibrated according to vendor instructions. Check sources shall be in places where required and all radiation monitors shall be tested using a check source. Upscale and downscale annunciator setpoints shall be set as calculated based on flow and release limits prior to this test. The required interfacing systems shall be available, as needed, to support the specified testing.

Additionally, appropriate simulation of sensors and PRMS response shall be available for use. Systems which may be tripped by the input process variables that are not intended to function during a prescribed test shall be blocked out before the test specified.

(3) General Test Methods and Acceptance Criteria

The PRMS consists of a number of subsystems that monitor the radiation levels of various liquid and gaseous process streams, building and area ventilation exhausts, and plant and process gaseous and liquid effluents. The offgas pre-treatment and post-treatment monitors and the main steamlines monitors are also included.

Performance shall be observed and recorded during a series of individual component and integrated subsystem tests. This test shall demonstrate that the PRMS operates properly as specified in Subsection 11.5 and the appropriate manufacturer's technical instruction manuals through the following testing:

(a) Proper calibration of detector assemblies and associated equipment using a standard radiation source or portable calibration unit.

(b) Proper functioning of indicators, recorders, annunciators, and alarms.

(c) Proper system trips in response to high radiation and downscale/inoperative conditions.

(d) Proper operation of system initiation and isolation, permissive, prohibit, interlock, and bypass functions.

(e) Proper operation of primary and backup sampling functions.

(f) Proper operation of all process sample racks in accordance with appropriate manufacturer's technical instruction manuals.

(g) Proper implementation and operation of the PRMS software-based controls and instrumentation. This test shall check the system behavior against the functional, performance and interface requirements as specified by the appropriate design documents and the Hardware/Software System Specification (HSSS).

14.2.12.1.24 Area Radiation Monitoring System Preoperational Test

(1) 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, including Reactor Building, Control Building, Service Building, Radwaste Building and Turbine Building.

(2) Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. High radiation alarm setpoints shall be properly established based on sensor location, background radiation level, expected radiation level and low occupation dose prior to the test. Indicator and trip units, power supplies, and sensor/converters have been calibrated according to vendor instructions.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated subsystem tests. This test shall demonstrate that the ARM System operates as specified in Subsection 12.3.4 and the appropriate manufacturer's technical instruction manuals through the following testing:

(a) Proper calibration of detector assemblies and associated equipment using a standard radiation source or portable calibration unit.

(b) Proper functioning of indicators, recorders, annunciators, and audible alarms.

(c) Proper system trips at correct prescribed setpoints in response to high radiation and downscale/inoperative conditions.

(d) Proper operation of permissive, prohibit, interlock, and bypass functions.

(e) Proper functioning and operation of the self-test feature for gross failure and loss of power detection.

(f) Proper operation of each ARM channel integrated from detector, local auxiliary units, with indicator and audible warning alarms to the recording devices.

14.2.12.1.25 Moved to 14.2.12.1.24

14.2.12.1.26 Containment Atmospheric Monitoring System Preoperational Test

(1) Purpose

To verify the ability of the Containment Atmospheric Monitoring System (CAMS) to monitor concentration of oxygen, hydrogen, and gross gamma radiation levels in the wetwell and drywell airspace regions of the primary containment.

(2) 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 setup has been accomplished per vendor instructions. The CAMS valve lineups are completed. All applicable power sources to supply electric power to control circuits and instrumentation are available for use. Appropriate simulation of sensors and CAMS response is provided prior to the test.

(3) General Test Methods and Acceptance Criteria

The Containment Atmosphere Monitoring System consists of radiation, oxygen, and hydrogen monitoring subsystems. Performance of each of these subsystems shall be observed and recorded during a series of individual component and integrated subsystem tests. These tests shall demonstrate that the CAMS operates properly as specified in Subsection 7.6.1.6 and applicable CAMS design specifications through the following testing:

(a) Proper calibration of detector assemblies and associated equipment using a standard radiation source or portable calibration unit.

(b) Verification of control room indicators, recorders, computer points, annunciators, and various component alarms for correct functions.

(c) Proper operation of the CAMS software-based controls and instrumentation. This test shall check the system behavior against the functional, performance and interface requirements as specified by the appropriate design documents and the HSSS.

(d) Proper operation of interlock, and bypass functions (for H_2/O_2 monitoring subsystem only).

(e) Proper initiation and operation of gamma radiation monitoring and H_2/O_2 monitoring subsystems in response to a LOCA signal in automatic mode and operator demand in manual mode.

(f) Proper operation of calibration gas supply systems and self-calibration functions.

(g) Proper operation of the heat tracing used in each H_2/O_2 sample line to maintain prescribed temperature.

(h) Proper operation of all remote-operated solenoid operated valves.

(i) Proper operation of oxygen and hydrogen analyzers as specified by the appropriate manufacturer's technical instruction manual.

(j) Proper operation of the CAMS containment isolation valves automatic closure function upon receipt of a simulated containment isolation initiation signal.

14.2.12.1.27 Instrument Air and Station Service Air Systems Preoperational Tests

(1) Purpose

To verify the ability of the Instrument Air (IA) and Service Air (SA) Systems to provide the design quantities of clean dry compressed air to user systems and components and the operation of air compressors, dryer units, air receiver and filters associated with the system.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Primary and backup electrical power, the supplied system and components loads, RCW System, HVAC System, HPIN System Atmospheric Control System and other required system interfaces are available, as needed, to support the specified testing. Additionally, valves in other systems that are required for the loss of instrument air pressure tests shall be available.

(3) General Test Methods and Acceptance Criteria

The IA System and the SA System are specified as separate systems. However, since they are so closely related, the preop test requirements are essentially the same.

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the IA and SA Systems operate as specified in Subsections 9.3.6 and 9.3.7, respectively, and applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms associated with air compressors, dryer units, air receiver and filters for correct actuation and reset.

(c) Proper operation of system valves, including timing and isolation functions if applicable, under expected operating conditions.

(d) Proper operation of compressors, after cooler and moisture separator, air receiver, dryer units and filters in all design operating modes.

(e) Ability of compressor(s) to maintain receiver at specified pressure(s) and to recharge within specified time under design loading conditions.

(f) Proper operating conditions (capacity, pressure, temperature and quality of air from the system) and system performance capability of the IA System during various mode of operations (normal operation mode, backup operation mode, refueling outage mode) in accordance with the appropriate IA System design specification.

(g) Proper compressor start sequence (including load and unload) and actuation of protective devices.

(h) Proper operation of interlocks and equipment protective devices in compressor and valve controls.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) 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.

(k) Proper operating conditions (capacity, pressure, temperature, and quality of air from the system) and the system performance capability of the SA System during various mode of operations (normal operating mode and IA System backup operation mode).

(l) Ability of the product air to meet end use cleanliness requirements with respect to oil, water, and particulate matter content.

(m) Continued operability of supplied loads in response to credible failures that result in an increase in the supply system pressure.

(n) Proper operation of the instrument air system in accordance with the design specification during a loss of instrument air testing. This test is done on each air line which serve safety-related equipment by shutting off the instrument and control air system in a manner that will simulate a sudden air pipe break and a gradual loss of pressure as required by Regulatory Guide 1.68.3.

14.2.12.1.28 High Pressure Nitrogen Gas Supply System Preoperational Test

(1) Purpose

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

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The Instrument Air System and communication equipment are available and operational for test use. User system loads and other required system interfaces shall be available, as needed, to support the specified system testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual components and integrated system tests. These tests shall demonstrate that the HPIN System operates properly as specified in Subsection 7.3.1.1.10 and applicable HPIN System design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms, for correct functions of alarm actuation and reset, alarm set value, alarm indication and operating logic.

(c) Proper operation of all motor-operated and air-operated valves, including valve operability, indicator lamp lighting, and timing and isolation function, if applicable.

(d) Ability to maintain receiver(s) at specified pressure(s) under design loading conditions.

(e) Proper system operation and performance capability at the following operating conditions:

(i) Nitrogen gas supplies to SRV accumulators with the pressure control valves maintaining specified value of supply pressure.

(ii) Supply pressure to the SRV accumulators meets the specified value described in the appropriate HPIN System design specification.

(iii) HPIN System is operated with the normal operation lineup in the following test cases:

— Atmospheric Control System is used as nitrogen source.

— Nitrogen gas bottles are used as nitrogen source.

(f) Proper operation of interlocks and equipment protective devices including operation of all components subject to interlocking, interlocking set value and operating logic.

(g) Proper operation of permissive, prohibit, and bypass functions.

(h) 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.

(i) Acceptable vibration levels and system piping movements during both transient and steady-state operation.

(j) Ability of the nitrogen gas to meet end use cleanliness requirements with respect to oil, water, and particulate matter content.

(k) Proper operation of the HPIN system during a loss of nitrogen gas testing. This test is done by shutting off the nitrogen gas supply system in a manner that will simulate a sudden nitrogen gas supply pipe break and a gradual loss of pressure (plugging or freezing) as required by Regulatory Guide 1.68.3.

14.2.12.1.29 Reactor Building Cooling Water System Preoperational Test

(1) Purpose

To verify the ability of the Reactor Building Cooling Water (RCW) System, including its ability to supply design quantities of cooling water, to essential and nonessential loads, as appropriate, during normal, abnormal, and accident conditions.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Primary and backup power, reactor Service Water, Instrument Air, MUWP System, 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 practicable during heat exchanger performance evaluation.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the RCW System and its auxiliary equipment operate properly as specified in Subsections 9.2.11 and 7.3.1.1.7 and applicable RCW System design specifications through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms for correct response to process variables and provide alarms at prescribed value.

(c) Proper operation of all motor-operated and air-operated valves, including open/closure cycling and timing, and position indicator verification and isolation function, if applicable.

(d) Proper operating conditions (flow, vibration, bearing temperature) of the RCW pumps in design mode of operations.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper operating conditions and system performance capability during the following system operational tests:

  (i) System operation tests at various operating modes (normal, shutdown cooling, hot standby without offsite power source, LOCA, and refueling outage)
  (ii) Switching capability test of RCW pumps and heat exchangers between 1-unit and 2-unit operations
  (iii) Operation mode transfer test from normal mode to LOCA mode by LOCA signal
  (iv) Transferability test to the hot standby mode operation upon loss of offsite power
  (v) System operation capability from the remote shutdown panel
  (vi) Flow balancing for all modes of operation

(g) Proper RCW pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks functions including operations of all components subject to interlocking. This test can be performed by using simulated signal, if actual initiation is not practical.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) 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. This includes isolation/shedding of nonessential loads and divisional interties when a LOCA signal is present.

(k) Acceptable pump/motor vibration and noise levels and system piping movements during both transient and steady-state operation. This test can be performed in conjuction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(l) Proper operation of system surge tank and chemical addition tank and their associated functions during system operational test.

(m) Acceptable performance capability of RCW heat exchangers, to the extent practical. Otherwise, RCW heat exchanger confirmatory test can be performed in startup test stage.

14.2.12.1.30 Not Used

14.2.12.1.31 Hot Water Heating System Preoperational Test

(1) Purpose

Verify the ability of the Hot Water Heating System (HWHS) to provide hot water to the appropriate HVAC systems and the operation of HWH pump, heat exchanger, surge tank and chemical addition tank.

(2) Prerequisites

The construction tests have been completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Electrical power, SA System, TCW System, Heat Steam System, HVAC System, HNCW System and other required interfacing systems shall be available, as needed, to support the specified testing. Additionally, a temporary strainer shall be installed at the suction side of the HWH pump.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the HWHS operates properly as specified in appropriate HWHS design specification and manufacturer's technical instruction manual through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms, for correct system response to process variable, and provides alarms at the prescribed value

(c) Proper operation of system valves, including open/closure cycling and position indicator verification, if applicable

(d) Proper operating conditions (flow, vibration, bearing temperature) of the HWH pumps during continuous pump run test

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper operating conditions and system performance capability during the following operation mode tests:

(i) Plant normal operation mode
(ii) Plant shutdown and inspection mode

(g) Proper pump motor start sequence and actuation of protective devices

(h) Proper operation of interlock functions, including operation of all components subject to interlocking (e.g., HWHS pump trip on low surge tank level, and system water temperature control, etc.)

(i) Proper operation of permissive, prohibit, and bypass functions

(j) Proper operation of system surge tank and chemical addition tank and their associated functions during system operation mode tests

14.2.12.1.32 HVAC Emergency Cooling Water System Preoperational Test

(1) Purpose

To verify the ability of the HVAC Emergency Cooling Water (HECW) 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 containing essential systems and equipment.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Normal and auxiliary electrical power, IA, MUWP, RCW, applicable HVAC System cooling coils, and other required system interfaces shall be available, as needed, to support the specified system testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the HECW System and its auxiliary equipment operate properly as specified in Subsections 9.2.13 and 7.3.1.1.9 and applicable HECW System design specification through the following testing:

(a) Proper operation of instrumentation and system control functions including flow switch, surge tank level controller, and chilled water temperature controller

(b) Verification of various component alarms, for correct alarm actuation and reset, alarm set value, alarm indication and operating logic

(c) Proper operation of system motor-operated and air-operated valves, including operability and position indication verifications, if applicable

(d) Proper operation of HECW pumps and motors during continuous run tests

(e) Acceptable pump NPSH under the most limiting design flow conditions

(f) Proper operating conditions (flow rate, pressure, and temperature) and system performance capability in conformity with the design during the following system operational tests:

(i) System flow rate test to confirm that system flow rate is prescribed value under the system design operating conditions.

(ii) Single operational test of HECW pumps to verify that each HECW pump can be individually operated continuously at rated flow rate without any abnormalities.

(iii) Operational test of all HECW pumps to confirm that all HECW pumps can be continuously operated without any problems in HECW System.

(iv) Flow rate to each load shall be verified and adjusted (if necessary) to be consistent with the prescribed value. This test shall also confirm that each coil in supply units has adequate cooling capacity and each room temperature is under the design temperature.

(v) Chemical addition test to confirm that the concentration of inhibitor in circulating water in HECW System is within prescribed limits.

(g) Proper pump motor start sequence and actuation of protective devices

(h) Proper operation of interlocks including confirmation that all components are operated in conformity with IBD and Sequence Diagram

(i) Proper operation of permissive, prohibit, and bypass functions

(j) 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

(k) Acceptable pump/motor vibration and noise levels and system piping movements during both transient and steady-state operation

14.2.12.1.33 HVAC Normal Cooling Water System Preoperational Test

(1) Purpose

To verify the ability of the HVAC Normal Cooling Water (HNCW) 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 containing nonessential equipment and systems.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Primary and auxiliary electrical power, IA System, TCW System, MUWP System, the applicable HVAC System cooling coils, and other required system interfaces shall be available, as needed, to support the specified system testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the HNCW System and its auxiliary equipment operate properly as specified in Subsection 9.2.12 and applicable HNCW System design specification through the following testing:

(a) Proper operation of instrumentation and system control functions, including surge tank level controller, chilled water temperature controller, and chilled water flow switches

(b) Verification of various component alarms, for correct alarm actuation and reset, alarm set value, alarm indication and operating logic

(c) Proper operation of system motor-operated and air-operated valves, including operability, position indication and isolation functions, if applicable

(d) Proper operation of HNCW pumps and motors during continuous run tests

(e) Acceptable pump NPSH under the most limiting design flow conditions

(f) Proper operating conditions (flow rate, pressure, and temperature) and system performance capability in conformity with the design during the following system operational tests:

(i) System flow rate test to confirm that system flow rate is prescribed value under the system design operating conditions.

(ii) Single operational test of HNCW pumps to verify that each HNCW pump can be individually operated continuously at rated flow rate without any abnormalities.

(iii) Operational test of all HNCW pumps to confirm that all HNCW pumps can be continuously operated without any problems in HNCW System.

(iv) Flow rate to each load shall be verified and adjusted (if necessary) to be consistent with the prescribed value. This test shall also confirm that each coil in supply units has adequate cooling capacity and each room temperature is under the design temperature.

(v) Chemical addition test to confirm that the concentration of inhibitor in circulating water in HNCW System is within prescribed limits.

(g) Proper pump motor start sequence and actuation of protective devices

(h) Proper operation of interlocks including confirmation that all components are operated in conformity with IBD and Sequence Diagram

(i) Proper operation of permissive, prohibit, and bypass functions

(j) 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

(k) Acceptable pump/motor vibration and noise levels and system piping movements during both transient and steady-state operation

(l) Proper operation of the standby chiller and pump auto start feature upon loss of an operating chiller or pump

14.2.12.1.34 Heating, Ventilation, and Air Conditioning Systems Preoperational Test

(1) Purpose

To verify the ability of the various Heating, Ventilating, and Air Conditioning (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 essential and nonessential equipment and systems.

(2) Prerequisites

The construction tests 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, RCW System, HVAC normal and emergency cooling water systems, HWH System, SGTS, IA System and any other required system interfaces shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

There are numerous HVAC Systems in the plant, located throughout the various buildings. Each system typically consists of some combination of supply and exhaust air handling units and local cooling units, and the associated fans, dampers, valves, filters, heating and cooling coils, and control and instrumentation. The HVAC Systems to be tested shall include the following: spent fuel pool area ventilation system, service building ventilation system, radwaste building HVAC System, auxiliary area ventilation system, diesel-generator area ventilation system, reactor building ventilation system, control building HVAC System, turbine island ventilation system, drywell cooling system and control room habitability area HVAC System.

Since 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. This test shall demonstrate that the HVAC System operates properly as specified in Subsection 9.4 and applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms used to monitor system operation and availability for correct alarm actuation and reset

(c) Proper operation of HVAC system valves and dampers, including operating times and isolation functions, if applicable, under expected operating conditions.

(d) Proper operation of HVAC system fans humidifiers, heaters, and air conditioners in all design operating modes

(e) Proper system operating conditions and system performance capability during the following system operational tests:

(i) Capabilities of system operation at normal-run mode and emergency-run mode

(ii) Capability of automatic switchover to the standby supply/exhaust fan in response to the overload trip signal of the operating equipment

(iii) Start/stop sequence of the supply/exhaust fans in either manual or automatic modes of operations

(iv) Overall system flow balancing for all modes of operation

(f) Proper operation of interlocks and equipment protective devices

(g) Proper operation of permissive, prohibit, and bypass functions

(h) Proper system operation while powered from primary and alternate sources, including transfers, and in degraded modes of which the system is expected to remain operational

(i) 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

(j) Ability of exhaust, supply, and recirculation filter units to maintain the specified dust and contamination free environment(s)

(k) Ability of the control room habitability function to detect the presence of smoke and/or toxic gas and to remove or prevent in-leakage of such (in accordance with Regulatory Guide 1.95)

(l) Proper operation of HEPA filters and charcoal adsorber sections of the control room ESF filter trains including the in-place testing requirements of Regulatory Guide 1.52 regarding visual inspections and airflow distribution, DOP penetration and bypass leakage testing

(m) Ability of the heating and cooling coils to maintain the specified thermal environment(s) while considering the heat loads present during the preop test phase

(n) Ability of primary and secondary containment HVAC System to provide sufficient purge, exhaust, and recirculation flows in support of drywell inerting and deinerting operations

(o) Ability of the standby refrigerator and pump units to automatically start upon receipt of a simulated high cooling water temperature or operating pump failure signal

(p) Ability of the standby control room habitability area HVAC division to automatically start in the emergency mode upon receipt of a simulated low flow signal from the operating control room habitability area HVAC division

14.2.12.1.35 Atmospheric Control System Preoperational Test

(1) Purpose

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

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure(s) and approved the initiation of testing. Electric power, IA System, HVAC System, HPIN, and SGTS are operational and available for use. The primary and secondary containments are intact, their HVAC systems operational, and all other required interfaces available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the ACS operates properly as specified in Subsection 6.2.5, and applicable ACS design specifications and manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms such as nitrogen gas supply equipment, electric heater and PCV monitoring instrumentation for correct alarm actuation and reset

(c) Proper operation of system valves, including timing and isolation functions, if applicable

(d) Proper operating conditions and system performance capability during various modes of operations (inerting, makeup operation, venting, and de-inerting) in accordance with the appropriate ACS design specification

(e) Proper operation of interlock functions and all components subject to interlocking

(f) Proper operation of permissive, prohibit, and bypass functions

(g) 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

(h) Proper operation of the ACS in providing nitrogen gas through inlet line to pressurize the PCV during containment structural integrity test (Subsection 14.2.12.1.40.2) and integrated leakage rate test (Subsection 14.2.12.1.40.1)

(i) Capability of opening the ACS drywell purge exhaust bypass valve, wetwell purge exhaust bypass valves and the exhaust isolation valves under a simulated primary containment isolation condition

14.2.12.1.36 Standby Gas Treatment System Preoperational Test

(1) Purpose

To verify the ability of the Standby Gas Treatment System (SGTS) to establish and maintain a negative pressure within the secondary containment and to adequately filter the resultant exhaust air flow.

(2) Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. IA System, MUWP System, electric power systems and communication equipment are available for use. All system instruments shall agree with P&ID and IDS and properly calibrated in accordance with instructions of instrument suppliers. The primary and secondary containments are intact and all other interfacing systems are available as required to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the SGTS operates properly as specified in Subsections 6.5.1.4 and 7.3.1.1.5 and applicable manufacturer's technical instruction manuals through the following:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms for correct alarm actuation and reset, alarm set value, alarm indication and operating logic.

(c) Proper operation of all motor-operated and air-operated valves and dampers, including operability using opening/closing switches in the main control room, valve indication lamp lighting and timing, if applicable.

(d) Proper operation of SGTS exhaust fans during continuous run tests.

(e) Performance and efficiency of HEPA filters and leaktightness of charcoal adsorber section per Regulatory Guide 1.52.

(f) Proper operating conditions and performance capability of the SGTS during following system operational tests:

 (i) Emergency Operating Mode Test: the system shall be brought to the rated flow operating condition by starting the SGTS exhaust fan and adjusting the dryer train inlet valve in single and parallel loop operation. By this test, it shall be confirmed that stabilized continuous system operation is possible and that performance of SGTS exhaust fan and heating coil, as well as differential pressure of each filter meet appropriate SGTS equipment requirement specification.

 (ii) Primary Containment Exhaust Operating Mode Test: the system shall be operated to exhaust from primary containment by operating SGTS under the conditions where primary containment is not isolated. The items to be confirmed by this test shall be the same as the emergency operating mode test.

(g) Ability to maintain air tightness of building structures forming reactor secondary containment and the openings and penetrations provided in those structures. This secondary containment leak rate test shall be performed by operating the SGTS with negative pressure maintained inside the building under reactor auxiliary building HVAC System isolated conditions. In addition, this test shall confirm that SGTS is operable without generating the alarm for high differential pressure between building and open air.

(h) Proper operation of interlocks and equipment protective devices, including operations of all components subject to interlocking, interlocking set value and operating logic.

(i) Proper operation of the system in response to an automatic startup signal while in standby condition. By this test, it shall be confirmed that the system is practically operable in accordance with IBD and sequence diagram and that there are no difficulties in the system operation.

(j) Proper operation of SGTS components including heaters, demister, and moisture separator, etc.

(k) 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.

14.2.12.1.37 Containment Isolation Valve Leakage Rate Tests

Those containment isolation valves (CIV) that receive leakage rate test (Type C) are indicated in Table 6.2-7. Description of and criteria for preoperational leakage rate tests of containment isolation valves are given in Subsection 6.2.6.3.

Prior to the commencements of Type C test on each CIV, the SCG shall have reviewed the test procedure and approved the initiation of testing. Additionally, the following pretest requirements shall be met:

(1) Required test instrumentation (e.g., pressure and temperature sensors, flowmeters and stop watch) has been installed, calibrated and functionally tested.

(2) Each CIV to be tested shall be closed by normal operation and without any preliminary exercising or adjustments (e.g., no tightening of valve after closure by valve motor).

(3) Each CIV to be tested is operable.

(4) Permanent pneumatic (air or nitrogen) supply or a portable air compressor with filters and valves must be available.

(5) Test connections for pressurizing or venting (or both) the test volume of the CIV to be tested shall be available.

(6) Test boxes used for Type C testing shall be checked for accuracy agreement between sensor readout and check standard daily when in use.

14.2.12.1.38 Containment Penetration Leakage Rate Tests

Those containment penetrations that receive Type B containment leakage testing are indicated in Table 6.2-8. Descriptions of and criteria for preoperational leakage rate tests of containment penetrations are given in Subsection 6.2.6.2. Prior to the commencement of Type B test on each containment penetration, the SCG shall have reviewed the test procedure and approved the initiation of testing. Additionally, the following pretest requirements for the containment penetration leakage rate test shall be met:

(1) A permanently installed system consisting of a pressurized gas source (air or nitrogen) and the manifolding and valving may be provided and used as pressurizing equipment.

(2) Required instrumentation for Type B test (e.g., temperature and pressure sensors, flowmeters) shall be calibrated, installed and ready to support the test.

(3) Test boxes used for Type B testing shall be checked for accuracy agreement between sensor readout and check standard daily when in use.

14.2.12.1.39 Containment Airlock Leakage Rate Tests

Descriptions of and criteria for preoperational leakage rate tests of containment airlocks are given in Subsection 6.2.6.2. The pretest requirements as listed in Subsection 14.2.12.1.38 above shall also be met for the performance of this test.

14.2.12.1.40 Containment Integrated Leakage Rate and Structural Integrity Tests

14.2.12.1.40.1 Containment Integrated Leakage Rate Test

The preoperational containment integrity leakage rate test (ILRT, Type A) is performed to verify that the actual measured containment leakage rate does not exceed the design limit stated in the Technical Specifications.

Prior to commencement of any Type A test, the following pretest requirements shall be met in addition to the normal testing requirements:

(1) Construction within primary containment has been completed.

(2) Reactor vessel and suppression pool are filled with water to the normal operating level.

(3) Primary containment penetration construction is complete through the first isolation valve.

(4) Required test equipment has been installed, calibrated, and functionally demonstrated.

(5) System required to support testing are operational.

(6) Individual leak rate tests, Type B and C of 10CFR50, Appendix J, have been completed.

(7) The structure integrity test (Subsection 14.2.12.1.40.2) has been satisfactorily completed.

(8) A general inspection of the accessible interior and exterior surfaces of the primary containment structures and components shall have been performed and corrective actions have been taken if evidence of structural deterioration exists.

(9) Functional tests of all containment isolation valves shall have been completed and closure of containment isolation valve is accomplished by normal operation without any preliminary exercising or adjustments prior to the start of Type A tests.

(10) The primary containment atmosphere is allowed to stabilize for a minimum of 4 hours after reading test pressure prior to the start of Type A tests.

(11) The fluid systems shall be aligned in accordance with 10CFR50, Appendix J, Section III A.1(d).

(12) Components not designed to withstand the test pressure, such as refueling equipment or instruments shall be removed or otherwise protected.

14.2.12.1.40.2 Containment Structural Integrity Test

The containment structure integrity test is performed to demonstrate the capability of primary containment to withstand specified internal pressure loads. Description of and criteria for the test is given in Subsection 3.8.1.7.1. In addition to the normal testing requirements, the following prerequisites must be completed prior to the test:

(1) For the first prototype ABWR containment structure only, instrumentation required for the measurement of strains shall be installed, calibrated and functionally demonstrated.

(2) Suppression chamber and spent fuel pool are filled with water to the normal operation level.

(3) The containment construction is complete and construction equipment removed.

(4) Pressurizing and test equipment is checked out and ready for the test.

(5) Equipment incapable of withstanding the test pressure removed from containment or otherwise protected.

(6) Primary containment inspection complete.

14.2.12.1.41 Pressure Suppression Containment Bypass Leakage Tests

The pressure suppression containment bypass leakage test is performed at high and low test pressures to detect leakage in the drywell to suppression chamber. The preoperational high-pressure leakage test is performed on a schedule consistent with the containment structural integrity test described in Subsection 14.2.12.1.40.2. This test will be performed at approximately the peak drywell to wetwell differential pressure following the high-pressure structural test of the diaphragm. The low-pressure leakage test is performed at a differential pressure corresponding to approximately the submergence of the drywell to suppression chamber vents.Test procedures are identical to those used for other penetrations under isolation conditions as discussed in Subsection 6.2.6. Description of and criteria for this test are given in Subsection 6.2.1.1.5. In addition to the normal testing requirements, the following requirements must be complete prior to the test:

(1) The pressure is allowed to stabilize for a period of one hour after attaining test pressure prior to start of the test.

(2) The containment ventilation system is operable to support this test.

(3) All closures are in place.

(4) Pressurizing and test equipment is checked out and ready for the test.

(5) Suppression chamber is filled with water to normal operating level.

14.2.12.1.42 Containment Isolation Valve and MOV Tests

14.2.12.1.42.1 Containment Isolation Valve Functional and Closure Timing Tests

The Containment Isolation System is discussed in Subsection 6.2.4 with characteristics of and requirements for individual valves listed in Table 6.2-7. 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 Table 6.2-7 for system affiliation of individual valves). Overall containment isolation initiation logic is a function of the LDS, the testing of which is described in Subsection 14.2.12.1.13. Prior to the start of each CIV functional and closure timing test, the following pre-test requirements shall be met in addition to the normal testing requirements:

(1) All permanently installed equipment and instrumentation shall have been functionally operated and calibrated.

(2) All CIVs and other equipment that starts or stops automatically upon receipt of a containment isolation signal must be operable and in their untripped condition prior to the test.

14.2.12.1.42.2 Safety-Related Motor-Operated Valves Baseline Pre-Service Tests

The motor-operated valve (MOV) testing under various differential pressure and flow up to maximum achievable conditions is discussed in Subsection 3.9.6.2.2. This type of testing is to determine the torque and thrust requirements of the valves at design conditions. Baseline pre-service testing (Subsection 3.9.7.3) of the safety-related MOVs will be done as part of the system operational tests of the systems to which such valves belong during the pre-operational test stage.

14.2.12.1.43 Wetwell-to-Drywell Vacuum Breaker System Preoperational Test

(1) Purpose

To verify proper functioning of the Wetwell-to-Drywell Vacuum Breakers System (WDVBS).

(2) Prerequisites

The visual inspections of major mechanical components associated with the WDVBS have been successfully completed and the SCG has reviewed the test procedure and has approved the initiation of testing. Additional prerequisites include but are not limited to the following:

(a) All permanently installed instrumentation have been calibrated and adjusted to the values specified in the applicable design documents.

(b) Facilities are provided in the suppression chamber air space to facilitate removal and servicing of the WDVBS valve intervals, if required.

(c) Pneumatic sources are available for performing the valve leaktightness test.

(d) Appropriate power sources to supply electrical power to all instrumentation are available for use.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the WDVBS operates properly as specified in Subsection 6.2.1.1.5 through the following testing:

(a) Proper operation of vacuum breaker valves, including verification of opening and closing setpoints.

(b) Proper operation of instrumentation and alarms used to monitor system status such as valve position indication.

(c) Proper functioning of valve positive closure devices including verification of adequate valve leak tightness.

14.2.12.1.44 Post Accident Monitoring System Instrumentation Preoperational Test

(1) Purpose

To verify the proper operation of the Post-Accident Monitoring System (PAMS) to provide information for long-term monitoring of the drywell and wetwell atmospheres and suppression pool temperature and level during both normal operations and accident conditions in the primary containment.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The suppression pool shall be filled and expected to undergo measurable level and temperature changes at some point during the scheduled testing. The required interfacing systems that provide instruments for PAM indications, such as NBS, CAMS, PRMS, and SPTM Systems shall be available and ready to the extent to support the specified testing. Additionally, any parallel testing to be performed in conjunction with the testing of this subsection is appropriately scheduled.

(3) General Test Methods and Acceptance Criteria

A description of the instrumentation required for containment monitoring is presented in Section 7.5 for the PAMS. Preoperational testing of these instruments will be performed in conjunction with the testing of the applicable systems. Only that instrumentation associated with the PAMS requiring special considerations is discussed below.

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the PAMS functions properly as specified in Subsection 7.5.1.1 and applicable system design specifications through the following testing:

(a) Proper tracking of drywell pressure by all instrument channels (see Subsection 1A.2.4) during containment integrated leak rate testing (Subsection 14.2.12.1.40.1)

(b) Proper operation and response of all suppression pool level instrumentation during actual changes in pool level

(c) Proper operation and tracking of all Suppression Pool Temperature Monitoring (SPTM) System instrument channels during actual change in pool temperature

(d) Proper functioning of associated indicators, recorders, annunciators, and alarms including those instruments in the main control room and at the remote shutdown panel

(e) Proper outputs to all system components that are required to function upon receiving inputs from the PAMS instruments at the prescribed high/low setpoints and inoperative conditions

(f) Proper signal processing of the PAMS related instrumentation by the microprocessor as specified by the appropriate design specification

(g) Proper operation of drywell and wetwell air temperature and pressure monitoring subsystem instrumentation

14.2.12.1.45 Electrical Systems Preoperational Test

The total plant electrical distribution network is described in Chapter 8. Because of the similarities in their design and function, the testing requirements for the systems associated with the plant electrical distribution network and their respective components can be divided into the three general categories as described below. The specific testing required for each system is described in the applicable design and testing specifications.

14.2.12.1.45.1 DC Power System Preoperational Test

(1) Purpose

To verify the ability of DC power systems to supply highly reliable, uninterruptable power for instrumentation, logic, control, emergency lighting and other normal and emergency loads that must remain operational during and after a loss of preferred power(LOPP).

(2) Prerequisites

The construction tests for the individual component associated with the DC power supply system have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All the permanently installed and test instrumentation shall have been properly calibrated and operational. The Fire Protection System shall be available. Adequate ventilation shall be available for the battery rooms. All DC emergency lighting shall be available. DC to AC inverters shall be available and operational. The 480 VAC system shall be in operation and supply power to the battery chargers for the 125 VDC safety-related loads. Additionally, a load shall be available for the performance of battery capacity check tests.

(3) General Test Methods and Acceptance Criteria

The DC power supply systems consist of Class 1E and non-class 1E electrical equipment including batteries, battery chargers, inverters, static transfer switches, and associated instrumentation and alarms, that is used to supply all required LOCA and/or LOPP loads or other required loads. Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the DC power system operates properly as specified in Subsection 8.3.2 through the following testing:

(a) Capability of each Class 1E DC battery system to provide the rated load demand as specified by Subsection 8.3.2, two hours for connected Class 1E loads, and eight hours for the battery associated with the RCIC System.

(b) Capability of each battery charger to fully recharge its associated battery (or bank), from the discharged state, while simultaneously supplying the specified loads.

(c) Verification of proper load sizing and rated capacity by performing a discharge test. The individual voltage and specific gravity of each cell shall be within the prescribed limits following the performance of discharge test.

(d) Capability of each DC bus in meeting the specified level of redundancy and electrical independence for its particular application.

(e) Proper functioning of transfer devices, breakers, cables and inverters (including load capability). Inverters and static transfer switches operations can be demonstrated in conjunction with the vital AC power supply system testing (Subsection 14.2.12.1.45.4).

(f) Proper calibration and trip settings of protective devices, including relaying, and proper operation of permissive and prohibit interlocks.

(g) Proper operation of instrumentation and alarms associated with under voltage, over voltage, and ground conditions.

(h) Capability of the DC emergency lighting system to provide required illumination levels to the areas specified in Table 9.5-4 of Subsection 9.5.3.2.3, and to provide backup illumination for periods after the loss of preferred power until the CTG energizes the standby lighting system. It also provides a backup in case of the loss of all the AC lighting sources as specified in Subsection 9.5.3.2.3.

(i) That the battery charger interlocks will prevent paralleling AC or DC divisions for the 125 VDC safety-related DC power distribution system, paralleling AC load groups or DC batteries for the 125 VDC non-safety-related DC power distribution system and paralleling AC load groups or battery chargers for the 250 VDC non-safety-related DC power distribution system.

(j) Capability of the 125 VDC Class 1E power system to supply power for Diesel Generator (DG) field flashing will be verified during DG preoperational test (Subsection 14.2.12.1.45.3). Sufficient capacity and capability of the Class 1E batteries to supply power to their connected loads is verified in Item (a) above in accordance with Section 7 of IEEE-308. Additionally, the DG qualification tests as described in the DG preoperational testing is performed in accordance with IEEE-387 and RG 1.9. Therefore, a separate test for verifying the performance requirements of DC power system in DG field flashing is not necessary.

14.2.12.1.45.2 Moved to 14.2.12.1.45.4

14.2.12.1.45.3 Diesel Generator Preoperational Test

(1) Purpose

To demonstrate the capability of the diesel generators to provide highly reliable electrical power during normal and simulated accident conditions when normal and alternate offsite power sources are unavailable, and to demonstrate the operability of the diesel generator auxiliary systems (e.g., diesel fuel oil transfer, DG starting air supply, jacket water, and lube oil).

(2) 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 instrumentation shall have been properly calibrated and operational. Appropriate electrical power sources, reactor building cooling water system, pneumatic sources, diesel-generator area ventilation system, and the portion of the fire protection system covering the DG area shall be available for use. The ECCS shall be available for operation as applicable to the diesel-generator under test. Additionally, sufficient diesel fuel shall be available, on site or readily accessible, to perform the scheduled tests.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the diesel generators (DGs) operate properly as specified in Subsection 9.5 and 8.3 through the following testing:

(a) Proper automatic startup and operation of the diesel generators upon simulated loss of AC voltage and attainment of the required frequency and voltage within the specified time limits. This test can be performed in conjunction with integrated ECCS LOPP/LOCA preoperational test (Subsection 14.2.12.1.46).

(b) Proper response and operation for design basis accident loading sequence to design basis load requirements, and verification that voltage and frequency are maintained within specified limits. This test can be performed in conjunction with integrated ECCS LOPP/LOCA preoperational test (Subsection 14.2.12.1.46).

(c) 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. This test can be performed in conjunction with integrated ECCS LOPP/LOCA preoperational test (Subsection 14.2.12.1.46).

(d) Verify that a LOCA signal will block generator breaker or field tripping by all protective relays except for the generator phase differential current and engine overspeed relays.

(e) Verify that a LOCA signal will initiate termination of parallel operations (test or manual transfer) and that the diesel generator will continue to run unloaded and available.

(f) Verify that the engine speed governor and the generator voltage regulator automatically return to an isochronous (constant speed) mode of operation upon initiation of a LOCA signal.

(g) Full-load carrying capability of the diesel generators for a period of not less than 24 hours, of which 22 hours at a load equivalent to the continuous rating of the diesel generator and 2 hours at the 2-hour load rating as described in Regulatory Guide 1.108, including verification that the diesel cooling systems function within design limits, and the diesel generator HVAC System maintains the diesel generator room within design limits. This test can be performed in conjunction with integrated ECCS LOPP/LOCA preoperational test (Subsection 14.2.12.1.46).

(h) Functional capability at operating temperature conditions by reperforming the tests in Items (a) and (b) above immediately after completion of the 24-hour load test per Item (g) above.

(i) Ability to synchronize the diesel generators with offsite power while connected to the emergency load, transfer the load from the diesel generators to the offsite power, isolate the diesel generators, and restore them to standby status.

(j) Verify that the rate of fuel consumption and the operation of any fuel oil supply pumping or transfer devices, while operating at the design-basis accident load, are such that the requirements for seven-day storage inventory are met for each diesel generator.

(k) Verify that all permissive and prohibit interlock, protective relays, controls, and alarms (both local and remote) operate in accordance with design specifications.

(l) Acceptable diesel generator reliability during starting and loading sequences as described in Regulatory Guide 1.108.

(m) Proper operation and correct setpoints for initiating and trip devices and verification of system logic not tested otherwise.

(n) Verify that the DG fuel oil transfer pumps start and stop automatically in response to a day tank low level and high level signal respectively as specified in Subsection 9.5.4.

(o) Verify that the DG can be started from minimum design starting air pressure and the air starting system has sufficient capacity for cranking the engine for prescribed number of automatic or manual starts without recharging as specified in Subsection 9.5.6.

(p) Verify that the DG jacket cooling water system functions properly to maintain engine temperatures within design limits in both standby mode and normal mode of operation as specified in Subsection 9.5.5.

(q) Verify that the DG lubrication system functions properly to supply clean, filtered oil to the engine and generator bearing surfaces at controlled pressure and temperature during normal operation and maintain sufficient circulation of warm oil at prescribed temperature when engine is in a standby condition as specified in Subsection 9.5.7.

(r) Verify that the DG combustion air intake and exhaust system functions properly in providing combustion air and exhausting gas during DG operation as specified in Subsection 9.5.8.

14.2.12.1.45.4 Electrical Power Distribution System Preoperational Test

(1) Purpose

To verify the ability of the Electrical Power Distribution System (EPDS) to provide a means for supplying AC power to safety-related and non-safety-related equipment including normal and standby lighting systems, from both onsite and offsite sources, via the appropriate distribution network(s).

(2) Prerequisites

The construction tests for the individual component associated with the EPDS 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 properly calibrated and operational. Appropriate electrical power sources shall be available for remote control, parameter information and annunciators associated with the electrical power distribution system. Adequate ventilation to both switchgear and battery rooms shall be available and operational. The portion of Fire Protection System covering the EPDS areas shall be available for use. Additionally, the plant EPDS (27 kV, 6.9 kV, 480V and 120 VAC and 125 VDC power) shall be installed prior to this test.

(3) General Test Methods and Acceptance Criteria

The capability of the non-Class 1E and the Class 1E power system portion of the onsite power system to provide power to plant loads under various plant operating conditions will be demonstrated. The system components to be tested include the medium and low voltage power distribution system, power centers, motor control centers, vital AC power supply system, and instrumentation and control power supply system as appropriate to each portion of the onsite power system. The system performance capability, including actual loading of the DG, is demonstrated in the DG system preoperational test (Subsection 14.2.12.1.45.3).

The ability of the DC power supply system to supply DC power to system loads is demonstrated in the DC power supply system preoperational test (Subsection 14.2.12.1.45.1). This test shall demonstrate that the EPDS operates properly as specified in Subsections 8.2, 8.3, 9.5.3 and 9.5.11 through the following testing:

(a) Proper operation of initiating devices for Class 1E and non Class 1E power system and transfer and trip devices for Class 1E power system.

(b) Proper operation of relaying and logic, including load shedding features for Class 1E power system.

(c) Proper operation of equipment protective devices, including permissive and prohibit interlocks.

(d) Verification of various component alarms used to monitor system and equipment status for correct alarm actuation and reset.

(e) Proper operation and load carrying capability of breakers, motor controllers, switchgear, transformers, and cables.

(f) Sufficient level of redundancy and electrical independence as specified for each application.

(g) Capability to transfer between onsite and offsite power sources as per design.

(h) Acceptable bus voltage and frequency variations between no load and full load conditions in accordance with Subsection 8.2.3. Verification of voltage and frequency variations on some buses can be performed in startup test stage, since insufficient loads are supplied by these buses during preoperational test stage.

(i) Capability of plant electrical equipment to start and operate properly when connected to Class 1E bus at 10% above and 10% below design voltage in accordance with Subsection 8.3.1.1.5.2.

(j) Ability of all required LOCA and/or LOPP loads to start in the proper sequence and to operate properly under simulated accident conditions, while powered from either preferred or standby sources, and over the specified range of available bus voltage in accordance with Subsection 8.3.1.1.8.3.

(k) Capability of the normal lighting system to provide adequate lighting illumination needed for operation, inspection and repairs to the non-essential equipment areas specified in Subsection 9.5.3.2.1.

(l) Adequacy of the standby lighting system to provide lighting illumination to the areas specified in Subsections 9.5.3.2.2.1 and 9.5.3.2.2.2 in the event of a loss of perferred power condition.

(m) Capability of the combustion turbine generator (CTG) to automatically start, accelerate to rated speed, reach nominal voltage, and begin accepting load within the time limit specified in Subsection 9.5.11. This test shall also demonstrate the capability of connecting the CTG to any one of the emergency buses using manually controlled breakers.

14.2.12.1.46 Integrated ECCS Loss of Preferred Power (LOPP)/LOCA Preoperational Test

(1) Purpose

To verify the proper integrated ECCS and plant electrical system response to a simulated LOPP/LOCA condition and to verify the independence of the redundant onsite divisional power sources and their associated load groups.

(2) Prerequisites

The preoperational test of the plant electrical system, including diesel generators, and the ECCS and related auxiliary systems, have been successfully completed. The SCG has reviewed the test procedure and approved the initiation of testing. Plant Class 1E buses loaded with their normal plant demands. The reactor vessel shall be ready to accept water. Otherwise, all ECCS shall be lined up in test return mode prior to the test. All ECCS pumps shall have an adequate suction source. The diesel generators shall have sufficient fuel available. Essential DC power system shall be available and operational. The RHR System, HPCF System, DG area ventilation system, switchgear and battery rooms ventilation systems, RCW System and Fire Protection System shall be available for use. All other required systems shall also be available, as needed, to support the specified integrated testing. Additionally, all permanently installed instrumentation shall have been properly calibrated and operable. All test instrumentation shall also be available and properly calibrated.

(3) General Test Methods and Acceptance Criteria

For each combination of divisional load groups, two at a time (I and II, II and III, I and III), with the other divisional load group completely isolated from both onsite and offsite power sources (including DC sources), simulate a divisional bus under-voltage condition (LOPP) followed immediately by a LOCA signal and verify the following:

(a) That the appropriate divisional diesel generators automatically start, reach rated speed and voltage, and connect to their respective divisional buses according to the EPDS single line diagram (Figure 8.3-1) and within the time limits as specified in Table 8.3-4.

(b) That all relaying and interlocks related to the LOPP/LOCA condition operate properly including the specified source transfer and re-energization operation, shedding and sequencing of loads as specified in Table 8.3-4 and the EPDS single line diagram (Figure 8.3-1).

(c) That all divisional loads operate as designed in response to the LOPP/LOCA condition, including establishment of the appropriate divisional ECCS flow to the vessel within the time limits as specified in the plant Technical Specifications and the preoperational test requirement specification.

(d) That independence of redundant Class 1E power sources and load groups exists as specified by the EPDS single line diagram (Figure 8.3-1).

The test of each combination shall be of sufficient duration to allow establishment of stable operating conditions such that any adverse conditions which may result from improper load group assignment (e.g., lack of forced cooling of a vital component or system) will be detected.

After the proper response of each divisional combination has been separately demonstrated, the integrated response of all ECCS and electrical divisions shall be demonstrated, by simulating a complete loss of preferred power and LOCA condition and then verifying Items (a) through (d) above for all three diesel generators and load groups as they respond and operate simultaneously.

14.2.12.1.47 Plant Communications System Preoperational Test

(1) Purpose

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

(2) Prerequisites

Vendor installation of equipment and testing 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 consistent with expectations of the acoustic environment and background noise levels for each location and for all modes of operation.

(3) General Test Methods and Acceptance Criteria

The communications systems to be tested include the paging facilities system, sound-powered telephone system, portable and fixed emergency communication systems, and the plant emergency alarms. Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the communication systems operate properly as specified in Subsection 9.5.2 and applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper functioning of all transmitters and receivers without excessive interference levels

(b) Proper operation of all controls, switches, and interfaces, including silencing and muting features

(c) Proper isolation and independence of various channels and systems

(d) Proper operation of systems under multiple user and fully loaded conditions as per design

(e) Proper operation of the Public Address System including the plant emergency alarms

(f) Audibility of speakers, handsets and receivers under anticipated background noise levels

(g) Ability to establish the communications required in the plant emergency plan

(h) 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

14.2.12.1.48 Fire Protection System Preoperational Test

(1) Purpose

To verify the ability of the Fire Protection System (FPS) and components to detect and alarm the presence of combustion, smoke or fire within the plant and to initiate the appropriate fire suppression systems or devices.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All permanently installed instrumentation is operable and properly calibrated. The required AC and DC electrical power and makeup water sources, diesel fuel oil system, and other appropriate interfaces and support systems, are available as needed for the specified testing.

(3) General Test Methods and Acceptance Criteria

The Fire Protection System is but one part of the overall fire protection program. This program is the integrated effort involving components, procedures, and personnel utilized in carrying out all activities of fire protection, in accordance with Criterion 3 of 10CFR50 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. The fire protection program begins with the initial design of all plant systems and equipment and of the buildings and structures in which they are located. A detailed analysis is then performed on this design to identify, qualify, and quantify all potential fire hazards, and their consequences, within the plant. Specific fire protection equipment is then added, where needed, when individual component design and features such as physical separation, walls, doors, and other barriers and passive devices, do not completely fulfill the requirements of the fire protection program.

The majority of the effort involved in demonstrating that the requirements of the overall fire protection program are met will be through analysis and documentation. Pre-operational testing of the Fire Protection System will mainly be limited to demonstrate that the equipment and facilities designed for the detection, annunciation, and suppression of fires operate properly as in Subsection 9.5.1 through the following testing:

(a) Verification of various system controls for correct functions in accordance with applicable FPS design specification

(b) Proper operation of interlock functions, including operation of all components subject to interlocking

(c) Proper operation of all remote-operated valves, including deluge valve and associated alarms

(d) Proper operation of the fire water supply system components such as motor-driven fire pump, diesel engine driven fire pump, jockey pump and tank for various operating conditions

(e) Proper performance of various components of water-based suppression systems such as automatic wet pipe sprinkler system, standpipe and hose reel system and deluge water suppression system and other suppression systems such as deluge foam-water sprinkler system, deluge sprinkler and preaction sprinkler system

(f) Proper operation of freeze protection devices, if applicable

(g) Proper functioning of smoke, heat and flame detection devices to detect a fire emergency and provide alarms and initiation signals

(h) Verification of both local and remote fire alarms systems, including those interfacing with outside agencies, for correct functions in conjunction with the various tests conducted

(i) Proper operation of primary and secondary electrical power sources, including fire protection system diesel generators

14.2.12.1.49 Radioactive Drain Transfer System Preoperational Tests

(1) Purpose

To verify the proper operation of the various equipment and pathways which make up the Radioactive Drain Transfer System within the Nuclear Island.

(2) Prerequisites

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

(3) General Test Methods and Acceptance Criteria

The testing described below consists of that of the equipment and pathways for the drainage and transfer of radioactive and potentially radioactive liquids within the plant. 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. These tests shall demonstrate that the system operates properly as described in Subsection 9.3.8 during the following testing:

(a) Proper operation of system controls, logic and interlock functions, including operation of all components subject to interlocking

(b) Proper operation of equipment protective features and automatic isolation functions in response to a simulated LOCA signal

(c) Verification of various component alarms for correct alarm actuation and reset

(d) Acceptable system and component flow paths and flow rates including pump capacities and sump or tank volumes

(e) Proper operation of system pumps, valves, and motors under expected operating conditions

(f) Proper functioning of drains and sumps, including those dedicated for handling of specific agents such as detergents

14.2.12.1.50 Fuel-Handling and Reactor Component Servicing Equipment Preoperational Test

(1) Purpose

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 invessel, undervessel, and drywell 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.

(2) 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, in the drywell, and on the refueling floor. The refueling floor (including the storage pools 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.

(3) General Test Methods and Acceptance Criteria

Fuel-handling and reactor component servicing equipment testing described herein includes that of the reactor building crane, refueling bridge, 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. Fuel pool cooling and cleanup functions are tested as described in Subsection 14.2.12.1.21. The HVAC systems serving the refueling floor and drywell are tested as described in Subsection 14.2.12.1.34.

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the system operates properly as described in Subsection 9.1.4 during following testing:

(a) Proper operation and installation of refueling equipment, including refueling and auxiliary platforms, used to move fuel bundles during a normal refueling outage as described in Subsection 9.1.4.2.10.2.4.1.

(b) Proper operation and assembly of the various cables, grapples, and hoists including brakes, limit switches, load cells, and other equipment protective devices.

(c) Proper functioning of all control, instrumentation, logic, interlocks and alarms associated with the refueling platform and service platform. The refueling interlock test will be performed in conjunction with the RCIS preoperational test (Subsection 14.2.12.1.7), including interlocks associated with the reactor mode switch.

(d) Proper assembly and operation of reactor vessel servicing equipment, including reactor vessel servicing tools, main steamline plugs, shroud head stud wrench, head holding pedestal, RPV head tensioning and detensioning, dryer/separator strongback, and head strongback carousel.

(e) Proficiency in fuel movement operations using dummy fuel prior to actual fuel loading.

(f) 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.

(g) Correct assembly and operation of invessel servicing equipment, such as incore instrument servicing, control rod assembly servicing, and in-vessel fuel support and guide tube servicing.

(h) Proper installation and operation of fuel servicing equipment, such as fuel preparation machine, new fuel inspection stand, channel bolt wrenches and handling tools, general-purpose grapples and fuel pool vacuum sipper.

(i) Correct installation and operation of under-reactor vessel servicing equipment, including FMCRD servicing tools and handling equipment, incore flange seal test plug, and RIP handling equipment.

(j) Proper assembly and operation of various servicing aids, such as underwater lights and viewing tube, viewing aids, underwater TV monitoring system, underwater vacuum cleaner, and pool tool accessories.

14.2.12.1.51 Expansion, Vibration and Dynamic Effects Preoperational Test

(1) 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.

(2) Prerequisite

Hydro testing and flushing of the piping systems shall have been completed. The SCG has reviewed the test procedure and approved the initiation of testing. All piping and components and their associated supports and restraints have been inspected and determined to be installed per design. Additionally, support devices such as snubbers and spring cans have been verified to be in their expected cold, static positions and temporary restraining devices such as hanger locking pins have been observed to be removed. The instrumentation system required by the remote measurements shall have been completely installed and the as-built locations and orientation of measurement instruments documented in the test records.

(3) General Test Method and Acceptance Criteria

Preoperational phase of vibration and thermal expansion testing will be conducted on plant systems and components of the following:

(a) The piping systems considered to be within the NSSS scope of testing are as following:

(i) Main steam piping bounded by the reactor vessel nozzles and the MSIV outside containment.

(ii) SRV discharge piping attached to the main steamlines and bounded by the SRV discharge flange and the quencher in the wetwell.

(iii) Feedwater piping bounded by the RPV and the isolation check valves outside containment.

(iv) Recirculation motor cooling piping, including RIPs.

(v) Small branch piping attached to the portions of the piping defined in Items (1), (2), and (3), are bounded by the large pipe branch connection and the first downstream anchor. Small branch pipes that can not be monitored due to limited access are excluded.

(b) The BOP scope of piping systems are as follows:

(i) Main steam piping downstream of the MSIV outside containment

(ii) Feedwater piping outside containment downstream of the isolation check valves

(iii) RPV head vent piping

(iv) CUW suction and discharge piping, including the head spray line

(v) RHR suction and discharge and injection piping in shutdown cooling mode and LPFL mode

(vi) RCIC turbine steam supply and exhaust piping

(vii) RCIC pump suction and discharge piping

(viii) SLC system piping (pump suction/discharge)

(ix) RSW suction and discharge piping

(x) RCW suction and discharge piping

(xi) HPCF suction and injection piping

(xii) Diesel generator fuel, cooling, intake and exhaust piping

(xiii) FCS hydrogen recombiner piping

(xiv) CRD system piping (pump suction/discharge)

Thermal expansion testing during the preoperational phase will consist of displacement measurements on the NSSS portion of piping during the RRS/RPV internal hot functional test (Subsection 14.2.12.1.2) and visual inspections at ambient temperature on the NSSS and BOP portions of piping. The testing will be in conformance with ANSI/ASME-OM7 as discussed in Subsection 3.9.2.1.2, and will consist of a combination of visual inspections and local and remote displacement measurements. This testing, as well as that performed during the power ascension phase per Subsection 14.2.12.2.10, includes the inspection and testing of RCPB component supports as described in Subsection 5.4.14.4. Visual inspections are performed to identify actual or potential constraints to free thermal growth prior to or between tests. Displacement measurements will be made utilizing specially installed instrumentations 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 will not produce unacceptable stress values.

Vibration testing will be performed on system components and piping during preoperational function and flow testing. This testing will be in accordance with ANSI/ASME-OM3 as discussed in Subsection 3.9.2.1.1 and will include 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.

14.2.12.1.52 Reactor Vessel Flow-Induced Vibration Preoperational Test

(1) Purpose

To collect information needed to verify the adequacy of the reactor internals design, manufacture, and assembly with respect to the potential effects of flow-induced vibration. Instrumentation of major components and the flow tests and inspections will provide assurance that excessive vibration amplitudes, if they exist, will be detected at the earliest possible time. The data collected will also help establish the margin to safety associated with steady-state and anticipated transient conditions and will help confirm the pretest analytical vibration calculations. This testing will fulfill the preoperational requirements of Regulatory Guide 1.20 for a vibration measurement and inspection program for prototype reactor internals, and applies only to the ABWR designated for testing of “prototype” reactor internals. Subsequent ABWRs, whose internals qualify as non-prototype, are subject to a reduced set of testing requirements in accordance with Regulatory Guide 1.20 (Subsections 3.9.2.4 and 3.9.7.1).

(2) Prerequisites

Prior to the dynamic measurements, the SCG shall have reviewed the test procedure(s) and approved the initiation of testing. The initial vibration analysis computations and specification of acceptance criteria shall be complete. These results shall be utilized to define final inspection and measurement programs. Preoperational testing of the recirculation system shall be sufficiently complete to ensure safe operation of the reactor internal pumps at rated volumetric flow at rated temperature and pressure for the duration of the scheduled flow testing. This includes all required auxiliary systems. 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 assembly and reactor vessel head but excludes the steam dryer. All temporary hardware devices, such as blade guides, must be removed. Also, during the flow testing, no incore instruments or neutron sources shall be installed and the control blades shall either be removed or be fully withdrawn and motion inhibited. The assembly and disassembly of vessel internals shall be choreographed such that structures and components requiring inspection are accessible at the proper times. All vibration sensors shall have been installed, connected to the applicable signal conditioning equipment and calibrated prior to the flow testing. Additionally, all other systems, components, and structures shall be available, as required, to support the reactor vessel internals vibration assessment program.

(3) General Test Methods and Acceptance Criteria

The reactor internals vibration assessment program consists of three parts: a vibration analysis program, a vibration measurement program, and an inspection program. Sensors used for the measurements are resistance wire strain gauges, displacement sensors, and accelerometers with double integrating output signal conditioning. More detailed descriptions of sensor locations shall be given in accordance with applicable test specifications. The vibration analysis portion is performed on the final design, prior to the preoperational test, and the results are used to develop the measurement and inspection portions of the program. The preoperational test therefore consists of an instrumented flow test and pre- and post-test inspections as described in the following paragraphs:

(a) 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 will be met by visual and remote observations of the installed reactor internals in a flushed and drained vessel. These inspections shall detect wear, cracking, loosening of bolts, failures and the presence of debris and loose parts on lower surfaces such as the lower head and the core plate. The following types of structures and components and the associated inspection activities shall be included in the vessel internals inspection program:

(i) Lower plenum surfaces for debris and loose or failed parts by removal of the center Control Rod Guide Tube and scanning with a TV camera

(ii) Core plate for debris and loose or failed parts

(iii) All peripheral control rod drive and incore housings, and their weld joints to the vessel by removal of eight control rod guide tubes and scanning with a TV camera

(iv) Peripheral incore guide tube stabilizer connections and stabilizer bars

(v) RIP and core differential pressure lines and bracket welds.

(vi) Shroud-to-shroud support weld

(vii) Fuel support castings (for evidence of lifting) and peripheral orifices

(viii) Reactor vessel surveillance program specimen holders, specimens and mounting brackets

(ix) Top guide to shroud holddown nuts, keepers, pins and associated welds

(x) Top guide and shroud head flange locating pins and bolts for evidence of deleterious motion marks other than those caused from normal installation

(xi) Core plate to shroud holddown nuts, keepers and associated welds

(xii) Steam separator, tie bar welds, outer rows of standpipes, stiffener bar welds, shroud head bolt support ring brackets and supports, and associated welds

(xiii) Feedwater and LPCF sparger structure and end bracket attachments

(xiv) HPCF coupling and HPCF spargers

(xv) Shroud head bolts at guide rings for wear

(xvi) Steam dryer hoods, end plates, tie bars, skirt, drain channels, and associated welds

(b) Flow testing

The preoperational flow test will be performed during the RRS/RPV internal hot functional test (Subsection 14.2.12.1.2) at rated volumetric core flow, at rated temperature and pressure conditions, with the vessel internals completely intact with the exception of the fuel bundles, the control blades (unless fully withdrawn), incore instruments, neutron sources, and the steam dryer assembly. A post fuel load, subcritical flow test (Subsection 14.2.12.1.2) will be performed later on the complete reactor assembly unless it is shown analytically or experimentally that the preoperational results are already conservatively bounding. Additionally, internals vibration will be measured during individual component or system preoperational testing where operation may result in significant vibrational excitation of reactor internals, such as HPCF testing.

The preoperational test operating conditions for flow-induced RPV internal vibration measurements shall include: (1) all pumps in operation at minimum, 50% of maximum flow, 75% of maximum flow, and maximum flow conditions; (2) with all pumps at maximum flow, perform single pump trips; (3) with seven pumps in operation at minimum, 50% of maximum flow, 75% of maximum flow and maximum flow conditions; (4) with seven pumps at maximum flow and the other three pumps at minimum flow, 50% of maximum flow, and 75% of maximum flow; (5) from maximum flow, trip all pumps simultaneously; and (6) complete the requirement for total operating time specified in the test specification.

The duration of preoperational testing at the various flow configurations shall ensure that each critical component is subjected to at least 10^6 cycles of vibration, as calculated using the lowest frequency for which the component is expected to experience a significant structural response.

(c) Post-Flow Vessel Inspection

The post-flow inspection shall be performed after the resultant vibrational excitation from the preoperational flow testing described above. The structures and components inspected shall be the same as specified for the preflow inspection. Visual and remote observations are performed after the vessel has been depressurized and drained. Inspection of critical surfaces and components shall be performed prior to any disassembly required for access to other internal structures.

(d) Acceptance 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.

During the dynamic measurements, the Vibration Engineer will monitor and record vibration amplitudes and frequencies obtained from the sensors mounted on the various components. The measured amplitudes and frequencies are then compared to the acceptance criteria as specified in Subsection 14.2.12.2.12. 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 the 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.

14.2.12.1.53 Condensate and Feedwater System Preoperational Test

(1) Purpose

To verify proper operation of the various components that comprise the Condensate and Feedwater System (CFS) and their capability to deliver the required flow from the condenser hotwell to the nuclear boiler system.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure(s) and approved the initiation of testing. Additional prerequisites include but are not limited to the following:

(a) All elements of the feedwater control system control algorithm have been implemented and adjusted if necessary to the values specified by the vendor's instructions or the results of preoperational testing (Subsection 14.2.12.1.4), as appropriate.

(b) All other system instrumentation associated with the condensate and feedwater system shall be in accordance with the P&ID, IED, and Instrument Data Sheets and have been properly calibrated per instrument supplier's instructions.

(c) Appropriate power sources to supply electric power to motors, control circuits and instrumentation shall be available, as required, to support testing.

(d) The system valve and electric lineups have been completed in accordance with the appropriate plant operation procedures prior to the test.

(e) A sufficient quantity of chemically acceptable demineralized water shall be available for test use.

(f) The Instrument Air System, TCW System and MUWC System (for storing and transferring demineralizer water) shall be available and operational.

(g) The main condenser is available as a water source and discharge point for the reactor feedwater pumps during this test.

(h) The condensate system shall be available to provide a flow path and the required NPSH for the reactor feedwater pumps testing.

(i) The feedwater pump adjustable speed drives shall have been functionally checked against the respective vendor operating and maintenance manual to ensure correct remote operation prior to pump operation; signals from the FWCS affect other systems such as feedwater pump ASDs, recirculation system and main turbine. Therefore, prior to the control logic and interlock testing, care must be taken to ensure that the input process variable signal from the FWCS can be accepted by those affected systems without harm to personnel or equipment.

(3) General Test Methods and Acceptance Criteria

Preoperational testing of the CFS will include the piping, components, and instrumentation between the condenser and the nuclear boiler, but not the condensate filters or demineralizers nor the feedwater heaters, which will be 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. This test shall demonstrate that the CFS operates as specified in Subsection 10.4.7 and applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms for correct actuation and reset, alarm indication and operation logic.

(c) Proper operation of system valves, including operability, position indicator and timing, if applicable.

(d) Proper operation of pumps and motors in all design operating modes.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper system flow paths and flow rates including pump capacity and discharge head.

(g) Proper pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks and equipment protective devices in pump, motor, and valve controls.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) Proper system operation while powered from primary and alternate sources, including transfers, and in degraded modes for which system components are expected to remain operational.

(k) Acceptable pump/motor vibration levels and system piping movements during both transient and steady-state operation. This test can be performed in conjunction with expansion, vibration and dynamic effects preoperational test (Subsection 14.2.12.1.51).

(l) Proper operation of controllers for pump drivers and flow control valves including those in minimum flow recirculation lines.

14.2.12.1.54 Condensate Purification System Preoperational Test

(1) Purpose

To verify proper operation of the Condensate Purification System (CPS) and the associated support facilities

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The Condensate and Feedwater System shall be operational with an established flow path capable of supporting full condensate filter and polisher flow. Adequate supplies of ion exchange resin shall be available, and the radwaste system shall be capable of processing the expected quantities of water and spent resins. The Instrument Air and Service Air Systems, TCW System, Process Sampling System, MUWP System, and appropriate electrical power sources shall be available for use. Other required interfacing systems shall also be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the CPS operates as specified in Subsection 10.4.6 and the applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms for correct alarm actuation/rest, alarm indication and operating logic

(c) Proper operation of system valves, including open/close cycling, remote indication and timing, if applicable

(d) Proper operating conditions and performance capability during the following system operational tests:

(i) Placing a standby polisher unit into service

(ii) Transferring the resin inventory of any polisher vessel into the resin receiver tank

(iii) Removing operating filter from service, backwashing and restoring to service

(iv) Transferring the resin storage tank resins to any polisher vessel

(v) Transferring resin from resin receiver tank to the radwaste system

(vi) Operating the system at full condensate flow with four filters and five polisher vessels

(e) Proper operation of interlocks and equipment protective devices

(f) Proper operation of permissive, prohibit, and bypass functions

(g) Ability to perform online exchange of standby and spent filter units and polisher vessels

(h) Proper operation of filter and polisher support facilities such as those used for regeneration of resins or for handling of wastes

(i) Proper operation of the system flow bypass feature through manually operating the system flow bypass valve from the main control room

14.2.12.1.55 Reactor Water Chemistry Control Systems Preoperational Test

(1) Purpose

To verify proper operation of the various chemical addition systems designed for actively controlling the reactor water chemistry, including the oxygen injection system, the zinc injection passivation system, the iron ion injection system, and the Hydrogen Water Chemistry System (HWCS).

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure(s) and approved the initiation of testing. The FCS, Offgas System, appropriate electrical power, and other required interfacing systems shall be available, as needed, to support the specified testing. The appropriate vendor precautions shall be followed with regards to the operation of the affected systems and components and for the actual reactor water chemistry given the existing reactor operating state.

(3) General Test Methods and Acceptance Criteria

Preoperational testing of these systems will concentrate on verifying proper operation of the equipment skids and the various individual components. Actual chemical injection demonstrations and/or simulations shall be listed 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). This test shall demonstrate that the specified reactor water chemistry control system (if installed during the construction stage) operate as described in Subsections 9.3.9, 9.3.10, 9.3.11 and applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of system controls, trips, interlocks, and various component alarm functions for the appropriate system as specified by the elementary diagrams, IDSs and IBDs.

(b) Performance capability of the hydrogen water chemistry system, including automatic shutdown and isolation features, as specified in Subsection 9.3.9 and the manufacturer's technical instruction manual. This test shall be done with all components, valves, piping and instruments that constitute the entire system as an integrated unit during automatic mode of operation.

(c) Operability of the oxygen injection system as specified in Subsection 9.3.10 and the manufacturer's technical instruction manual with the integrated operation of condensate oxygen injection module and the gas flow regulating valve in manual mode of control from the main control room.

(d) Operability of the zinc injection system, including automatic shutdown feature, as specified in Subsection 9.3.11 and the appropriate manufacturer's technical instruction manual.

(e) Operability of the iron ion injection system as specified by the appropriate manufacturer's technical instruction manual.

14.2.12.1.56 Main Condenser Evacuation System Preoperational Test

(1) Purpose

To verify the ability of the mechanical vacuum pumps and the steam jet air ejectors of the Main Condenser Evacuation System (MCES) to establish and maintain a vacuum in the main condenser as per design.

(2) Prerequisites

Construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Instrumentation calibration and integrated loop checks shall have been completed. The main condenser shall be intact. The turbine gland sealing system and exhaust blower shall be in operation with steam supplied by the auxiliary boiler or some other temporary source. The main turbine shall be on the turning gear. The Instrument Air System, TCW System, MUWP System, Offgas System, Condensate System, and electrical power systems shall be available for use. Other required interfacing systems shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the MCES operates as specified in Subsection 10.4.2 and applicable manufacturer's technical instruction manual through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms for correct alarm actuation and reset alarm indication and operating logic

(c) Proper operation of all remote-operated valves, including open/close cycling and remote indication, if applicable

(d) Proper operation of the mechanical vacuum pumps including the ability to establish the required vacuum condition in the main condenser within the design time frame

(e) 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)

(f) Proper pump motor start sequence and actuation of protective devices

(g) Proper operation of interlocks, including operation of all components subject to interlocking in this system

(h) Proper operation of permissive, prohibit, and bypass functions

(i) Proper operation of the mechanic vacuum pump trip function and its discharge valve closure upon receipt of a simulated main steam high-high radiation signal

(j) Proper operation of the isolation valve closure for the Offgas System upon receipt of a simulated low steam flow signal

14.2.12.1.57 Offgas System Preoperational Test

(1) Purpose

To verify proper operation of the Offgas (OG) System, including valves, recombiner, condensers, coolers, filters, and hydrogen analyzers.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All system instrumentation shall be in accordance with the P&ID and Instrument Data Sheets and have been calibrated per instrument supplier's instructions. Additionally, the IA System, Electrical Power System, RCW System, SA System, heating steam, and Heating Steam Condensate Return System, and other required system interfaces shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the OG System functions properly as specified in Subsection 11.3 and applicable OG System design specification through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms for correct alarm actuation and reset, alarm set value, alarm indication and operating logic.

(c) Proper operation of system valves, including isolation features as appropriate, opening/closing operation with the operating switch and valve position indication, if applicable.

(d) Proper operation of components, including OG filter, charcoal adsorber and OG exhaust unit.

(e) Proper operation of recombination unit and charcoal adsorption unit during normal system operation. By this test, the working flow rate, pressure, and temperature shall be confirmed to satisfy design value.

(f) Proper operation of interlocks, including operations of all components subject to interlocking in this system.

(g) Proper operation of permissive, prohibit, and bypass functions.

(h) 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.

(i) Acceptable performance capability of the OG heat exchanger to the extent practical. Otherwise, the OG heat exchanger confirmatory test can be performed in startup test stage.

14.2.12.1.58 Hotwell Level Control System Preoperational Test

(1) Purpose

To verify design level control capability in the main condenser hotwell.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All system instrumentation shall be in accordance with the P&ID and Instrument Data Sheets and have been properly calibrated per instrument supplier's instructions. The applicable power sources to supply electric power to motor, control circuits and instrumentation shall be available for use. The MUWP System, condenser, condensate storage tank, condensate pumps, and associated valves and piping shall be operational and the other required interfacing systems shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the hotwell level control system functions properly as specified in Subsection 10.4.1.5.1 and applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of system components in all combinations of logic and in response to all expected controller demands.

(b) Verification of various component alarms used to monitor system operation and status for correct alarm actuation and reset.

(c) Proper operation of emergency and normal makeup control valves and condensate reject control valves in response to simulated signals to maintain the desired hotwell condensate inventory.

14.2.12.1.59 Makeup Water Condensate System Preoperational Test

(1) Purpose

To verify the ability of the Makeup Water Condensate (MUWC) System to provide an adequate reserve of condensate quality water for makeup to the condensate system, as a preferred suction source for the RCIC and HPCF Systems, and for other uses as designed.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Additional prerequisites include but are not limited to the following:

(a) All system instrumentation shall be in accordance with the P&ID and Instrument Data Sheets and have been properly calibrated per instrument supplier's instructions.

(b) The applicable power sources to supply electric power to motors, control circuits and instrumentation shall be available, as required, to support the performance of this testing.

(c) The system valve lineups shall have been completed in accordance with applicable system's operation procedures prior to the test.

(d) Instrument air system and MUWP System shall be available for use in support of this test, as required.

(e) A sufficient quantity of chemically acceptable water shall be available for performing this test.

(f) Temporary strainer screens shall be installed at the pump inlets of MUWC throughout the test.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the MUWC System operates properly as specified in Subsection 9.2.9 and applicable MUWC System design specifications through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Proper operation of permissive and prohibit interlocks including components subject to interlocking

(c) Verification of various component alarms used to monitor system operation and status, including condensate storage tank (CST) volume and/or level, for correct alarm actuation and reset

(d) Proper operation of freeze protection devices, if applicable

(e) Verification that each unit of the MUWC pumps can be operated normally during the following system operation tests:

(i) System operation test to confirm pump performance including: stable operation condition, pump discharge pressure comparison against the shop test pump curve, and the ability to provide desired flow rates to each applicable system and/or component

(ii) Pump minimum flow test to confirm a stable pump operation and ability to operate continuously with pump discharge valve in the closed position

(iii) Standby pump automatic start test to confirm auto start feature of a standby pump upon the trip of a running pump

14.2.12.1.60 Circulating Water System Preoperational Test

(1) Purpose

To verify the proper operation of the Circulating Water System (CWS) and its ability to circulate cooling water from the ultimate heat sink through the tubes of the main condenser in sufficient quantities under all expected operating conditions.

(2) 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, ultimate heat sink, bearing lubricating and shaft sealing water, vacuum priming and chemical additive subsystems, MUWC System, appropriate electrical power source(s) and other required interfacing systems shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the CWS operates properly as specified in Subsection 10.4.5 and applicable design specifications and manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms for correct alarm actuation/reset and operating logic.

(c) Proper operation of all major system valves which control flow path, including open/closure cycling and position indication verification, if applicable.

(d) Proper operation of pumps and motors during continuous run tests.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper operating conditions (flow, pressure vibration) and performance capability during integrated operation of circulating water, waterbox fill and drain, traveling screens, and chemical additive subsystems.

(g) Proper pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks including operation of all components subject to interlocking.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) Proper operation of freeze protection function, if applicable, when recirculating water from discharge side of the condenser back to the screen house intake.

(k) 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.

(l) Acceptable performance capability of the main condenser, to the extent practical. Otherwise, the main condenser confirmatory test can be performed in startup test stage.

14.2.12.1.61 Reactor Service Water System Preoperational Test

(1) Purpose

To verify proper operation of the Reactor Service Water (RSW) System and its ability to supply design quantities of cooling water to the RCW System heat exchangers.

(2) Prerequisites

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

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the RSW system operates properly as specified in Subsection 9.2.15 and the applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms including system responses to process variables and provides alarms at the specified values.

(c) Proper operation of system motor- and air-operated operability, position indicator verification and timing, if applicable.

(d) Proper operating conditions (bearing temperature, flow, vibration) of the RSW pumps during continuous pump run test, including normal and emergency modes operations and switching of these modes.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper operating conditions and system performance capability during the following system operational tests:

(i) System operation tests at various operating modes (normal, shutdown cooling, hot standby without offsite power source, LOCA and refueling outage)

(ii) Switch-over test of RSW pumps and heat exchanges between 1-unit and 2-unit operations

(iii) Transfer test from normal operation mode to LOCA mode by LOCA signal

(iv) Transferability test to the hot standby mode operation upon loss of offsite power

(v) System operation capability from the remote shutdown panel

(vi) Adequacy of orifice confirmation

(g) Proper pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks, logic and trip functions in accordance with IBD and P&ID using simulated signals.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) Proper operation of freeze protection devices, if applicable.

(k) 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.

(l) Deleted.

(m) Proper operation of the standby RCW heat exchanger cooling water inlet and outlet valve opening upon receipt of a simulated LOCA signal.

14.2.12.1.62 Turbine Building Cooling Water System Preoperational Test

(1) Purpose

To verify proper operation of the Turbine Building Cooling Water (TCW) System and its ability to supply design quantities of cooling water, to designated plant loads.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Primary and backup power, Turbine Service Water (TSW), Instrument Air, MUWP System 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.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the TCW System operates properly as specified in Subsection 9.2.14 through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms for correct system response to process variables and provides alarms at the prescribed values.

(c) Proper operation of system valves, including open/closure cycling and timing and position indicating verification, if applicable.

(d) Proper operating conditions (flow, vibration, bearing temperature) of the TCW pumps during continuous pump run test.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper system performance capability during design mode of operation.

(g) Proper pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks function including operation of all components subject to interlocking.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) Proper system operation while powered from primary and alternate sources, including transfers, and in degraded modes for which the system is expected to remain operation.

(k) Proper operation of system surge tanks and chemical addition tanks and their associated functions.

(l) Acceptable performance capability of TCW System heat exchangers, to the extent practical. Otherwise, TCW heat exchanger confirmatory test can be performed in startup test stage.

(m) Proper operation of system surge tank and chemical addition tank and their associated functions during system operational test.

14.2.12.1.63 Turbine Service Water System Preoperational Test

(1) Purpose

To verify the ability of the Turbine Service Water (TSW) System to supply design quantities of cooling water to the TCW heat exchangers.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Primary and backup electrical power, TCW System heat exchangers, instrument air, and other required interfacing systems shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the

TSW system operates properly as specified in Subsection 9.2.16 through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms for correct system responses to process variables and provides alarms at the prescribed value.

(c) Proper operation of all motor- and air-operated valves, including open/closure cycling, timing and valve position indicator verifications, if applicable.

(d) Proper operating conditions (bearing temperature, flow, vibration) of the TSW pumps during continuous pump run test.

(e) Acceptable pump NPSH under the most limiting design flow conditions.

(f) Proper system performance capability during design mode of operation, including flow balancing.

(g) Proper pump motor start sequence and actuation of protective devices.

(h) Proper operation of interlocks functions, including operation of all components subject to the interlocking.

(i) Proper operation of permissive, prohibit, and bypass functions.

(j) Proper operation of freeze protection devices, if applicable.

(k) 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.

14.2.12.1.64 Main Turbine Control System Preoperational Test

(1) Purpose

To verify proper operation of the TCS, which operates the turbine stop valves, control valves, and combined intermediate valves (CIV) through their associated actuators and hydraulic control.

(2) Prerequisites

All applicable preliminary tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All applicable power sources to supply electrical power to motors, control circuits, and instrumentation are available. The system valve lineups are completed.

The steam bypass and pressure control system shall be operational and other required interfacing systems shall be available, as needed, to support the specified testing.

(3) 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 TCS functions properly as specified in Subsection 10.2.2 and applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper functioning of instrumentation and system controls, including operating and trip devices for main stop and control valves and combined intermediate valves (CIVs)

(b) Verification of various component alarms used to monitor system operation and status for correct alarm actuation and reset

(c) Correct operation of main stop and control valves and combined intermediate valves in response to simulated signals related to turbine speed, load, and reactor pressure as specified in Subsection 10.2.2

(d) Proper operation of the hydraulic control subsystem, including hydraulic fluid pumps and accumulators, and power supplies

(e) Proper operation of main stop and control valves and CIVs upon loss of control system electrical power or hydraulic system pressure

(f) Capability of manual operation of main stop and control valves and CIVs, including verification of position indications and stroke rate adjustments

(g) Proper interface with the steam bypass and pressure control system (i.e., response and feedback)

(h) Proper operation and performance of all of the other valves with associated control functions of the turbine-generator

14.2.12.1.65 Main Turbine Bypass System Preoperational Test

(1) Purpose

To verify proper operation of the Turbine Bypass System (TBS) which operates the main turbine bypass valves through their associated actuators and hydraulic power unit.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All applicable power sources to supply electrical power to motors, control circuits, and instrumentation are available for use. The system valve lineups shall have been completed prior to this test. The preoperational test of the SB&PC System (Subsection 14.2.12.1.66) shall have been completed and operational. All other required interfacing system shall be available, as needed, to support the specified testing.

(3) 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 TBS operates properly as specified in Subsection 10.4.4 and the applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper functioning of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms for correct alarm actuation/reset and alarm indication

(c) Capability of manual bypass operation, including stroke rate adjustments and verifications, position indications, and timing verification

(d) Proper integration operation of valve chest assembly and hydraulic fluid power unit, including hydraulic accumulators, high pressure fluid pumps, filters, and heat exchangers

(e) Proper operation of bypass valve closure in response to loss of condenser vacuum, control system electrical power or hydraulic pressure

(f) Proper operation of bypass valve opening inhibit feature upon a simulated MSIV closure condition, including annunciation in the main control room and the alarm reset function

(g) Proper bypass valve response following a simulated turbine and generator trip initiation signal, including the fast opening timing requirements per Technical Specifications

(h) Verification of deadband from bypass steam flow demand to bypass valve motion for correct value

(i) Proper interface with the steam bypass and pressure control system (i.e., response and feedback)

14.2.12.1.66 Steam Bypass and Pressure Control System Preoperational Test

(1) Purpose

To verify proper operation of the SB&PC System, including, as appropriate, higher level control of the TBS, the TCS, the Automatic Power Regulator System and the Recirc Flow Control System.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The preoperational tests have been completed on the TBS and TCS (including the EHC System) to extent necessary to support integrated system testing and all SB&PC components have been initially calibrated in accordance with vendor instructions. The required supporting systems and equipment shall be available, as needed, for the specified testing configurations.

(3) General Test Methods and Acceptance Criteria

The SB&PC System is primarily an electronic control system. It does not include any large mechanical equipment (i.e., turbine stop, control and bypass valves) nor any associated hydraulic actuators, but does provide for their integrated control. System preoperational testing will be limited to demonstrations without (or with significantly reduced, from a temporary source) turbine steam flow. Comprehensive steam flow testing will be conducted during the startup test stage (Subsection 14.2.12.2.15).

Performance shall be observed and recorded during a series of individual component and integrated system test. These tests shall demonstrate that the SB&PC System operates properly as specified in Subsection 7.7.1.8 through the following testing:

(a) Verification of the dynamic characteristics of pressure controller, steamline resonance compensator, pressure compensator, governor free filter and rate limiter of turbine control valve demand signal for correct functions

(b) Preliminary adjustments of controllers for prescribed open-loop frequency response or step response

(c) Verification of signal continuity, scaling, interface matching, sensor calibration and limiter setpoints for correct functions

(d) Proper operation of redundant controller upon simulated operating controller failure

(e) Proper operation of pressure setpoint and load demand step test functions

(f) Proper calibration of redundant pressure sensors to within the prescribed limits as specified in the appropriate SB&PC design specification

(g) Capability of the self-test and online diagnostic features of the FTDC in identifying the presence of a fault and determining the location of the failure

(h) Capabilities of the FTDC cold and warm start features (i.e., self-starting following a power interruption to the full system and bringing a processing channel online with the other channels in operation without the need for operator or technician action)

(i) Proper operation of the technician interface unit (TIU) in the various operational modes as defined by the SB&PC design specification

(j) Verification of acceptable deadband from pressure controller to turbine control valve

14.2.12.1.67 Feedwater Heater and Drain System Preoperational Test

(1) Purpose

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

(2) Prerequisites

All applicable preliminary component tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All applicable instrument calibration and loop checks have been completed in accordance with the instrument supplier’s instructions. Appropriate AC power sources that supply electric power to motors, controls circuits and instrumentation are available to support testing. The system valve and electric lineups shall have been completed per the applicable plant operation procedures. The Instrument Air System and Communication System shall be available and operational for test use. Additionally, a simulated input signals for feedwater heater level transients shall be provided during the performance of heater level control testing.

(3) General Test Methods and Acceptance Criteria

The Feedwater Heater and Drain (FWHD) 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 components and integrated system tests. This test shall demonstrate that the FWHD System operates properly as specified in Subsection 10.4.7 and the applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip, including turbine trip and heater level control functions

(b) Verification of various component alarms used to monitor system operation and status for correct alarm actuation and reset

(c) Proper operation of system valves and actuators under expected operating conditions

(d) Proper operation of interlocks and equipment protective devices

(e) Proper operation of permissive, prohibit, and bypass functions

(f) Proper operation of the low and high pressure heater level control system, including response of the associated drain/dump valves

14.2.12.1.68 Extraction Steam System Preoperational Test

(1) Purpose

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

(2) Prerequisites

All applicable preliminary component tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All permanently installed instrumentation has been properly calibrated and loop checks completed in accordance with the instrument supplier's instructions. Applicable power sources to supply electric power to motors, control circuits, and instrumentation are available. The system valve and electric lineups have been completed per the applicable plant operation procedures. The Instrument Air System and communication equipment shall be available and operational for test use.

(3) General Test Methods and Acceptance Criteria

Comprehensive testing of the Extraction Steam System (ESS) will require the turbine generator to be online with a substantial amount of steam flow available. Since significant steam flow conditions are dependent on nuclear heating, the preoperational phase testing that is possible will be limited. Performance shall be observed and recorded during a series of component and system tests. This test shall demonstrate that the ESS operates properly as specified in Subsections 10.2 and 10.4.7 and the applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms for correct response to process variable and providing alarm at the prescribed value

(c) Proper operation of system valves under expected operating conditions, including response of air assisted extraction nonreturn valves to a turbine trip signal

(d) Proper operation of interlocks and equipment protective devices

(e) Proper operation of permissive, prohibit, and bypass functions

14.2.12.1.69 Moisture Separator/Reheater System Preoperational Test

(1) Purpose

To verify proper operation of the turbine moisture separator/reheaters (MSRs) and their associated drain pathways, steam extraction lines, and isolation and extraction nonreturn valves.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Additional prerequisites include but are not limited to the following:

(a) All instrumentation and devices associated with the MSR System have been installed and permanent wiring connections made, and shall have been adjusted to the values specified by the vendor's instructions.

(b) The applicable power sources to supply electrical power to motors, control circuits, and instrumentation shall be available as required to support testing.

(c) The system valve and electrical lineups have been completed in accordance with the applicable system's operating procedures prior to the test.

(d) The Instrument Air System, test pressure sources and pressure test gauges, and communication equipment shall be available and operational for test use.

(3) General Test Methods and Acceptance Criteria

The MSRs include both a moisture separator and a reheater compartment each with its own drains, shell and tube side isolation valves, shell side vents and safety/relief valves, and associated instrumentation, control and logic.

Comprehensive testing of the ESS will require the turbine generator to be online with a substantial amount of steam flow available. Since significant steam flow conditions are dependent on nuclear heating, the preoperational phase testing that is possible will be limited.

Performance shall be observed and recorded during a series of individual components and integrated system tests. This test shall demonstrate that the MSR and its associated instrumentation and control operate properly as specified in the manufacturer's technical instruction manuals and Subsection 10.2.2 through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip

(b) Verification of various component alarms used to monitor system operation and status for correct alarm actuation and reset

(c) Proper operation of system valves and actuators (including isolation function, if applicable, and extraction nonreturn valves) under expected operating conditions

(d) Proper operation of interlocks and equipment protective devices

(e) Proper operation of permissive, prohibit, and bypass functions

(f) Proper operation of moisture separator and reheater compartment drain pathways

14.2.12.1.70 Main Turbine and Auxiliaries Preoperational Test

(1) Purpose

To verify that the operation of the main turbine and its auxiliary systems, including the Turbine Gland Sealing System (TGSS), 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 specified separately (Subsections 14.2.12.1.64 and 14.2.12.1.65).

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. To the extent practicable, a temporary steam supply shall be available to apply to the main turbine and reactor feed pump seals. The turbine instruction manual shall be reviewed in detail in order that precautions relative to turbine operation are followed. The main turbine and condenser shall be ready to receive gland sealing steam. The main turbine shall be on the turning gear before placing the TGSS into service. The main condenser evacuation system shall be available and operational to draw vacuum and maintained on the main condenser. Applicable electrical power sources and pneumatic sources shall also be available for use. The TCS and the SB&PC Systems shall be available and operational. All other required interfacing systems shall be available, as needed, to support the specified testing and the corresponding system configurations.

(3) General Test Methods and Acceptance Criteria

Since preoperational testing is performed utilizing a temporary steam supply, the extent to which the turbine itself can be tested may be limited. Therefore, the testing effort at this stage will concentrate on assuring that the necessary turbine auxiliaries are functioning properly.

Performance shall be observed and recorded during a series of individual component, subsystem and integrated system tests. These tests shall demonstrate that the turbine and its auxiliaries operate properly as specified in Subsection 10.2 and the applicable manufacturer’s technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms used to monitor system operation and availability, including the turbine-generator supervisory instruments as specified by Subsection 10.2.2.6 for correct alarm actuation and reset.

(c) Proper operation of the turbine lube oil pumps and turning-gear motor during continuous run tests.

(d) Proper operation of turbine lube oil system to provide lube oil to bearing surfaces. This test shall also verify the automatic starting features of all motor-driven lube oil pumps, the alarm functions of lube oil level gauges and the pressure drop of lube oil purifier.

(e) Proper operating conditions and performance capability of the TGSS and exhaust blower to maintain a prescribed steam pressure in the seal steam header. This test shall also verify correct steam sealing regulating valve functions.

(f) Proper turbine operation during continuous turning-gear run test. This test shall also verify correct turning-gear engagement and disengagement functions as specified by the manufacturer’s technical instruction manual.

(g) Proper performance capability of the Emergency Trip System (ETS) in shutting down the turbine and closing the main stop and control valves and CIVs. This test shall also verify the instrumentation associated with the ETS for correct functions and setpoints.

(h) Proper operation of the turbine overspeed protection system to provide mechanical overspeed trip and electrical backup overspeed trip as specified by 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.

(i) Acceptable turbine displacement and vibration levels, during both transient and steady-state operation. This test can be performed in the startup test stage when adequate nuclear steam is available for turbine operation.

14.2.12.1.71 Main Generator and Auxiliary Systems Preoperational Test

(1) 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, transformers and isophase bus duct, and the generator protection system, is as specified.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure(s) and approved the initiation of testing. Applicable electrical power sources and pneumatic sources shall be available for use. Turbine Building Cooling Water System shall be available and operational. Control systems in support of initial T/G operation shall be available and operational. The generator instruction manual shall be reviewed in detail in order that precautions relative to generator operation are followed. All required interfacing systems shall be available, as needed, to support the specified testing and the corresponding system configurations.

(3) General Test Methods and Acceptance Criteria

Since preoperational testing in part is performed without nuclear steam, the extent to which the turbine, and therefore the generator, can be tested may be limited. Therefore, the testing effort at this stage will concentrate on assuring that the necessary individual generator components and auxiliaries are functioning properly. Several testing items shown in (a), (b), and (g) below can be performed during the startup test stage when adequate nuclear steam becomes available for T/G operation.

Performance shall be observed and recorded during a series of individual component, subsystem and integrated system tests. This test shall demonstrate that the generator and its auxiliaries operate properly as specified in Subsection 10.2 and the applicable manufacturer's technical instruction manuals through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip.

(b) Verification of various component alarms used to monitor system operation and availability, including the turbine-generator supervisory instrumentation for correct alarm actuation and reset.

(c) Proper operation of the seal oil pumps and stator cooling water pumps during continuing pump run tests.

(d) Proper operating conditions and performance capability of the gas control system in removing air from and filling generator with hydrogen and providing gas pressure and temperature control during normal mode of operation. Generator hydrogen purity and leakage rate shall meet the appropriate design requirements.

(e) Proper operation of the stator cooling system to provide adequate stator cooling water flow at prescribed flow rate and maintain inlet temperature and conductivity control.

(f) Correct function of the generator runback circuits in response to simulated high stator cooling water outlet temperature and low stator cooling water pressure signals.

(g) Proper operation while powered from primary and any alternate sources, including transfers, and in degraded modes for which the system, subsystem or component is expected to remain operational.

(h) Acceptable generator clearance and vibration levels, during both transient and steady-state operation. This test can be performed during the startup test stage in conjunction with turbine testing.

(i) Acceptable differential pressure between air side and hydrogen side of generator seal oil system.

14.2.12.1.72 Flammability Control System Preoperational Test

(1) Purpose

To verify the ability of the Flammability Control System (FCS) to recombine hydrogen and oxygen and therefore maintain the specified inert atmosphere in the primary containment during long term post accident conditions.

(2) Prerequisites

The construction tests, including the pressure proof test, have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All system instrumentation shall be in accordance with the FCS instrument data sheets and calibrated per instrument supplier's instructions. All services, including water, electricity and communications, shall be available and performing at their rated design levels (flow, voltage, pressure, etc.). The wetwell and drywell airspace regions of the primary containment shall be intact, and all other required interfaces shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests. This test shall demonstrate that the

FCS operates properly as specified in Subsection 6.2.5 and applicable FCS design specifications through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic

(b) Verification of various component alarms including alarm actuation and reset, alarm set value, alarm indication and operating logic

(c) Proper operation of all motor-operated and air-operated valves, including stroking using valve opening/closing switches at the control room, verification of indicator lamp, timing and isolation function, if applicable

(d) Proper system operating conditions (i.e., the system shall be operated normally without any abnormalities, vibration, or leakage in components, valves, and piping within the FCS) for the following test cases while the FCS is in accident operating mode and regular testing mode of operation as defined in the design specification:

    (i) Triple heater test for inside heater box temperature during steady-state operation

    (ii) Blower running test for blower flow rate, flow control valve position and each line's gas flow rate

    (iii) Reaction chamber heatup test for blower flow rate, flow control valve position, each line's gas flow rate and the time for heating up the reactor chamber

(e) Proper operation of interlocks including operation of all components subject to interlocking, interlocking set value and operating logic

(f) Proper operation of permissive, prohibit, and bypass functions

(g) 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

14.2.12.1.73 Loose Parts Monitoring System Preoperational Test

(1) Purpose

To verify proper functioning of Loose Parts Monitoring System (LPMS) equipment.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. Reactor internals shall be in place with all LPMS sensors installed and connected. LPMS instrumentation and control testing shall have been completed. Additionally, the LPMS sensor signal checks shall have been completed with acceptable results.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of individual LPMS component tests. This test shall demonstrate that the LPMS operates properly as specified by Subsection 4.4.4.3 through the following testing:

(a) Proper operation of instrumentation and alarms, including system trouble alarm (low alarm) set value, sensor signal verification and sensitivity measurements

(b) Adequacy of alert level (high alarm) setpoints based on preliminary data including automatic data acquisition function upon receipt of alert level signal

14.2.12.1.74 Seismic Monitoring System Preoperational Test

(1) Purpose

To verify that the Seismic Monitoring System (SMS) will operate as designed in response to a seismic event.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. The required AC and DC electrical power shall be available and all system recording devices shall have sufficient storage medium available, based on the expected duration of the testing schedule. Additionally, instrument calibration and instrument loop checks shall have been completed.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of tests, as recommended by the manufacturer. This test shall demonstrate that the SMS functions properly as specified in Subsection 3.7.4 and appropriate manufacturer's technical instruction manuals through the following testing:

(a) Proper calibration and response of seismic instrumentation, including verification of alarm and initiation setpoints

(b) Proper operation of internal calibration or test features

(c) Proper operation of the SMS functions in the test, record, and playback modes

(d) Proper integrated system response, including annunciation, to a simulated seismic event by displacing the seismic switches and triggers of the system

14.2.12.1.75 Liquid and Solid Radwaste Systems Preoperational Tests

(1) Purpose

To verify the proper operation of the various equipment and processes which make up the Liquid and Solid Radwaste Systems.

(2) 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. Service Air, RCW, heating steam, MUWP, and Process Sampling Systems shall be operational and available for use. Additionally, 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.

(3) General Test Methods and Acceptance Criteria

The testing described below consists of that of the equipment and processes for the handling, treating, storing, and preparation for the disposal or discharge of liquid and solid radwaste. Gaseous effluents are treated and released by the Offgas System or the SGTS, the testing of which is specifically described in Subsection 14.2.12.1.57 and Subsection 14.2.12.1.36, respectively.

The liquid and solid radwaste performance shall be observed and recorded during a series of individual component and integrated system tests. These tests shall demonstrate that the Liquid and Solid Radwaste System operate properly as specified by Subsection 11.2 and Subsection 11.4 through the following testing:

(a) Proper operation of instrumentation and system controls in all combinations of logic and instrument channel trip, including prohibit and permissive interlocks and automatic operation functions.

(b) Proper operation of equipment protective features and automatic isolation functions, including those for ventilation systems and liquid effluent pathways.

(c) Verification of various component alarms used to monitor system operation and status for correct alarm actuation and reset.

(d) Acceptable operation of the low conductivity waste (LCW) subsystem, high conductivity waste (HCW) subsystem, and detergent waste (DW) subsystem associated with liquid waste system for correct process flow rates and flow paths, including discharge flow control and sampling technique, as specified by Subsection 11.2.

(e) Proper operation of system pumps, valves, and motors under expected operating conditions, including remote operation.

(f) Proper operation of phase separators and waste evaporators to collect, decant, and hold liquid/liquid-solid solutions in accordance with design.

(g) Acceptable functions of the thin film dryer, pelletizer, pellet filling machine, mixing tank, drum conveyor and incinerator during integrated solid radwaste system operation in solidifying, packaging, compacting, and incinerating processes, as specified by Subsection 11.4.

(h) Proper operation of filter and demineralizer regeneration cycles of the liquid radwaste system and their associated support facilities.

(i) Proper functioning of drains and sumps, including those dedicated for handling of specific agents such as detergents.

(j) Capability of the solid radwaste system to receive, process and transfer waste between designated locations using simulated waste variation in accordance with the Process Control Program (PCP).

(k) Proper operation of the automatic isolation function of radwaste system containment isolation valves upon receipt of a simulated containment isolation initiation signal.

14.2.12.1.76 Moved to 14.2.12.2.35

14.2.12.1.77 Ultimate Heat Sink Preoperational Test

(1) Purpose

To verify that the ultimate heat sink (UHS) is capable of supplying design quantities of cooling water to the Reactor Service Water (RSW) System.

(2) Prerequisites

The construction tests have been successfully completed, and the SCG has reviewed the test procedure and approved the initiation of testing. All instrumentation and devices associated with the UHS has been properly calibrated. The HVAC System within spray pond pump structure is operational and available. The Reactor Service Water System is operational and available for all anticipated modes of RSW System operation. Sufficient quantity of water are available in the spray pond for use. All of the required interfacing systems shall be available, as needed, to support the specified testing.

(3) General Test Methods and Acceptance Criteria

Performance shall be observed and recorded during a series of component and system testing. This test shall demonstrate that the UHS operates properly as specified in Subsection 9.2.5 and applicable UHS design specifications through the following testing:

(a) Proper operation of instrumentation and various components alarms used to monitor system operation and status, including indications for UHS water level, temperature and blowdown volumes, etc., as specified in Subsection 9.2.5.9.

(b) Proper operating conditions and performance capability of the UHS spray networks during all anticipated modes of the RSW System operations as specified in Subsection 9.2.5.4.1.

(c) Proper operating conditions and performance capability of the UHS in cold weather mode of operation through the bypass line as specified in Subsection 9.2.5.4.2.

(d) Proper operation of the makeup water valve to maintain proper water level in the UHS spray pond through makeup line and maintain water quality in conjunction with the blowdown operation as specified in Subsection 9.2.5.3.4.

(e) Proper operation of blowdown from the UHS spray pond to remove excess water and maintain water quality control through the blowdown line as specified in Subsection 9.2.5.3.4.

14.2.12.2 General Discussion of Startup Tests

Those tests proposed and expected to compromise 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.

Since 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 being explored and evaluated.

Where applicable, a definition of the relevant acceptance criteria for the test is given and is designated either Level 1 or Level 2. A Level 1 criterion normally relates to the value of process variables assigned in the design or analysis of the plant, component systems, or associated equipment. If a Level 1 criterion is not satisfied, the plant will be placed in a suitable hold condition until resolution is obtained. Tests compatible with this hold condition may be continued. Following resolution, applicable tests may be repeated to verify that the requirements of the Level 1 criterion are ultimately satisfied. A Level 2 criterion is associated with expectations relating to the performance of sytems. If a Level 2 criterion is not satisfied, operating and testing plans would not necessarily be altered. However, an engineering evaluation, such as an investigation of the measurements and of the analytical techniques used for the predictions, would be started. If a certain Level 2 criterion is not satisfied after a reasonable effort, then the cognizant engineering organization may choose to document the results with a full explanation of their recommendations. Thus, all Level 2 requirements may not be satisfied provided that the overall system performance is evaluated to be acceptable based on engineering's recommendations. The specific actions required for dealing with criteria failures and other testing exceptions or anomalies will be described in detail in the startup administrative manual.

Testing to be performed and the applicable acceptance criteria for each startup test will be documented in detailed test procedures to be made available to the NRC approximately 60 days before fuel loading. The specifics of the startup tests relating to test methodology, plant prerequisites, initial conditions, acceptance criteria, analysis techniques, and the like, will come from the appropriate design and engineering organizations in the form of plant, system and component performance and testing specifications.

14.2.12.2.1 Chemical and Radiochemical Measurements

(1) 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, including the requirements of Regulatory Guide 1.56.

(2) 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 all prerequisite testing complete prior to the test. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

Prior to fuel loading, a complete set of chemical and radiochemical samples will be taken to ensure all sample stations function 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 will be taken and measurements will be 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 steam jet air ejectors, liquid effluent activities from the radwaste system discharge, decay times in the offgas lines, and performance of filters and demineralizers.

Calibrations will be made of monitors in effluent release paths, waste handling systems, and process lines. Proper functioning of such monitors will be 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 will be verified. In this regard, sufficient data will be taken to assure proper setting of, or to make needed adjustments to, the alarm and trip settings of the applicable instrumentation.

Additional testing conducted throughout the test program will include evaluation of fuel performance, evaluations of CUW filter/demineralizer operations (i.e., no cleanup test), measurements of condensate filter and polisher performance, confirmation of condenser integrity, demonstration of proper steam separator- dryer performance, measurement and calibration of the Offgas System, and the evaluation and calibration of certain process instrumentation (including that used to monitor condensate and reactor water conductivity as required by Regulatory Guide 1.56). The demonstration, and adjustment if necessary, of the proper functioning of the Hydrogen Water Chemistry System, the Oxygen Injection System, the Zinc Injection Passivation System and the Iron Ion Injection System will also be performed, as appropriate, to the extent that proper performance could not be adequately demonstrated during the pre-operational phase of testing. Data for these purposes are secured from a variety of sources such as plant operating records, regular routine coolant analysis, radiochemical measurements of specific nuclides, and special chemical tests.

(4) Criteria

Level 1

Chemical and radiochemical factors defined in the plant Technical Specifications must be maintained within the limits specified.

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

Water quality shall remain within the guidelines of the water quality specifications.

Level 2

Not Applicable

14.2.12.2.2 Radiation Measurements

(1) 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.

(2) 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 prior to the test. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

A survey of natural background radiation throughout the plant site will be made prior to fuel loading. Subsequent to fuel loading but prior to initial criticality, 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 will be made at specific locations throughout the plant. All potentially high radiation areas will be surveyed, including:

(a) Containment penetrations

(b) All accessible areas where intermittent activities have the potential to produce transient high radiation conditions before, during, and after such operations

(c) A complete survey of all accessible floor areas within the plant prior to fuel loading, at intermediate powers, and at full power

(4) Criteria

Level 1

The radiation doses of plant origin and the occupancy times of personnel in radiation zones shall be controlled consistent with the guidelines outlined in 10CFR20 "Standards for Protection Against Radiation".

Level 2

Not Applicable

14.2.12.2.3 Fuel Loading

(1) Purpose

To load fuel safely, correctly and efficiently to the full core size.

(2) Prerequisites

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

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

(a) The status of all systems required for fuel loading will be specified and will be in the status required.

(b) Fuel and control rod inspections will be complete and control rods are fully inserted and functionally scram tested.

(c) The required number of SRNM channels will be calibrated and operable with high flux scram and rod block trips being set conservatively low in the non-coincident mode.

(d) The operability of the SRNMs will be source checked with a neutron source prior to loading or resumption if significant delays are incurred for verifying required minimum count rate and signal-to-noise ratio.

(e) The status of secondary containment will be specified and established.

(f) Reactor vessel status will be specified relative to internal component placement and this placement established to make the vessel ready to receive fuel.

(g) Final functional testing of the Reactor Protection System to demonstrate proper trip points and logic, as well as the operability of scram valves, and manual scram functions will have been completed.

(h) Final reactor coolant system leak rate test(s) to verify that system leak rates are within specified limits will have been completed.

(i) Reactor vessel water level will be established above the minimum level prescribed.

(j) All other required systems shall be operable as defined by the plant technical specifications and as demonstrated by the applicable surveillance tests.

(3) Description

Fuel loading will commence and proceed according to detailed written procedures in a predetermined sequence that will assure a safe, correct and efficient loading. The neutron count rates shall be monitored as the core loading progresses to ensure continuous subcriticality, and shutdown margin demonstrations will be performed at specified loading intervals.

(4) Criteria

Level 1

The partially loaded core must be subcritical by at least the amount (in terms of reactivity) specified on the Cycle Management Report or Vendor's prediction with the analytically determined highest worth rod pair fully withdrawn (a rod pair is defined as having a shared accumulator).

Level 2

Not Applicable

14.2.12.2.4 Full Core Shutdown Margin Demonstration

(1) Purpose

To demonstrate that the reactor will be subcritical throughout the first fuel cycle with the highest worth control rod pair (two CRDs with a shared accumulator) fully withdrawn.

(2) Prerequisites

The applicable preoperational tests have been completed and plant management has reviewed the test procedure and approved the initiation of testing. Additionally, the following prerequisites shall be met prior to performing the full core shutdown margin tests:

(a) The predicted critical rod position will be available.

(b) The Standby Liquid Control System will be available.

(c) The SRNM instrumentation will be operable in the non-coincident trip mode with the minimum neutron count rate and signal-to-noise ratio as specified by technical specifications.

(d) High-flux scram and rod block trips are set conservatively low on the SRNMs.

(3) Description

This test will be performed in the fully loaded core in the xenon-free condition. The shutdown margin test will be performed by withdrawing the control rods from the all-rods-in configuration until criticality is reached. If the highest worth rod pair will not be withdrawn in sequence, other rods may be withdrawn providing that the reactivity worth is equivalent. The difference between the measured K_{eff} and the calculated K_{eff} for the insequence critical will be applied to the calculated value to obtain the true shutdown margin.

(4) Criteria

Level 1

The shutdown margin of the fully loaded, cold (20°C), 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 shutdown margin is determined at some time during the cycle other than the most reactive time, compliance with the above criterion is shown by demonstrating that the shutdown margin is the specified amount plus an exposure dependent correction factor which adjusts for the difference in core reactivity between the most reactor time and the time at which the shutdown margin is demonstrated.

Level 2

Criticality shall occur within the specified tolerance of the predicted critical.

14.2.12.2.5 Control Rod Drive System Performance

(1) Purpose

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

(2) 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. Additionally, a special test fixture contains a small pump and associated hydraulic control shall be available for performing drive line friction testing.

(3) 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. Thus, 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.

Coupling test will be performed by attempting to withdraw each drive to the overtravel out position. Each CRD will also demonstrate insert/withdraw motions in response to rod movement commands from the RCIS, individually and as a ganged group, while in notch driving and continuous driving modes. The scram performance will be demonstrated at cold temperature conditions with no flow in the Reactor Recirculation System and at rated temperature and pressure conditions with flow in the RRS by both two-CRD (single HCU) scram tests and full core (all CRDs) scram tests. In addition, the drive-line friction will be measured in terms of the pressure under hollow piston for each CRD at cold conditions (if not previously done during preoperational test phase) and again verified on four selected CRDs at rated temperature and pressure conditions during initial heatup of the startup test program.

(4) Criteria

Level 1

Each CRD must have a maximum withdraw speed in the continuous driving mode no greater than the value specified by the CRD System Design Specification.

For vessel pressure between 6.55 Pa G and 7.24 MPaG, the maximum scram insertion time of individual fully withdrawn control rods to each specified positions, based on de-energization of scram pilot valve solenoids as time zero, shall be less than or equal to the limits specified on the plant Technical Specifications.

Level 2

Each CRD must have a continuous rod motion speed while inserting or withdrawing as specified by the applicable CRD System Design Specification.

For continuous insert friction tests, the measured drive-line friction shall be consistent with the baseline data obtained during pre-operational test (Subsection 14.2.12.1.6) or the limits specified by the applicable CRD System Design Specification.

For scram tests at cold conditions with ambient pressure, the 60% scram insertion time for each CRD from fully withdrawn position, based on de-energization of scram pilot valve solenoids as time zero, must be less than or equal to the limit specified by the plant Technical Specifications.

For continuous ganged rod motion, the rods shall move together such that the positions of all rods agree with all other rods in each ganged group within the tolerance specified by the CRD System Design Specifications. A rod block shall be initiated if the rod positions within the rod ganged group disagree by more than this specified tolerance.

14.2.12.2.6 Neutron Monitoring System Performance

(1) Purpose

To verify response, calibration and operation of startup range neutron monitors (SRNMs), local power range monitors (LPRMs), average power range monitors (APRMs), automatic traversing incore probes (ATIPs), and other hardware and software of the neutron monitoring system during fuel loading, control rod withdrawal, heatup and power ascension.

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

Testing of the Neutron Monitoring System will commence prior to fuel load and will continue at intervals up to and including rated power. The SRNM count-rate data will be taken during fuel loading and during rod withdrawal on the approach to criticality and heatup to rated temperature and pressure, and compared with stated criteria on signal and signal-to-noise ratio. The LPRMs, APRMs and ATIPs will be tested as soon as sufficient flux levels exist and at specified intervals during the ascension to rated power.

Each SRNM channel will be adjusted for proper alignment between the counting flux and MSV flux ranges while operating at the overlap region. The LPRM channel will first be checked for correct connections during initial heatup. Then, each LPRM channel will be calibrated to make the LPRM readings proportional to the neutron flux in the LPRM water gap at the chamber elevation. During heatup, a preliminary calibration will be made so that the SRNM and APRM channels read equal to or greater than the core thermal power value based on a constant heatup rate heat balance. Each APRM channel reading will again be adjusted in the power range by a heat balance as soon as adequate feedwater indication is available. The top and bottom limits for each ATIP channel to start and stop data acquisitions will initially be established at cold condition. After the plant reaches rated temperature during initial heatup, the established top and bottom limits of each ATIP channel will be adjusted as necessary based on the comparison against fuel channel spacer dip locations. Proper ATIP alignment will finally be confirmed by determining ATIP uncertainties during power ascension to mid and high power levels. The total ATIP uncertainty (including random noise and geometry uncertainty components) is determined by averaging the uncertainties for all ATIP data sets obtained during the test.

(4) Criteria

Level 1

Each required operable SRNM shall have a count-rate signal with a signal-to-noise ratio of at least 3:1 and a signal count rate of at least 3 counts per second.

Each required operable SRNM shall be adjusted so that a bumpless transfer is achieved when transferring between the counting and MSV flux ranges.

The APRM channels must be calibrated to read equal to or greater than actual core thermal power.

Level 2

Each SRNM channel shall overlap with the APRMs consistent with the requirements of applicable Neutron Monitoring System Design Specification or plant Technical Specifications.

Each LRPM reading shall agree with its calibrated value within the accuracy specified by the GE Startup Test Specifications.

At reactor power ≥ 25% of rated, the APRM channels will be considered to be reading accurately if they agree with the heat balance within ±2% of rated power as specified by the plant Technical Specifications.

The total ATIP uncertainty (including random noise and geometry uncertainty components) shall be less than the limits specified by the GE Startup Test Specifications.

14.2.12.2.7 Process Computer System Operation

(1) Purpose

To verify the ability of the Process Computer System (PCS) to collect, process, and display plant data, execute plant performance calculations, and interface with various plant control systems during actual plant operating conditions.

(2) Prerequisites

The applicable preoperational tests have been completed and plant management has reviewed the testing 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. Computer diagnostic tests shall have been completed prior to the test. Additionally, construction and construction testing on each input instrument and its cabling shall be completed.

(3) Description

Computer system program verifications and calculational validations are accomplished through the implementation of both static and dynamic test cases. Static and simulated dynamic test cases are performed at the computer supplier's site and following delivery to the plant site during the preoperational test phase. Dynamic test cases are performed beginning with plant heatup and continuing through the ascension to rated power and flow conditions.

During plant heatup and the ascension to rated power, the various process variables that are monitored by the PCS and required by the reactor core performance and plant performance calculations begin to enter their respective ranges for normal plant operation. During this time, it will be verified that the PCS correctly receives, validates, processes, and displays the applicable plant information. Recording and playback features will also be tested. Data manipulation and plant performance calculations using actual plant inputs will be verified for accuracy, using independent calculations for comparison. Also, the ability of the PCS to interface correctly with other plant control systems during operation will be demonstrated.

(4) Criteria

Level 1

Not Applicable

Level 2

The reactor core performance calculation programs that calculate the core performance parameters (MCPR, MAPLHGR, and MLHGR) and LPRM gain adjustment factors shall produce results that agree with an independent method of calculation within the accuracy specified by the GE Startup Test Specifications.

The remaining reactor core performance and plant performance calculation programs will be considered operational upon successful completion of the static and dynamic testing.

14.2.12.2.8 Core Performance

(1) Purpose

To demonstrate that the various core and reactor performance characteristics such as power versus 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.

(2) 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, especially on plant systems to be used for collection or evaluation or pertinent data. Additionally, applicable system instrumentation shall have been installed and calibrated and test instrumentation calibrated.

(3) Description

This test will collect data sufficient to demonstrate that reactor and core performance characteristics remain within design limits and expectations for all operational conditions which the plant is normally expected to encounter. During plant heatup and the ascension to rated power, pertinent data will be collected at various rod patterns and power and flow conditions.

(4) Criteria

Level 1

The Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) shall not exceed the limits specified by the plant Technical Specifications.

The steady-state Minimum Critical Power Ratio (MCPR) shall exceed the minimum limit specified by the plant Technical Specifications.

For any non-GE fuel only, the Maximum Linear Heat Generation Rate (MLHGR) shall not exceed the limits specified by the plant Technical Specifications.

Steady-state reactor power shall be limited to the design rated core thermal power and values on or below the minimum of either rated thermal power or the licensed highest flow control line as shown on the power-flow map.

Core flow as indicated by operating data shall not exceed its design rated value.

Level 2

Not Applicable

14.2.12.2.9 Nuclear Boiler Process Monitoring

(1) 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.

(2) 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. Additionally, system instrumentation shall have been installed and calibrated and test instrumentation calibrated.

(3) Description

At rated temperature and pressure during initial heatup and under steady-state conditions during power ascension, reactor vessel level indication from the various water level instruments will be monitored and recorded. Data collected at various operating conditions will be used to define the effect of core flow velocity, subcooling, and carryunder on indicated wide range level. Additionally, the temperature of the reference legs of reactor vessel water level instrumentation shall be monitored for comparison with the initial calibration assumption.

During various operating modes throughout the ascension to rated power conditions, the bottom drain line temperature, reactor coolant temperature, and other applicable indications of reactor coolant temperatures will be monitored and recorded. The collected data will be used to identify any potential stratification in the vessel bottom head region, either with all RIPs in operation or with one or more RIPs inactive.

At several power-flow conditions during ascension to rated power, pertinent data such as RIP pump deck differential pressure, RIP pump speed, core plate differential pressure, and other applicable reactor parameters, will be recorded and used as inputs to determine total core flow based on the CPDP (core plate differential pressure) and PDDP (pump deck differential pressure) methods of flow calculations and conversions. The coefficients used in the CPDP method will be calibrated against the results of the PDDP method. The CPDP flow results are used in both the RFC process control and in safety function trips. The PDDP core flow signal is used as an input to the MCPR calculations in addition to being used as a calibration source of the CPDP core flow.

(4) Criteria

Level 1

An idle recirculation pump shall not be started unless the temperature difference between vessel bottom coolant temperature and the saturated water temperature inferred from steam dome pressure is within the limit (i.e., 80°C) as specified by Subsection 7.7.1.3.(5).

Level 2

The APRM instrument performing the APRM calculations shall provide correct core flow data to Data Communication Function at rated conditions.

The flow reference logic shall provide correct flow-biased setpoint values for the APRM alarm and thermal power trip function of the APRM at rated conditions.

The difference between the actual reference leg temperature and the value(s) assumed during initial calibration shall be less than that amount which will result in a scale end point error as specified in the GE Startup Test Specifications (i.e., 1% of the instrument span for each range).

With all recirculation pumps in operation at rated core flow and power conditions, the bottom head temperature as measured by the bottom drain line thermocouple shall agree with the saturated water temperature corresponding to steam dome pressure within the accuracy specified by the GE Startup Test Specifications.

14.2.12.2.10 System Expansion

(1) Purpose

The purpose of the thermal expansion test is to confirm that both NSSS and Balance-of-Plant (BOP) pipe suspension systems are working as designed and the piping is free of obstructions that could constrain free pipe movement caused by thermal expansion.

(2) Prerequisites

The applicable 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. Additionally, the required remote monitoring instrumentation shall be calibrated and operational.

(3) Description

The NSSS scope of thermal expansion testing consists of measuring displacements, strains, and temperatures of piping as listed below during various modes of plant operations. Additionally, a visual examination for obstructions/interference or evidence thereof, will also be performed on the system piping at appropriate hold points during initial heatup to rated temperature conditions and after three heatup and cooldown cycles. Thermal movement, strain, and temperature measurements will be recorded at least at the following points during power ascension:

(a) Ambient temperature (for baseline data).

(b) 1.03 MPaG reactor pressure.

(c) 4.14 MPaG reactor pressure.

(d) Rated reactor water temperature.

(e) 100% of rated power.

(f) At points (a) and (e) above for a total of three times on three separate heatup and cooldown cycles (to measure possible shakedown effects).

(g) Plant at hot standby conditions following reactor scram and during plant startup with cold feedwater in low flow conditions (i.e., at plant conditions with maximum potential for feedwater temperature stratification in both loop A and loop B piping). This is applicable to feedwater piping only.

The piping systems considered to be within the NSSS scope of thermal expansion testing are:

(a) Main steam piping bounded by the RPV nozzles and the MSIVs outside containment.

(b) SRV discharge piping attached to the main steamlines and bounded by the SRV discharge flange and the quencher in the wetwell.

(c) Feedwater piping bounded by the RPV nozzles and the isolation check valves outside containment.

(d) Recirculation Motor Cooling (RMC) piping, including RIPs. (If hot functional test (HFT) has been performed, then Recirculation System (RRS) thermal expansion test is not required during power ascension test.).

(e) Small branch piping attached to those portions of the piping defined in Items (a), (b), and (c), are bounded by the large pipe branch connection and the first downstream anchor. Small branch pipes that can not be monitored due to limited access are excluded from the scope of this test.

The BOP scope of thermal expansion testing consists of measuring displacements of the piping systems at various temperatures using installed test instruments. Visual observations will also be made by a system walkdown to determine acceptability of the system under the conditions existing during the specified test. Thermal movements will be recorded at appropriate temperature increments up to the required test temperature for each of the below listed BOP scope of piping systems:

(a) Main steam piping downstream of the outboard MSIVs

(b) Feedwater piping outside containment downstream of isolation check valves

(c) RCIC turbine steam supply and exhaust piping

(d) RCIC pump suction and discharge piping

(e) RHR suction and discharge piping in shutdown cooling mode

(f) CUW suction and discharge piping, including the head spray line

(g) RPV head vent piping

Additionally, thermal movement due to possible feedwater temperature stratification will also be measured for the feedwater piping outside containment with plant at hot standby conditions following reactor scram and during plant startup with cold feedwater in low flow conditions as described above in the NSSS scope of testing.

(4) 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 Level 1 and Level 2 thermal expansion limits and the locations to be monitored are specified in the Piping System Test Requirement Specification. To assure that the criteria are applied at relevant test conditions, the criteria are not applicable prior to the reactor vessel and system piping temperatures being at meaningful values. The designated thermal expansion limits would have been exceeded if readings from any of the installed remote sensors exceed the limits specified.

Level 1

The Level 1 limits are intended to set bounds on pipe motion which, if exceeded, makes a test hold or termination mandatory. If a Level 1 limit is exceeded, the test shall be terminated or the plant shall be placed in a satisfactory hold condition below the Level 1 limit and the cognizant engineering organization shall be advised and reconciliation or corrective action taken prior to moving beyond plant conditions at which thermal expansion has been demonstrated to be acceptable.

Level 2

The Level 2 limits are expected levels of pipe motion which, if exceeded, require that the cognizant engineering organization be advised so that investigation of the measurements and of the criteria and calculations used to generate the pipe motion limit can be initiated. If a Level 2 limit is not satisfied, however, plant operating and startup test plans need not necessarily altered.

14.2.12.2.11 System Vibration

(1) 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 operational transients.

(2) 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 test iteration, the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. Additionally, the required remote monitoring instrumentation shall be calibrated and operational.

(3) Description

Vibration testing during the power ascension phase will be 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 14.2.12.1.51. For those monitored locations with potentially high levels of radiation present during power operation, the testing will be performed using remote monitoring instrumentation. Additionally, system walkdown and local measurements will be conducted to look for excessive vibration with the system at the required test conditions. Displacement, acceleration, and strain data will be collected at various critical steady-state operating conditions and during significant transients.

The NSSS scope of vibration displacement and strain measurements will be made during steady-state of each of the below listed conditions:

(a) Remote measurements of vibration displacements on the main steam and feedwater piping at:

(i) 25% ± 5% of rated main steam flow and coincident temperature

(ii) 50% ± 5% of rated main steam flow and coincident temperature

(iii) 75% ± 5% of rated main steam flow and coincident temperature

(b) Remote measurements of vibration displacements and strains on the main steam, feedwater, and SRV discharge lines, and RMC piping at the instrumented locations at 100% of rated electrical power.

(c) Remote measurements of vibration displacements on the recirculation RMC piping at:

   (i) Recirculation at minimum flow and coincident flow
   (ii) Recirculation flow at 50% ± 5% of rated on 100% rod line and at operating temperature
   (iii) Recirculation flow at 75% ± 5% of rated on 100% rod line and at operating temperature

The BOP scope of steady-state vibration displacement and strain measurements will be made during the following conditions:

(a) Remote measurements of vibration displacements on the main steam piping downstream of outboard MSIVs at:

   (i) Plant shutdown with the turbine stop valves closed and 100% bypass team flow to the condenser
   (ii) Main steam flow at 100% of rated

(b) Remote measurements of vibration displacements and strains on the feedwater piping outside containment during:

   (i) Feedwater flow at 100% of rated and operating temperature
   (ii) Hot standby with cold feedwater at low flow conditions

(c) Remote vibration displacement measurements on RCIC turbine steam supply line and local measurement using a hand held vibrometer on RCIC turbine exhaust, pump suction and discharge piping while RCIC steamline at 100% of rated flow and coincident temperature (Subsection 14.2.12.2.22)

(d) Remote vibration displacement measurements on the RHR suction and discharge piping while RHR is operating at 100% of rated flow in shutdown cooling mode (Subsection 14.2.12.2.20)

(e) Remote vibration displacement measurements on the CUW suction and discharge (including head spray) piping while CUW is operating at 100% of rated flow and operating temperatures (Subsection 14.2.12.2.21)

Additionally, with the system as near as obtainable to normal operating temperatures and flows, system walkdown and local vibration measurements at the specified locations will be conducted to look for excessive vibrations. Special attention will be given to small attached piping and instrument connections to insure their movements are within limits.

The NSSS scope of transient vibration displacement and strain measurements will be conducted in conjunction with the following plant transient tests:

(a) Transient vibration displacement measurements on main steam, RMC, and SRV discharge line piping and strain measurements on main steam piping upon turbine control or stop valve closure during generator load rejection or turbine trip test (Subsection 14.2.12.2.33)

(b) Transient vibration displacement and strain measurements on main steam, RMC, SRV discharge lines, and feedwater piping during plant transient tests that results in SRV discharge (Subsections 14.2.12.2.27, 14.2.12.2.32, 14.2.12.2.33, and 14.2.12.2.34)

(c) Transient vibration displacement and strain measurements for feedwater piping during feedwater pump trip and recovery test (Subsection 14.2.12.2.29)

(d) Transient vibration displacement measurements on RMC piping during RIP trip at 100% of rated flow and recovery tests (Subsection 14.2.12.2.30)

The BOP scope of transient vibration and strain measurements will be performed during the following plant transient tests:

(a) Transient vibration displacement and strain measurements on feedwater piping outside containment during feedwater pump trip and restart tests (Subsection 14.2.12.2.29)

(b) Transient vibration displacement measurements on main steam piping outside containment upon turbine control or stop valve closure during generator or turbine trip test (Subsection 14.2.12.2.33)

(c) System walkdown or local vibration measurements to look for excessive vibration during selected transient, if required by the Piping System Test Requirement Specifications

(4) Criteria

Criteria will be calculated for those points monitored for vibration for both steady-state and transient cases. Two levels of criteria will be 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 will be no failures from fatigue over the life of the plant.

The Level 1 and Level 2 vibration displacement and strain limits and the locations to be monitored are specified in the applicable Piping System Test Requirement Specifications.

Level 1

(a) Steady-State Vibration: Level 1 limits on steady-state operational vibration displacements and strains are based upon keeping piping stresses and pipe mounted equipment accelerations within safe limits and ASME code limits. If any one of the remote sensors indicate that the prescribed limits are exceeded, the test shall be placed on hold.

(b) Operating Transients: Level 1 limits on transient vibration displacements and strains are based on keeping the loads on piping and suspension components within safe limits and ASME Code limits. If any one of the remote sensors indicate that these movements have been exceeded, the test shall be placed on hold.

Level 2

(a) Steady-State Vibration: The evaluation of Level 2 criteria on steady-state vibration takes two forms: limits on vibratory displacement and limits on acceleration. The limits have been set based on consideration of analysis, operating experience and protection of pipe mounted components.

(b) Operating Transients: Remote sensors have been placed near points of maximum anticipated movement. Where movement values have been predicted, tolerances are prescribed for differences between measurements and predictions. Tolerances are based on instrument accuracy and suspension free play. Where no movements have been prescribed, limits on displacements will be prescribed.

14.2.12.2.12 Reactor Internals Vibration

(1) 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 in accordance with the requirements of Regulatory Guide 1.20.

(2) Prerequisite

The applicable 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, all vibration sensors shall have been installed, connected to the applicable signal conditioning equipment and calibrated.

(3) Description

Reactor internal vibration testing subsequent to fuel loading is merely an extension of the program described during the preoperational phase in Subsection 14.2.12.1.52. The vibration measurement portion of that program is expanded during the power ascension phase to include intermediate and critical power and flow conditions during steady-state operation and anticipated operational transients that are expected to result in limiting or significant levels of reactor internals vibration over and above what was observed during the preoperational test phase. The extent to which reactor internals vibration testing is conducted during the power ascension phase is dependent on the classification of the reactor internals as prototype or not in accordance with Regulatory Guide 1.20, as discussed in Subsections 3.9.2.4 and 3.9.7.1. To the degree required by Regulatory Guide 1.20, per the applicable prototype designation, testing will include the precritical operation as well as power operation on the 60% and 100% rod lines.

The pre-critical tests shall be performed at least to include balance flow tests at various flow values, single and three RIP pumps trip tests, and unbalance flow tests after three RIP pump trip. These test conditions shall be attained with the reactor subcritical and with the vessel at the same temperature and pressure as the preoperational phase tests.

The 60% rod line tests will include a minimum of eight test points, including flow balance tests at four equally-spaced flow points, and RIP trip tests.

The 100% rod line tests will include a total of nine test conditions minimum, including balance flow tests at four equally-spaced flow points, three RIP pump trip tests and rated power turbine trip test.

During the vibration test, the Vibration Engineer will monitor and record vibration amplitudes and frequencies obtained from the sensors mounted on the various components. Based upon the results at each test conditions specified above, the cognizant engineering organization may specify conditions where additional steady-state unbalanced flow vibration measurements are required.

(4) Criteria

The Level 1 and Level 2 internal vibration limits and the locations to be monitored are specified in the Reactor Internal Vibration Monitoring System Test Specification. A dynamic analysis of instrumented components will be performed to determine peak component stresses as a function of strains and displacements at sensor locations, for each of the lower natural vibration modes of the various components. Based on the analysis, and on the vibration stress limits of the core support structure, or on other components design specifications where applicable, a report specifying acceptance criteria for this vibration measurement program will be prepared. The Level 1 criteria specifies allowable response amplitudes, in terms of peak sensor responses, for each of the lower natural modes of the instrumented components. The Level 2 criteria is based on the low stress limit which is suitable for sustained vibration in the reactor environment for the design life of the reactor components.

Level 1

The peak stress intensity may exceed 68.95 MPa (single amplitude) when the component deformed in a manner corresponding to one of its normal or natural modes, but the fatigue usage factor must not exceed 1.0.

Level 2

The peak stress intensity shall not exceed 68.95 MPa (single amplitude) when the component is deformed in a manner corresponding to one of its normal or natural modes.

14.2.12.2.13 Recirculation Flow Control

(1) Purpose

To demonstrate the Recirculation Flow Control (RFC) System's control capability over the entire flow control range for all applicable modes of operations across the span of expected operational conditions and to determine that all controllers are set for desired system performance and stability.

(2) 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. This includes preliminary adjustment and optimization of control system components as appropriate.

(3) Description

Startup phase testing of the RFC System is intended to demonstrate that the overall response and stability of the system meets design requirements subsequent to controller optimization. Performance shall be demonstrated at a sufficient number of power and flow points to bound the expected system operational conditions including flow auto, automated load following (ALF), and total manual modes of operations. Testing will be accomplished by manual manipulation of controllers and/or by direct input of demand changes at various levels of control.

(4) Criteria

Level 1

The transient response of any recirculation system-related variable to any test input must not diverge as stated in the applicable Recirculation Flow Control System Design Specification.

Level 2

The responses of the ALF mode, flow auto mode, and total manual mode to any test input shall be at least quarter-damped; that is, the decay ratio of the second-to-first overshoot for each variable is less than or equal to 0.25 as stated in the applicable Recirculation Flow Control System Design Specification.

In the total manual mode, the speed response of a single RIP to speed demand step (10% or greater) and the speed responses of all RIPs to speed demand step (5% or less) shall meet the performance requirements as stated in the applicable Recirculation Flow Control System Design Specification for the following parameters:

(a) Maximum rate of speed response (in either increasing or decreasing pump speed direction)

(b) Dead band

(c) Delay time

(d) Speed overshoot

(e) Speed settling time

(f) Speed rise time

When operating in the flow auto mode, the response of core inlet flow to flow demand step (5% or less) shall meet the dynamic performance requirements as stated in the applicable Recirculation Flow Control System Design Specification for the following parameters:

(a) Maximum overshoot

(b) Response time

(c) Settling time

(d) Delay time

In the ALF mode, the dynamic response to a load demand step (10% or greater) shall comply with the maximum rate of steam flow response (i.e., plus or minus 20% steam flow change per minute) as stated in the applicable Recirculation Flow Control System Design Specification. Also, the sum of steam flow delay time and response time in response to a load demand step (10% or less) shall be within the limit (i.e., 10 seconds) as stated in the applicable Recirculation Flow Control System Design Specification.

For any of the above test maneuvering, no high flux scram shall result as stated in the applicable Recirculation Flow Control System Design Specification and the trip avoidance margins shall at least comply with the requirements as stated in the GE Startup Test Specifications (i.e., at least 7.5% for neutron flux and 5.0% for simulated heat flux).

At steady-state during any recirculation flow control mode of operations, the overall limiting cycles (if any) contributed by the RFC System on RIP pump speed and core flow shall be within the allowable range (i.e., plus or minus 5%) as stated in the applicable Recirculation Flow Control System Design Specification.

14.2.12.2.14 Feedwater Control

(1) Purpose

To demonstrate that the stability and response characteristics of the feedwater control system are in accordance with design performance requirements for applicable system configurations and operational conditions.

(2) 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. This includes preliminary adjustments and optimization of control system components as appropriate.

(3) Description

Power ascension phase testing of the feedwater control system consists of both open loop and closed loop testing at each selected test condition. During open loop testing, feedwater flow responses to small and large actuator demand steps will be verified for acceptable stability and response. For closed loop testing, reactor water level setpoint changes of approximately 15 cm and greater will be used to evaluate and adjust if necessary the master level controller settings for all power and feedwater system operating modes. The level setpoint changes also demonstrate core stability to subcooling changes. Testing will begin during plant heatup for any special configurations designed for very low feedwater or condensate flow rates and will continue up through the normal full power line up. Testing will be accomplished by manual manipulation of controllers and/or by direct input of demand changes at various levels of control. Additionally, steady-state gain curve data will be collected during ascension to rated power for verifying the linearity of the main actuators in controlling water level. Linearization/smoothing of the curve will be done as necessary together with the controller optimization.

(4) Criteria

Level 1

The transient responses of feedwater flow and vessel level to any test maneuvering must not diverge as stated in the applicable Feedwater Control System Design specification.

Level 2

The response of feedwater flow (and vessel level) to any test input shall be at least quarter-damped, that is, the ratio of the second-to-first feedwater flow (and vessel level) overshoot is less than or equal to 0.25 as stated in the applicable Feedwater Control System Design Specification.

For Open Loop Testing:

The dynamic flow response of the main feedwater actuators (i.e., MDRFP flow control valve and low flow control valve) to small (10% of rated pump flow or less) step disturbances shall be in compliance with the performance requirements stated in the applicable Feedwater Control System Design Specification for the following parameters:

(a) Maximum time to 10% of disturbance

(b) Maximum time from 10% to 90% of step disturbance

(c) Settling time to 100% ± 5% of step disturbance

(d) Peak overshoot

(e) Deadband

For large (20% of rated pump flow or greater) step disturbance, the average rate of feedwater flow response for MDRFP flow control valve and stroke time for low flow control valve shall meet the requirements as stated in the applicable Feedwater Control System Design Specification. Rated pump flow is equivalent to the capacity of a single feedwater pump and the response requirement is assessed by determining the time required to pass linearly through the 10% and 90% response points.

For Closed Loop Testing:

The dynamic response of the master level controller to small step of level disturbances (7.5 to 15 cm) shall comply with the performance requirements as stated in the applicable Feedwater Control System Design Specification for the following parameters:

(a) Maximum time to 10% of step disturbance

(b) Maximum time from 10% to 90% of step disturbance

(c) Settling time to 100% ± 5% of step disturbance

(d) Peak overshoot

For large step of level disturbances (15 cm and greater), the average rate of vessel level response shall meet the minimum requirement (i.e., 2.54 cm/s) as stated in the applicable Feedwater Control System Design Specification. The response requirement is assessed by determining the time required to pass linearly through the 10% and 90% response points.

14.2.12.2.15 Pressure Control

(1) Purpose

To determine the optimum settings for the pressure control loop and to demonstrate the adequacy of the pressure control system in maintaining a stable and fast pressure response to pressure transients. Additionally, smooth pressure control transition between the turbine control valves and the bypass valves will be demonstrated when the reactor steam generation exceeds the steam flow used by the turbine.

(2) 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. This includes preliminary adjustment and optimization of control system components as appropriate.

(3) Description

Plant response to pressure setpoint step change input will be verified for stability and response with recirculation flow control system in various modes of operation. At specified test conditions, the load limit setpoint is set so that the entire pressure transient during the test is handled by turbine control valves, bypass valves, or both. The response of the system will be measured and evaluated and the pressure controller settings will be optimized. Turbine control valve linearity (incremental regulation) will be verified over the load range for acceptability throughout the course of optimizing pressure controller settings.

(4) Criteria

Level 1

The transient response of any pressure control system-related variable to any test input must not diverge as stated in the applicable Steam Bypass and Pressure Control System Design Specification.

Level 2

The response of any pressure control system-related variable to any test input shall be at least quarter-damped; that is, the ratio of the second-to-first overshoot for each variable is less than or equal to 0.25 as stated in the applicable Steam Bypass and Pressure Control System Design Specification.

The pressure response time from initiation of pressure setpoint change to the pressure controller sensed pressure peak shall be within the limit (i.e., 10 seconds) as stated in the applicable Steam Bypass and Pressure Control System Design Specification.

Pressure control system deadband, delay, etc., shall be small enough that steady-state limit cycles (if any) magnitude and frequency shall not exceed the requirements as stated in the applicable Steam Bypass and Pressure Control

System Design Specification (i.e., within plus or minus 0.5% rated turbine steam flow in magnitude and greater than 5 seconds in period).

For all pressure controller transients, no high flux or vessel pressure scram shall result and the trip avoidance margin shall at least meet the requirements as stated in the GE Startup Test Specifications (i.e., at least 7.5% for neutron flux, 5.0% for simulated heat flux and 68.6 kPaD for vessel pressure).

The incremental regulation is defined as the ratio of incremental change in steam flow demand and incremental change in steam flow. The maximum variation in incremental regulation, defined as the ratio of the maximum-to-minimum value of incremental regulation for each specified flow ranges, shall not exceed the limits as stated in the applicable Steam Bypass and Pressure Control System Design Specification as following:

% of Steam Flow	Variation in Incremental Regulation
0 to F*	≤ 4:1
F* to 97	≤ 2:1
F* to 99	≤ 5:1

* F is defined to be 85% for full-arc admission turbine and 90% for partial-arc admission turbine.

14.2.12.2.16 Plant Automation and Control

(1) Purpose

To verify that the Power Generation Control System (PGCS) will operate properly with automatic power regulator (APR) to support automation of the normal plant startup, shutdown and power range operations.

(2) Prerequisites

The applicable preoperational tests have been completed and plant management has reviewed the testing procedure and approved the initiation of testing. Additionally, affected systems and equipment, including lower level control systems such as RCIS, recirc flow control, feedwater control and turbine control, as well as monitoring and predicting functions of the plant process computer and/or automation computer, shall have been adequately tested under actual operating conditions.

(3) Description

The PGCS provides a means to automatic or manual operation of the plant startup, shutdown, and power maneuvering in its three basic modes of operations: automatic, semi-automatic, and manual. During ascension to rated power and flow conditions, the following set of performance tests will be conducted:

(a) Plant startup operation with the use of the PGCS and APR functions

(b) Plant shutdown operation with the use of the PGCS and APR functions

(c) Power range maneuvering with the use of the PGCS and APR functions

The performance parameters of the total system and its components will be measured at each of the above plant operations. Capability of the PGCS to operate properly with the APR to support automation of the normal plant startup, shutdown, and power range operation is demonstrated by verifying that each parameter is within limits specified.

Capability of automated load following (ALF) under the control of APR function is demonstrated separately in Subsection 14.2.12.2.13. Such testing is conducted to assure that the dynamic response of the plant to design load swings, including limiting step and ramp changes, as appropriate, is in accordance with design requirements.

(4) Criteria

Level 1

Not Applicable

Level 2

Under normal conditions, no single equipment failure shall result in the disturbance of plant operation (i.e., the plant shall be operated without the PGCS functions).

No single equipment failure shall cause the inadvertent setpoint change and switch over the system operation mode.

14.2.12.2.17 Reactor Recirculation System Performance

(1) Purpose

To verify that RRS steady-state performance characteristics are in accordance with design requirements.

(2) 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.

(3) Description

Ganged RIP steady-state performance testing with 7 to 10 RIPs in service will be conducted at several power-flow conditions during power ascension test program. Pertinent recirculation system and related performance parameters will be monitored and recorded beginning with the ganged RIPs at minimum speeds and continuing through simultaneously increasing RIP speeds in specified steps until plant rated condition is reached. Parameters to be monitored and evaluated shall at least include RIP speeds, pump deck and core plate differential pressures, pump efficiencies, maximum core flow capability, and any number of other variables that may indicate the status of the RIPs and their shafts, motors, or heat exchangers. Data shall also be taken and evaluated during transient conditions such as RIP pump trips and restarts, and during off normal conditions such as one RIP pump out-of-service operation. Of particular interest will be the onset of reverse flow through idle pumps and the calibration of total core flow indictions during both normal and off normal operating conditions.

(4) Criteria

Level 1

Not Applicable

Level 2

With all ten RIPs in service, the RIPs performing as a group shall provide a minimum core flow at the flow rate and system operating conditions as stated in the applicable Reactor Recirculation System Design Specification.

With one RIP out of service, the RIPs performing as a group shall provide 100% core flow at least at the flow rate and system operating conditions as stated on the Reactor Recirculation System Process Flow Diagram (Figure 5.4-5).

At rated power and flow, the measured efficiency for each RIP shall meet or exceed the value as stated for the applicable Reactor Recirculation System Design Specification.

At rated power and flow, each RIP, individually, shall be capable of providing the flow and head as stated on the Reactor Recirculation System Process Flow Diagram (Figure 5.4-5).

At rated power and flow, the measured core pressure drop shall not exceed the predicted value by an amount as required by the GE Startup Test Specifications.

The RFCS shall provide controls to limit each highest RIP pump speed to a maximum speed consistent with the reactor operating conditions and nuclear safety operational analysis requirements (Subsection 15.4.5).

14.2.12.2.18 Feedwater System Performance

(1) Purpose

To verify that the overall feedwater system performance characteristics are in accordance with design requirements.

(2) 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.

(3) Description

Pertinent parameters will be 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 and capacity are in accordance with design. Parameters to be monitored include temperatures, pressures, flow rates, pressure drops, pump speeds and developed heads, and general equipment status. Of special interest will be data that serves to verify design assumptions used in plant transient performance and safety analysis calculations like maximum feedwater runout capabilities, feedwater temperature versus power level and feedwater flow versus vessel pressure relationships. During the data collection process, measured data will be compared against expected values to ensure proper instrument calibration and compliance with the design requirements. The measured maximum feedwater flow will also be adjusted to the Tier 2 pressures before comparing with the Tier 2 maximum flows. If the Tier 2 maximum flows are exceeded, the system can either be adjusted so that the licensing assumption is not exceeded or be applied with an additional penalty to the Δ CPR. steady-state and transient testing will be 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.

(4) Criteria

Level 1

The total feedwater flow for all pumps runout shall not exceed the value assumed in Subsection 15.1.2.3.1 at the design pressure specified. The change of flow below the pressure specified shall not exceed the sensitivity value stated in the applicable Feedwater Control System Design Specification.

The runout capacity of one feedwater pump shall be greater than the value assumed in Subsection 15.1.2.3.1 at the design pressure specified.

Level 2

Not Applicable

14.2.12.2.19 Main Steam System Performance

(1) Purpose

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

(2) 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 prerequisite testing complete. Additionally, applicable instrumentation shall have been installed and checked or calibrated as appropriate.

(3) Description

Pertinent system parameters, such as temperatures, pressures, and flows, will be 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 at hot conditions based on feedwater flow element measurements to verify that acceptable steam flow measurements have been made.

The total main steamline pressure drop from the reactor vessel steam space to the main steamline header will be evaluated for acceptance while reactor vessel pressure is at the design rated value. The evaluation is accomplished through an additional measurement of steam delivery pressure taken at the pressure tap downstream of outboard MSIVs. The test is to demonstrate that the pressure drops, from the reactor vessel steam space to the pressure tap downstream of outboard MSIVs and from the pressure tap downstream of outboard MSIVs to the pressure tap at main steamline header, are within the design values.

(4) Criteria

Level 1

Not Applicable

Level 2

The main steamline pressure drops from the reactor vessel steam space to the pressure tape downstream of outboard MSIV and from the pressure tap downstream of outboard MSIV to the pressure tap at main steamline header shall be within the design values as given by the Nuclear Boiler System Process Diagram at rated steam flow conditions as specified in Table 10.1-1.

The measured main steamline flow venturi differential pressure at rated steam flow conditions shall be equal to or greater than the design rated value as specified by the applicable Nuclear Boiler System Design Specification.

The accuracy and noise level of the total steam flow measurements obtained from the main steamline flow venturi as compared to the calibrated feedwater flow shall meet the input signal requirements as stated in the applicable Feedwater Control System Design Specification.

14.2.12.2.20 Residual Heat Removal System Performance

(1) Purpose

To demonstrate the ability of the Residual Heat Removal (RHR) System to remove residual and decay heat from the nuclear system.

(2) 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.

(3) Description

Startup phase testing of the RHR System is intended to demonstrate the capabilities of the system beyond what was possible during the preoperational test phase due to insufficient temperature and pressure conditions. Pertinent system parameters will be monitored in the suppression pool cooling and shutdown cooling modes to verify that overall system operation and heat removal capabilities are in accordance with design requirements. An attempt shall be made to obtain results with flow rates and temperatures near process diagram values. However, due to the relatively low core exposures and decay heat loads expected during the startup program, care shall be taken such that the limit on vessel cooldown rate is not exceeded.

(4) Criteria

Level 1

Not Applicable

Level 2

The RHR System shall be capable of operating in the suppression pool cooling and shutdown cooling modes at the heat exchanger capacity determined by the flow rates and temperature differentials indicated on the RHR System Process Flow Diagram (Figure 5.4-11).

14.2.12.2.21 Reactor Water Cleanup System Performance

(1) Purpose

To verify that Reactor Water Cleanup (CUW) System performance, in all modes of operation, is in accordance with design requirements at rated reactor temperature and pressure conditions.

(2) 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

Startup phase testing of the CUW System is an extension of the preoperational tests for rated temperature and pressure conditions. System parameters will be monitored in the various modes of operation at critical temperature, pressure and flow conditions.

With the reactor at rated temperature and pressure, process variables will be monitored and recorded when the CUW System is in steady-state operation in four modes as defined by the System Process Diagram: Normal, Blowdown, Hot Standby, and RPV Spray.

Each heat exchanger will be demonstrated to meet the established heat exchanger rate performance requirements while the system is operating in Normal Mode.

When the reactor water is at rated temperature, the entire planned blowdown flow rate will be discharged into the LCW collector tank to confirm that a stable operation in Blowdown Mode can be performed.

During the process of reactor shutdown, 100% system flow rate will be passed into the reactor pressure vessel head spray line and the temperature change of various parts of RPV is measured and recorded to confirm the RPV Spray Mode of operation.

With the reactor at hot standby conditions, the cleanup system flow will be recirculated back to reactor without passing the filter demineralizers to confirm that a stable operation in Hot Standby Mode can be established in order to minimize difference in reactor water temperature.

(4) Criteria

Level 1

Not Applicable

Level 2

The temperature at the tube side outlet of the CUW non-regenerative heat exchangers shall not exceed the limits specified by the applicable CUW System Design Specification while the system is in the blowdown mode and normal mode of operations.

The total dynamic head (TDH) of the CUW pump shall meet the design values specified by the applicable CUW System Design Specification for all modes of system operations.

The measured heat exchange capacity of each CUW non-regenerative heat exchanger shall meet the established heat exchange rate performance requirement as stated in the applicable CUW System Design Specification.

The CUW pump and motor vibration shall be less than or equal to the limits given by the Hydraulic Institute Standard during all modes of system operations.

The cooling water supplied to the CUW non-regenerative heat exchangers shall be within the flow and outlet temperature limits indicated in the CUW System Process Flow Diagram (Figure 5.4-13) and applicable CUW System Design Specification.

14.2.12.2.22 RCIC System Performance

(1) Purpose

To verify proper operation of the Reactor Core Isolation Cooling (RCIC) System over its expected operating pressure and flow ranges, and to demonstrate reliability in automatic starting from cold standby with the reactor at power.

(2) 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.

(3) Description

The RCIC System will be tested in two ways, through a full flow test line leading to the suppression pool and by flow injection directly into the reactor vessel. The first set of tests will consist of manual and automatic mode starts and steady-state operation, at 1.03 MPaG and near rated reactor pressure conditions, in the full flow test mode. During these tests, an attempt will be made to throttle pump discharge pressure in order to simulate reactor pressure and the expected pipeline pressure drop. This testing is done to demonstrate general system operability. After the operability demonstration, the RCIC turbine speed control loop will be adjusted at near rated reactor pressure conditions. Reactor vessel injection tests at near rated reactor pressure will follow to complete the controller adjustments, as necessary, and to demonstrate automatic starting from hot standby condition. Subsequently, a reactor vessel injection demonstration at 1.03 MPaG reactor pressure, including an automatic mode start and stability demonstration, shall be conducted to verify satisfactory system performance under the final set of optimized controller settings. Proper controller adjustment is verified by introducing small step disturbances in speed and flow demand and then demonstrating satisfactory system response at both low RCIC pump flow (but above minimum turbine speed) and near rated RCIC pump flow conditions, in order to span the RCIC operating range.

After all controller and system adjustments have been made, two consecutive successful reactor vessel injections, by automatic initiation from the cold standby condition, will be conducted to demonstrate system reliability. Cold is defined as a minimum of 72 hours without any kind of RCIC operation. Following these tests, system data will be collected while operating in the full flow test mode to provide a benchmark for comparison with future surveillance tests. Additionally, a demonstration of extended operation of up to two hours (or until the pump and turbine and their auxiliaries have stabilized) of continuous operation at rated flow conditions will be performed. For all testing proper operation of the system and related auxiliaries will be evaluated.

Additionally, sufficient operating data will be taken in order to verify proper setting of, or to adjust as necessary, the high RCIC steamline flow trip setting of the leak detection and isolation system trip logic.

Also, any RCIC System testing that was not performed during the preoperational test phase, due to the insufficiency of the temporary steam supply source utilized, will be completed as early in the program as is practicable. Verification of actual RCIC turbine steam supply line isolation valve automatic closure and timing will be conducted as part of the IST program as stated in Table 3.9-8.

(4) Criteria

Level 1

The RCIC turbine shall not trip or isolate during the manual or automatic start tests.

The average pump discharge flow must be equal to or greater than the 100% rated value specified on the RCIC System Process Flow Diagram (Figure 5.4-9) for all operating modes.

The starting time for the RCIC System from receipt of actuation signal to delivering design flow shall be within the limit specified by the applicable RCIC System Design Specification at any reactor pressure between 1.03 MPaG and rated.

Level 2

The RCIC turbine speed and pump flow control loops shall be adjusted so that the RCIC System flow related variable responses to test inputs are at least quarter-damped (i.e., the decay ratio of the second-to-first overshoot of each variable is less than or equal to 0.25) as stated in the applicable RCIC System Design Specification.

The RCIC Turbine Gland Seal System shall be capable of preventing significant steam leakage to the atmosphere.

For automatic start tests, in order to provide margins to overspeed and isolation trip setting, the transient start first and subsequent turbine speed peaks shall not exceed the requirement specified by the GE Startup Test Specifications.

The RCIC Turbine Steam Supply line high flow isolation trip shall be calibrated to actuate at the value specified in the plant Technical Specifications.

14.2.12.2.23 Plant Cooling/Service Water System(s) Performance

(1) Purpose

To verify performance of the various plant cooling/service water systems, including the RCW System, the RSW System, the TCW System and the TSW System, under expected reactor power operation load conditions.

(2) 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) 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 test phase. Pertinent parameters shall be monitored in order to provide a final verification of proper system flow balancing and heat exchanger performance under near design or special conditions, as appropriate. This will include extrapolation of results obtained under normal or test conditions as needed to demonstrate required performance at limiting or accident conditions.

(4) Criteria

Level 1

Not Applicable

Level 2

The Reactor Building Cooling Water (RCW) System shall be capable of removing heat loads from plant auxiliaries at the heat exchanger capacity determined by the flow rate and temperature differentials indicated in the RCW System Process Flow Diagram (Figure 9.2-1A) for both normal and emergency operating conditions.

The Turbine Building Cooling Water (TCW) System shall be capable of providing cooling water to the various heat exchangers (Table 9.2-12). It serves to maintain system parameters within the design temperature limits specified (Subsection 9.2.14.1.2 and applicable vendor’s instructions).

The Reactor Service Water (RSW) System shall be capable of providing cooling water to remove heat from the RCW System heat exchangers while maintaining RCW heat exchanger outlet temperature within the design limits (Figure 9.2-1A) for both normal and emergency operating conditions.

The Turbine Service Water (TSW) System shall be capable of providing cooling water to remove heat from the TCW System heat exchangers to maintain TCW heat exchanger outlet temperatures within the design limits (Subsection 9.2.16.1.2).

14.2.12.2.24 HVAC System Performance

(1) Purpose

To verify the ability of various heating, ventilation and air conditioning (HVAC) Systems to maintain area temperatures and relative humidity within specified limits during reactor power operation.

(2) Prerequisites

The 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 the specified prerequisite testing complete. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) 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 test 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 is appropriate. This will include extrapolation of results obtained under normal or test conditions as needed to demonstrate required performance at limiting or accident conditions.

(4) Criteria

Level 1

Not Applicable

Level 2

Area ventilation systems shall be capable of maintaining the temperature and relative humidity within the environmental qualification requirements for the affected equipment as stated in Appendix 3I, Tables 3I.3-1 to 3I.3-5.

14.2.12.2.25 Turbine Valve Performance

(1) Purpose

To demonstrate proper functioning of the main turbine control, stop, and bypass valves during reactor power operation and to verify the maximum capacity of the bypass system.

(2) Prerequisites

The 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 the specified prerequisite testing complete. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

Early in the startup test phase with the reactor at a moderate power level and with the turbine generator online, the operability of the control, stop, and bypass valves will be demonstrated. This testing will be similar to the individual valve testing required by the Technical Specification surveillance program. In addition to valve operability, the overall plant response will be observed. Since turbine valve testing is required routinely during power operation, it may also be desirable to determine the maximum power level at which such tests can safely be performed by extrapolating plant response during such tests at successively power levels during power ascension.

Additionally, at an intermediate power level during power ascension, the total capacity of installed bypass valves will be measured. After completion of the functional test of the bypass system, the bypass steam flow will be increased until the maximum flow capability of the bypass system is determined. Adjustments to reactor power level and/or auxiliary load on the generator may be necessary to achieve this.

(4) Criteria

Level 1

The reactor shall not scram or isolate during full closure testing of individual main turbine control, stop, and bypass valves at power levels up to the maximum allowable power level for conducting such tests as specified by the applicable plant surveillance procedure.

Level 2

During full closure testing of individual turbine control, stop, and bypass valves, the transient peak values of reactor vessel pressure, neutron flux, simulated fuel surface heat flux, and main steamline flow must have adequate scram avoidance margins as required by the GE Startup Test Specifications.

The measured total bypass valve capacity shall be equal to or greater than that used for the nuclear safety operational analysis (NSOA) as shown in Table 15.0-1.

14.2.12.2.26 MSIV Performance

(1) Purpose

To demonstrate proper operation of and to verify closure times for main steamline isolation valves, including branch steamline isolation valves, during power operation.

(2) Prerequisites

The 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 the specified prerequisite testing complete. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

At rated temperature and pressure, and then again at an intermediate power level, each MSIV will be individually stroked in the fast closure mode. Valve operability and closure time will be verified and overall plant response observed. Closure times will be evaluated consistent with Technical Specification and safety analysis requirements. The MSIV closure time equals the interval from de-energization of the valve solenoids until the valve is 100% closed. If appropriate, it may also be desirable to determine the maximum power level at which such tests can safely be performed by extrapolating plant response during such tests at successively power levels during power ascension. In addition, at rated temperature and pressure, proper functioning and stroke timing of branch steamline isolation valves (e.g., on common drain line) will be demonstrated as part of the IST program (Table 3.9-8).

(4) Criteria

Level 1

MSIV closure time (exclusive of electrical delay), for any individual value, shall be within the upper and lower closure time limits specified in the plant Technical Specifications.

The reactor shall not scram or isolate during full trip closure of individual MSIV at power levels up to the maximum allowable power level for conducting such tests as specified by the applicable plant surveillance procedure.

Level 2

During full trip closure testing of individual MSIV, the transient peak values of reactor vessel pressure, neutron flux, simulated fuel surface heat flux, and main steamline flow must have adequate scram avoidance margins as required by the GE Startup Test Specifications.

14.2.12.2.27 SRV Performance

(1) Purpose

To demonstrate that there are no major blockages in the relief valve discharge piping, and that each safety/relief valve can be opened and closed properly in the manual actuation mode, and will reseat properly after operation, during reactor power operation.

(2) Prerequisites

The 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 the specified prerequisite testing complete. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

A functional and flow demonstration test of each SRV shall be made when adequate reactor steam dome pressure is available to avoid damaging the valve. Adequate pressure at which this test is to be performed is 6.55 MPaG, as recommended by the valve manufacturer. Opening and closing of each valve, as well as evidence of steam discharge, will be verified by response of SRV discharge tailpipe temperature sensors and by observed changes in steamflow in the main steamlines downstream of the SRVs. Downstream indications of SRV operation could be changes in such parameters as turbine valve positions or generator output. Such changes will also be evaluated for anomalies which may indicate a restriction or blockage in a particular SRV tailpipe by making valve-to-valve comparisons. Additionally, during applicable plant transient testing, where SRVs are expected to open, operability, operating setpoints, and test pressures will be verified as part of those tests.

(4) Criteria

Level 1

There shall be a positive indication of steam discharge during the manual actuation of each SRV.

Level 2

During opening and closing of each SRV, the responses of pressure control system related variables shall be at least quarter-damped (i.e., the decay ratio of the second-to-first overshoot for each variable is less than or equal to 0.25).

The temperature measured by thermocouples on the discharge side of the safety/relief valves shall return to the temperature recorded before the valve was opened within 5.6°C range as specified in the GE Startup Test Specifications.

During the manual actuation of each SRV, the steam flow discharge through the valve (as measured by change in MWe, BPV position etc.) shall not differ from the average of all the valve responses by more than the limit as specified in the GE Startup Test Specifications.

14.2.12.2.28 Loss of Feedwater Heating

(1) Purpose

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

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

The credible single failure or operator error results in the largest feedwater temperature reduction and will be initiated at between 80 and 90% of rated thermal power with the recirculation flow near its rated value while considering the event analyzed and the predicted results. Core performance and overall plant response will be observed in order to demonstrate proper integrated response and to compare actual results with those predicted. This comparison will take into account the differences between actual initial conditions and observed results and the assumptions used for the analytical predictions. Proper operation of the SCRRI function will also be verified if the difference between actual and reference feedwater temperatures exceeds the ΔT setpoint as a result of the Loss of Feedwater Heating transient.

(4) Criteria

Level 1

The maximum feedwater temperature loss due to single operator error or equipment failure shall not exceed the value assumed in the design basis plant transient analysis (Subsection 15.1.1.1.1).

The resultant MCPR due to loss of feedwater heating shall be greater than the fuel thermal safety limit.

The increase in simulated fuel surface heat flux shall not exceed the predicted Level 2 criterion value by more than 2%, as specified by the Transient Safety Analysis Design Report (TSADR) document.

Level 2

The increase in simulated fuel surface heat flux shall not exceed the predicted value referenced to the actual test values of feedwater temperature drop and power level. The predicted value is provided in the plant TSADR and will be used as the basis to which the actual transient is compared.

SCRRI (selected control rods run-in) function shall be initiated, if the temperature differential between the actual and reference feedwater temperatures exceeds the ΔT setpoint specified in the applicable Feedwater Control System Design Specification. The reactor power shall be brought to below 80% rod line as shown on the power-flow operating map.

14.2.12.2.29 Feedwater Pump Trip

(1) Purpose

To demonstrate the ability of the plant to respond to and survive the loss of an operating feedwater pump.

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

From an initial reactor power level of greater than the capacity of one feedwater pump, one of the operating feedwater pumps will be tripped and it will be demonstrated that the RIP speed runback circuits is actuated during the vessel level transient to drop the reactor power to within the capacity of the remaining feedwater pump. Specifically, it shall be verified that the Feedwater Control System is sufficiently responsive, in conjunction with the automatic RIP speed runback feature to prevent a reactor trip due to the water level transient. Separate tests may be required to demonstrate features such as automatic core flow runback or auto start of a standby feedpump, if appropriate.

(4) Criteria

Level 1

Not applicable.

Level 2

The reactor shall avoid low water level scram by the margin required by the GE Startup Test Specifications from an initial water level halfway between the high and low level alarm setpoints.

14.2.12.2.30 Recirculation Pump Trip

(1) Purpose

To demonstrate acceptable plant response and to obtain recirculation system performance data during and subsequent to potential reactor internal pump (RIP) trip transients.

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

A potential threat to plant availability is the reactor trip due to high water level that may result from an unexpected trip of one or more of the RIPs. One and three RIP trip tests will be conducted to demonstrate the Feedwater Control System's ability to control reactor water level in time to avoid a high water level trip. Also to be demonstrated are the coastdown characteristics of the tripped pump(s), the onset of reverse flow through the idle pump(s), and the ability to restart the pump(s). A trip test of an RIP M/G set along with three RIPs connected is conducted to confirm RIPs and M/G set coastdown characteristics prior to the high power turbine/generator (T/G) trip tests (Subsection 14.2.12.2.33) and subsequent plant operations. The testing described will also help to verify proper operation of the SCRRI function, if the three RIPs trip results in a power and flow conditions that fall outside the appropriate SCRRI logic setpoints.

(4) Criteria

Level 1

The reactor shall not scram during RIP trip and recovery transients.

The resultant MCPR after one and three RIP trip must be greater than the fuel thermal limit.

After three RIPs trip, the core flow coastdown transient during the first three seconds must be bounded by the limiting curves defined in the applicable transient/stability performance requirements document.

Level 2

The reactor water level swell during RIP trip transients shall have a minimum scram avoidance margin as required by the GE Startup Test Specifications.

During RIP trip recovery, the scram avoidance margins for neutron flux and simulated fuel surface heat flux shall at least meet the requirements as specified by the GE Startup Test Specifications.

The SCRRI feature shall function as designed, if the flow and power setpoints are reached after the three RIPs trip (i.e., the total delay time between start of RIP trip and start of pre-selected control rod motions shall not exceed the limit specified in the applicable transient/stability performance requirements document) and the reactor power shall be brought to below 80% rod line as designed.

14.2.12.2.31 Shutdown From Outside the Main Control Room

(1) Purpose

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

(2) Prerequisites

The preoperational tests have been successfully completed 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 have been checked or calibrated as appropriate. Additionally, an adequate number of qualified personnel shall be onsite to perform the specified testing as well as their normal plant operational duties.

(3) Description

The hot standby capability demonstration portion of this test shall be performed from a low initial power level but from one that is sufficiently high such that a majority of plant systems are in their normal configurations with the T/G in 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 complement as defined by the plant Technical

Specifications. Additional qualified personnel will be available as control room observers to monitor the progress of the test and to re-establish control of the plant should an unsafe condition develop. These personnel will also perform predefined non-safety-related activities to protect plant equipment where such activities would not be required during an actual emergency situation. The test will be initiated by simulating a control room evacuation and then tripping and isolating the reactor by means outside of the control room. Achievement and maintenance of the hot standby condition is then demonstrated through control of vessel pressure and water level from outside control room using SRVs, HPCF, and RHR. The ability to reach cold shutdown is demonstrated by cooling the reactor down with some form of residual heat removal and establishing a heat rejection path to the ultimate heat sink, by means entirely outside of the main control room. 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. This cooldown portion of the test may be performed in conjunction with another startup test or plant events when sufficient decay heat is available and reactor cooldown is required. 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.

(4) Criteria

Level 1

Not applicable.

Level 2

During a simulated control room evacuation, the hot standby capability demonstration portion of the test must demonstrate that the reactor can be brought down from a normal initial steady-state power level to hot standby condition with reactor vessel pressure and water level under control using minimum shift crew and equipment and controls outside the main control room. The plant shall be maintained at stable hot standby conditions for at least 30 minutes.

The cold shutdown capability demonstration portion of the test must demonstrate that the reactor coolant temperature and pressure can be lowered sufficiently to put the RHR System in the Shutdown Cooling mode of operation and under control from outside the main control room. The reactor coolant temperature shall be reduced at least 27.8°C at a rate that would not exceed the plant Technical Specifications limit using the RHR System.

14.2.12.2.32 Loss of Turbine/Generator and Offsite Power

(1) Purpose

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

(2) Prerequisites

The preoperational tests have been successfully completed 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 have been checked or calibrated as appropriate. Additionally, sufficient numbers of qualified personnel shall be available to handle the needs of this test, as well as those associated with normal plant operation.

(3) Description

This test shall be performed at a relatively low power level early in the power ascension phase, but with the generator online at greater than 10% load. The test will be initiated in a way such that the T/G 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 will be 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.

(4) Criteria

Level 1

Reactor Protection System actions shall prevent violation of fuel thermal limits.

All safety systems, such as the Reactor Protection System, the diesel-generator (D/G), and the ECCS system must function properly without manual assistance, and HPCF and/or RCIC System action, if necessary, shall keep the reactor water level above the initiation level of the Low Pressure Flooder

(LPFL) mode of the RHR System, the Auto Depressurization System (ADS), and MSIV closure.

The turbine steam bypass valves shall open after T/G trips and remain operable (i.e., with power available and not isolated due to low condenser vacuum) for at least the minimum time period assumed by the plant transient safety analysis, subsequent to trip of the condenser circulating water pumps.

Level 2

Proper instrument display to the reactor operator shall be demonstrated, including power monitors, vessel pressure, reactor water level, control rod positions, suppression pool temperature, and reactor cooling system status. Displays shall not be dependent on specially installed instrumentation. Temporary interruption of instrument display is acceptable provided that the operator has sufficient information available for long-term operation to properly access the plant status.

14.2.12.2.33 Turbine Trip and Load Rejection

(1) 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.

(2) Prerequisites

The preoperational tests have been successfully completed 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

From an initial power level near rated, a load rejection event will be initiated in order to verify the proper reactor and integrated plant response. The method for initiating the trip shall be chosen so that the turbine is subjected to maximum overspeed potential, provided there are expected to be relevant differences among the options available. Typically, this trip is initiated by opening of the generator output breakers. Reactor parameters such as vessel dome pressure and simulated fuel surface heat flux will be 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, main steam safety/relief valves, the Reactor Protection System, the Feedwater System and Recirculation System will also be demonstrated. The core flow coastdown characteristics should be evaluated upon actuation of the recirculation pump trip logic. 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, since the generator is unloaded prior to complete shutoff of steam to the turbine.

For a direct trip of the turbine, the generator remains loaded and there is no overspeed. At high power levels, the dynamic response of the reactor is very similar between the generator and turbine trip transient. Therefore, a separate turbine trip test at high power level is not required.

A turbine trip or load rejection test shall also be performed at low power level such that nuclear boiler steam generation is just within the capacity of the bypass valves to demonstrate scram avoidance. At low power levels, sufficient reactor protection following the trip is provided, if needed, by high neutron flux and vessel high pressure scrams. Therefore, the protective trip actuated by stop/control valve motion is automatically bypassed at low power levels. However, there will be no significant pressure or power transient as a result of this low power turbine trip or load rejection event and, therefore, no reactor scram should occur for this test.

(4) Criteria

Level 1

For turbine trip or load rejection event at power levels greater than 50% of rated, bypass valve quick opening shall begin no later than the specified time delay following the start of stop/control valve closure, and bypass valves shall be opened to a point corresponding to greater than or equal to 80% of their capacity within the specified time interval from the beginning of stop/control valve closure. The time delay and time interval are specified in the GE Startup Transient Test Specifications.

Feedwater Control System settings must prevent flooding of the steamline following generator or turbine trip transients.

The core flow coastdown transient during the first three seconds after either turbine trip or load rejection at greater than 50% of rated power must be bounded by the limiting curves defined in the plant transient/stability performance requirements document.

The positive change in vessel dome pressure occurring within 30 seconds after either turbine trip or load rejection at greater than 50% of rated power must not exceed the Level 2 criteria by more than 172.6 kPaD as specified by the Transient Safety Analysis Design Report (TSADR) document.

The positive change in simulated fuel surface heat flux shall not exceed the Level 2 criteria by more than 2% as specified by the applicable TSADR document.

Level 2

An automatic MSIV isolation shall not occur during the first three minutes of the transient resulting from either turbine trip or load rejection at greater than 50% of rated power. Operator actions shall not be required during that period to avoid an MSIV closure trip.

(NOTE: The operator may take action as he desires after the first three minutes, including switch out of the RUN mode. The operator may also switch out of the RUN mode in the first three minutes, if he confirms from the measured data that this action will not prevent an automatic MSIV closure trip due to low reactor water level.)

The reactor shall not scram for turbine trip or load rejection event initiated from initial thermal power values within that bypass valve capacity.

The Feedwater Control System shall be capable of avoiding loss of feedwater pumps due to high reactor water level (Level 8) trip during the event.

Low water level RIP trips and HPCF/RCIC initiations shall not occur during the transient.

If any SRVs open, the temperatures, measured by the thermocouples on the discharge side of the actuated SRVs must return to the temperature recorded before the valve was opened within 5.6°C range as specified by the GE Startup Test Specifications.

The positive change in vessel dome pressure and simulated fuel surface heat flux occurring within the first 30 seconds after the initiation of either turbine trip or load rejection must not exceed the predicted values referenced to actual test conditions of initial power level and vessel dome pressure and corrected for the measured control rod insertion speed and initiation time. The predicted values are provided in the applicable TSADR document based on the beginning-of-cycle design basis analysis and shall be used as the basis to which the actual transient is compared.

If any SRVs open, the response times of actuated SRVs shall be within the limits specified in Subsection 5.2.2.4.1 and applicable Nuclear Boiler System (NBS) design specifications.

14.2.12.2.34 Reactor Full Isolation

(1) 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.

(2) Prerequisites

The preoperational tests have been successfully completed 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

A simultaneous full closure of all MSIVs will be 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, will be 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, SRVs, and Reactor Protection System, and the Feedwater and Recirculation Systems will also be demonstrated.

(4) Criteria

Level 1

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

The FWC System settings must prevent flooding of the main steamlines following the full MSIV closure transients.

The recorded MSIV full closure times must be within the limits specified in the plant Technical Specifications.

The positive change in vessel dome pressure occurring within the first 30 seconds after closure of all MSIVs must not exceed the Level 2 criteria by more than 172.6 kPaD as specified by the applicable TSADR document.

The positive change in simulated fuel surface heat flux shall not exceed the Level 2 criteria by more than 2%, as specified by the applicable TSADR document.

Level 2

If any SRVs open, the temperature measured by the thermocouples on the discharge side of the actuated SRVs must return to the temperature recorded before the valve was opened within 5.6°C range as specified by the GE Startup Test Specifications.

The HPCF and RCIC Systems shall be initiated automatically, if the low-water-level (Level 1.5 and 2, respectively) is reached during the initial transient following isolation. The minimum capacity and maximum delay time (including instrumentation delay) between the time vessel water level drops below the setpoint and makeup water enters the vessel shall meet the safety analysis requirements specified in the applicable plant transient/stability performance requirements document.

A trip of four RIPs shall be initiated, as appropriate, if the low-water-level (Level 3) setpoint is reached. Trip of the remaining six RIPs shall be initiated if the low-water-level (Level 2) setpoint is reached.

The positive changes in vessel dome pressure and simulated fuel surface heat flux occurring within the first 30 seconds after the closure of all MSIVs must not exceed the predicted values referenced to actual test conditions of initial power level and dome pressure and corrected for the measured control rod insertion speed and initiation time. The predicted values are provided in the applicable TSADR document based on the beginning-of-cycle design basis and shall be used as the basis to which the actual transient is compared.

If any SRVs open, the response times of actuated SRVs shall be within the limits specified in Subsection 5.2.2.4.1 and applicable NBS design specifications.

14.2.12.2.35 Gaseous Radwaste Management/Offgas System

(1) Purpose

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

(2) 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 interaction, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

Proper operation of the Gaseous Radwaste Management/Offgas System during all design modes of operations will be demonstrated by monitoring pertinent parameters such as temperature, pressure, flow rate, humidity, hydrogen content, dewpoint, dilution steam flow, radiolytic gas production rate, 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 periodically throughout the power ascension test program while at various steady-state conditions for specific components such as catalytic recombiners, and activated carbon absorbers 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. Testing of the Offgas System is also discussed in Subsection 11.3.9.

(4) Criteria

Level 1

The release of radioactive gaseous and particulate effluents must not exceed the limits specified by the plant Technical Specifications or License conditions.

Flow of dilution steam to the non-condensing stage must be maintained at an amount no less than the low alarm setpoint when the steam jet air ejectors are operating.

Level 2

The system flow rate, temperature, humidity, and hydrogen concentration shall comply with Subsection 11.3.4 in all design modes of operations.

All applicable system components such as offgas preheater, offgas recombiner, offgas condensers, cooler condensers, refrigeration units, pre-filters, charcoal adsorbers, and offgas filters shall function properly during all design modes of operation (i.e., there shall be no gross malfunctioning of these components) (Subsection 11.3).

14.2.12.2.36 Loose Parts Monitoring System Baseline Data

(1) Purpose

To collect baseline data for the Loose Parts Monitoring System (LPMS) under normal plant operational conditions.

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been checked or calibrated as appropriate.

(3) Description

LPMS data will be collected at appropriate power and flow conditions to provide a baseline set of data indicative of normal plant operations. During steady-state operation at the specified power and flow level, baseline data will be obtained in the form of cassette recordings and waveform plots for each installed sensor locations. The data obtained will be used to help verify the adequacy of, or to facilitate needed changes to, initial alert level settings above normal levels.

(4) Criteria

Level 1

Not applicable.

Level 2

Initial baseline data for the Loose Parts Monitoring System has been satisfactorily established for each specified power and flow conditions during steady-state operations.

14.2.12.2.37 Concrete Penetration Temperature Surveys

(1) Purpose

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

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been installed and checked or calibrated as appropriate.

(3) Description

Concrete temperature data will be collected at various power levels and system configurations in order to verify the ability of natural heat transfer to adequately cool the concrete surrounding the penetrations of high energy fluids piping, including main steam, feedwater, and RHR shutdown cooling pipings. 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.

(4) Criteria

Level 1

Not applicable.

Level 2

The temperature of concrete around the selected high energy fluid piping penetrations shall be kept below the maximum level specified in the Piping Penetration Design Requirements Specification for long term normal operating conditions.

14.2.12.2.38 Liquid Radioactive Waste Management System Performance

(1) Purpose

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

(2) Prerequisites

The preoperational tests have been completed 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 have been checked or calibrated. Additionally, applicable precautions shall be taken relative to activities conducted in the vicinity of radioactive material or potential radiation areas.

(3) Description

The Liquid Radioactive Waste Management System operation will be monitored, and appropriate data collected, during the power ascension test phase to demonstrate that system operation in processing, storage and release of liquid radioactive waste is in accordance with design requirements. Operation of Liquid Radioactive Waste Systems is discussed in detail in Section 11.2. Performance shall be demonstrated periodically throughout the power acsension test program while at various steady-state conditions for low conductivity, high conductivity and detergent waste subsystems. Also to be evaluated are the piping, valving, instrumentation and control that comprise the overall system. Additionally, radiochemical analysis to confirm acceptable liquid effluents activities from the radwaste system is also done as part of testing discussed in Subsection 14.2.12.2.1.

(4) Criteria

Level 1

The Liquid Radioactive Waste Management System shall be capable of collecting, processing, and controlling the liquid wastes as designed such that the release of radioactive liquid effluents remain within the limits specified by the plant Technical Specifications or license conditions. (Subsection 11.2.1.2).

Level 2

All applicable system components shall function properly during various modes of typical plant operation (i.e., there shall be no gross malfunctioning of these components) as described in Subsection 11.2.2.

14.2.12.2.39 Steam and Power Conversion System Performance

(1) Purpose

To demonstrate acceptable performance of the various plant steam-driven auxiliaries and power conversion systems under expected operational conditions, particularly that equipment that could not be fully tested during the preoperational phase due to inadequate steam flow conditions.

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been checked or calibrated.

(3) Description

Operation of steam-driven plant auxiliaries and power conversion systems will be 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/reheaters, the main condenser and condenser evacuation system, and the main circulating water system. 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 14.2.12.2.25, and plant transient testing involving the main turbine generator is described in Subsection 14.2.12.2.33.

(4) Criteria

Level 1

Not applicable.

Level 2

Each steam jet air ejector (SJAE), individually, must be able to maintain the main condenser pressure within design limits during normal full load operation (Subsection 10.4.2.2).

The Circulating Water (CW) System shall supply cooling water at a sufficient flow rate to condense the steam in the condenser, as required for optimum heat cycle efficiency (Subsection 10.4.5.1.2).

The Feedwater Heater System shall heatup the reactor feedwater to a nominal temperature of 215.6°C during full load operation and to lower temperatures during part load operation (Subsection 10.4.7.1.2).

The feedwater heater drains and vents system shall be capable of maintaining a water level in each of the LP/HP heaters and heater drain tanks within the normal operating limits during power operations (Subsection 10.4.7.2.2).

The MSR shall maintain a balanced steam flow to the LP turbine and feedwater heaters during steady-state and transient operations in accordance with design requirements (Figure 10.1-2).

The main condenser shall be capable of maintaining the LP turbine exhaust conditions below the maximum allowable pressure and temperature (Subsection 10.4.1.1.2).

The main condenser hotwell water level control system shall maintain the hotwell water level at nominal operating range during normal full load operation (Subsection 10.4.1.5.1).

The turbine/generator shall be operated with a heat rate compatible with the design value during normal full load operations (Figure 10.1-2).

14.2.12.2.40 Steam Separator/Dryer Performance Test

(1) Purpose

To verify that the steam separator/dryer system will meet minimum performance requirements at conditions within allowable regions of the power-flow operating map.

(2) Prerequisites

The preoperational tests have been completed 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. Additionally, applicable instrumentation shall have been installed and checked or calibrated as appropriate.

(3) Description

Maximum moisture carryover is expected to occur at a condition of high flow and low power, where the steam separator/dryer performance decreases with reduced steam flow. However, the Recirculation Flow Control (RFC) System limits the core flow/power to analyzed allowable regions by providing an automatic RIP speed runback prior to reaching the separator/dryer performance limit as shown on the power-flow operating map. This test verifies that the analytically established limit is sufficient to prevent excessive moisture carryover of the steam exiting the reactor and that the established separator/dryer performance limit line is adequate to prevent operation outside the allowable region.

With the RIPs at maximum permissible speeds and flows, this test is initiated from a power level just above the most limiting region of the power-flow operating map. At this point, the moisture carryover in the steam exiting the reactor is determined (typically by injecting Na-24 into the feedwater and then measuring the concentration of such that reaches the condenser versus that remains in the reactor coolant). Reactor power will then be gradually lowered by inserting control rods. At each incremental power level, the moisture carryover is again determined. This incremental power reduction and moisture carryover determination is continued until either the separator limit line as shown on the power-flow operating map is reached or excessive moisture carryover (i.e., 0.01% and greater) of the exit steam is determined, whichever occurs first. If the separator performance limit line is reached first, testing may be continued at next lower power level until such time as the 0.01% limit is reached if desired to justify lowering of the established limit. The point at which the RIP speed runback logic is automatically actuated during power reduction shall be recorded. During the performance of this test, the actual RIP speed runback may be temporarily defeated as long as the moisture content of the exit steam is determined to be acceptable. This is to simplify the test without having to recover from a recirculation runback and continue the testing at low power levels.

(4) Criteria

Level 1

Steam separator/dryer exit moisture must not exceed 0.1% while operating in the analytically allowable region of the power-flow operating map (i.e., on or above the separator/dryer performance limit line).

Level 2

Further power reduction shall be discontinued once moisture carryover of the exit steam exceeds 0.01%.

The RIP speed runback logic shall be verified to be conservatively established relative to the separator/dryer performance limit line on the power-flow operating map to prevent operation in areas where excessive moisture carryover in exit steam from separator/dryer is predicted to occur.

14.2.13 COL License Information

14.2.13.1 Other Testing

Other testing, with respect to COL applicant supplied aspects of the plant will be necessary to satisfy certain ABWR requirements. The COL applicant will ensure that testing of such systems and components are adequate to demonstrate conformance to such requirements as defined throughout the specific chapters of the Tier 2. Below are systems that may require such testing:

(1) Electrical switchyard and equipment

(2) The site security plan

(3) Personnel monitors and radiation survey instruments

(4) The automatic dispatcher control system (if applicable)

14.2.13.2 Test Procedures/Startup Administrative Manual

The COL applicant will provide the following for NRC review:

(1) The scoping documents (i.e., Preoperational and Startup Test Specifications) containing testing objectives and acceptance criteria applicable to its scope of design responsibility (Subsection 14.2.3).

(2) The scoping document delineates 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 to be reviewed by the NRC at the time of the combined operating license (Subsection 14.2.3).

(3) The scoping document delineates any reconciliation methods needed to account for test conditions, methods or results if testing is performed at conditions other than representative design operating conditions (Subsection 14.2.3).

(4) The approved preoperational test procedures approximately 60 days before their intended use and startup test procedures approximately 60 days before fuel loading (Subsection 14.2.3).

(5) A startup administrative manual (procedure) and any other documents that delineate the conduct of the test program to be reviewed by the NRC at the time of the combined operating license (Subsection 14.2.4).

(6) A startup administrative manual (procedure) and any other documents that delineate the review, evaluation, and approval of test results for the NRC review (Subsection 14.2.4).

(7) A startup administrative manual (procedure) and any other documents that delineate the method of controlling prefuel load checks, initial fuel loading, precritical testing and initial criticality for the NRC review (Subsection 14.2.10).

(8) A startup administrative manual (procedure) and any other documents that delineate the test program schedule for NRC review (Subsection 14.2.11).

(9) A startup administrative manual (procedure) that will authorize the determinations of operability and availability of interfacing support systems requirements (Subsection 14.2.3).

Also to be supplied by the COL applicant is the startup administration manual described in Section 14.2.4, which will describe, among other things, what specific permissions are required for the approval of test results and the permission to proceed to the next testing plateau.

Table 14.2-1 Startup Test Matrix

Power Ascension Test	Testing Plateau OV	HU	LP	MP	HP	Notes
Chemical and Radiochemical Measurements:						
Reactor Water Chem. and Radiochem. Measurement	✔	✔	✔	✔	✔	
Process Rad Monitor Calibration	✔	✔	✔	✔	✔	
Liquid and Gaseous Effluent Activity Measurement		✔	✔	✔	✔	
Condensate Filter/Demin. Performance		✔				
CUW Filter/Demineralizer Performance (No Cleanup Test)				✔	✔	At high-power/high-flow corner
Radiation Measurements:						
Background Radiation Survey	✔	✔				OV — Prior to fuel loading, HU — prior to initial criticality
Complete Standard Radiation Survey		✔	✔	✔	✔	
Fuel Loading:						
Core Loading	✔					
Partial Core S/D Margin	✔					
Full Core Verification	✔					
Full Core Shutdown Margin Demonstration	✔					

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel **HU = Nuclear Heatup** **LP = Low Power** **MP = Mid Power** **HP = High Power**

Table 14.2-1 Startup Test Matrix (Continued)

Power Ascension Test	Testing Plateau OV	HU	LP	MP	HP	Notes
Control Rod Drive System Performance:						
CRD Functioning Testing	✔					Including I/W timing, position indication, coupling
Friction Testing	✔	✔				HU - 4 selected rods at rated pressure
Rod Pair Scram Testing	✔	✔				HU - 4 selected rods at 4.14 MPaG, 5.51 MPaG and all rods at rated pressure
Full Core Scram				✖	✖	With planned scrams to determine 4 slowest rods
Ganged Rod Motions		✔				
Neutron Monitoring System Performance:						
SRNM Calibration/Response	✔	✔	✔			HU - Constant H/U rate calibration
LPRM Calibration/Response		✔		✔	✔	MP, HP - at high power/flow ends
APRM Calibration/Response		✔	✔	✔	✔	HU - Constant H/U rate calibration
ATIP System Alignment/Response	✔	✔		✔	✔	OV - Cold alignment, HU - Hot alignment MP, HP - Reproducibility test
Process Computer System Operation:						
NSS/BOP Monitoring Programs		✔	✔	✔	✔	
Core Performance		✔	✔	✔	✔	
Nuclear Boiler Process Monitoring:						
Reactor Coolant Temperature Measurement		✔		✖	✖	MP, HP-during steady-state and RIP trip testing

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel HU = Nuclear Heatup LP = Low Power MP = Mid Power HP = High Power

Table 14.2-1 Startup Test Matrix (Continued)

Power Ascension Test	OV	HU	LP	MP	HP	Notes
	Testing Plateau					
Reactor Water Level and Reference Leg Temperature Measurement		✔	✔	✔	✔	
Core Flow Calibration/Measurement		✔	✔	✔	✔	
System Expansion:						
Visual Observation		✔	✖	✖	✖	LP, MP, HP - Only as needed upon return to cold setting conditions after planned shutdowns subsequent to HU
Displacement Measurements		✔	✔	✔	✔	
System Vibration:						
Steady-State Vibrations and Strains		✔	✔	✔	✔	
Transient Vibrations and Strains			✖	✖	✖	During major transients
Reactor Internals Vibration (If Required)	✔			✔	✔	Specified testing may not be required. See Subsection 14.2.12.2.12 for discussion of applicability of testing based on classification of reactor internals (i.e., prototype or not) in accordance with RG 1.20. Cold, zero power, test, if required, will be done with RPV head on during HU. OV–Pre-critical MP–Along 60% LL HP–Along 100% L.L.
Recirculation Flow Control						
Control System Adjustment/Confirmation			✔	✔	✔	

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel HU = Nuclear Heatup LP = Low Power MP = Mid Power HP = High Power

Table 14.2-1 Startup Test Matrix (Continued)

Power Ascension Test	OV	HU	LP	MP	HP	Notes
				Testing Plateau		
Feedwater Control:						
Control System Adjustment/Confirmation		✔	✔	✔	✔	HU–Low flow control
Pressure Control:						
Control System Adjustment/Confirmation		✔	✔	✔	✔	
Plant Automation and Control						
Plant Startup/Shutdown		✔	✔	✔	✔	LP, MP, HP–During plant shutdown, as needed
Power Range Maneuvering			✔	✔	✔	
Reactor Recirculation System Performance:						
Steady-State Performance		✔	✔	✔	✔	
RIPs Out of Service				✖	✖	In conjunction with recirculation pump trip
Pump Restarts				✖	✖	In conjunction with recirculation pump trip
Feedwater System Performance:						
Steady-State Performance		✔	✔	✔	✔	
Maximum Runout Flow Determination					✔	
Main Steam System Performance:						
MSL Flow Venturi Calibration				✔	✔	
Steady-State Performance		✔	✔	✔	✔	HP - at rated condition if possible

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel HU = Nuclear Heatup LP = Low Power MP = Mid Power HP = High Power

Table 14.2-1 Startup Test Matrix (Continued)

Power Ascension Test	Testing Plateau OV	HU	LP	MP	HP	Notes
Residual Heat Removal System Performance:						
Suppression Pool Cooling			✖			In conjunction with SRV test or after testing which adds heat to the suppression pool; may not be sufficient heat at lower power levels to fully demonstrate Hx heat removal capability.
Shutdown Cooling			✖		✖	LP–System operability must be demonstrated prior to exceeding 25% RTP. However, there may not be sufficient reactor decay heat at lower power levels to fully demonstrate Hx heat removal capability. HP–Shutdown following major transient.
Reactor Water Cleanup System Performance:						
Steady-State Performance		✔				
RPV Spray Mode			✖	✖	✖	Shutdown following major transient, as needed
RCIC System Performance:						
System Controller Optimization		✔				At rated pressure
System Control and Stability Demonstration		✔				At 1.03 MPaG and rated pressure
Hot/Cold Quick Starts		✔	✔			LP–As need to complete required quick starts subsequent to initial heatup
Plant Cooling/Service Water System Performance:						
Steady-State Power Operations	✔	✔	✔		✔	

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel HU = Nuclear Heatup LP = Low Power MP = Mid Power HP = High Power

Table 14.2-1 Startup Test Matrix (Continued)

Power Ascension Test	OV	HU	LP	MP	HP	Notes
	Testing Plateau					
Off-Normal Operations					✖	During RHR Hx operation, as practicable, may be performed at earlier test conditions
HVAC System Performance:						
Steady-State Power Operations		✔			✔	
Off-Normal Operations					✖	In individual spaces as conditions allow (i.e., as pertinent equipment is operated), may be performed at earlier test conditions
Turbine Valve Performance:						Only bypass valves needed be tested at HU
Individual CV, SV, BPV Cycling					✔	Along 100% loadline up to max. allowable power level, if applicable
BPV Capacity Measurement				✔		
MSIV Performance:						
Individual MSIV Closure/Timing		✔	✔		✔	HP–Along 100% loadline up to max. allowable power level, if applicable
Branch Line Closure/Timing		✔				In conjunction with IST program, at near rated temperature and pressure
SRV Performance:						
Individual Valve Functioning and Flow Demonstration			✔			At >6.55 MPaG

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel HU = Nuclear Heatup LP = Low Power MP = Mid Power HP = High Power

Table 14.2-1 Startup Test Matrix (Continued)

Power Ascension Test	Testing Plateau OV	HU	LP	MP	HP	Notes
Automatic Opening Verification					✖	In conjunction with major transients
Loss of Feedwater Heating					✔	At 80–90% CTP, 100% Flow during HP
Feedwater Pump Trip:					✔	
Recirculation Pump Trip						
One RIP Trip				✔	✔	At near rated flow
Three RIP Trip				✔	✔	From near rated flow at MP and from a point that will result in SCRRI at HP
Shutdown from Outside the Control Room			✔			At >10% Generator Load
Loss of Turbine Generator and Offsite Power			✔			At 10–20% rated power
Turbine Trip and Load Rejection:						
Turbine Trip within Bypass Capacity			✔			
Full Power Load Rejection					✔	
Reactor Full Isolation					✔	
Gaseous Radwaste Management/Offgas System Performance		✔	✔	✔	✔	
Power Conversion Equipment Performance		✔	✔	✔	✔	
Loose Parts Monitoring System Baseline Data		✔	✔	✔	✔	
Liquid RadWaste Management System Performance		✔	✔	✔	✔	

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel **HU = Nuclear Heatup** **LP = Low Power** **MP = Mid Power** **HP = High Power**

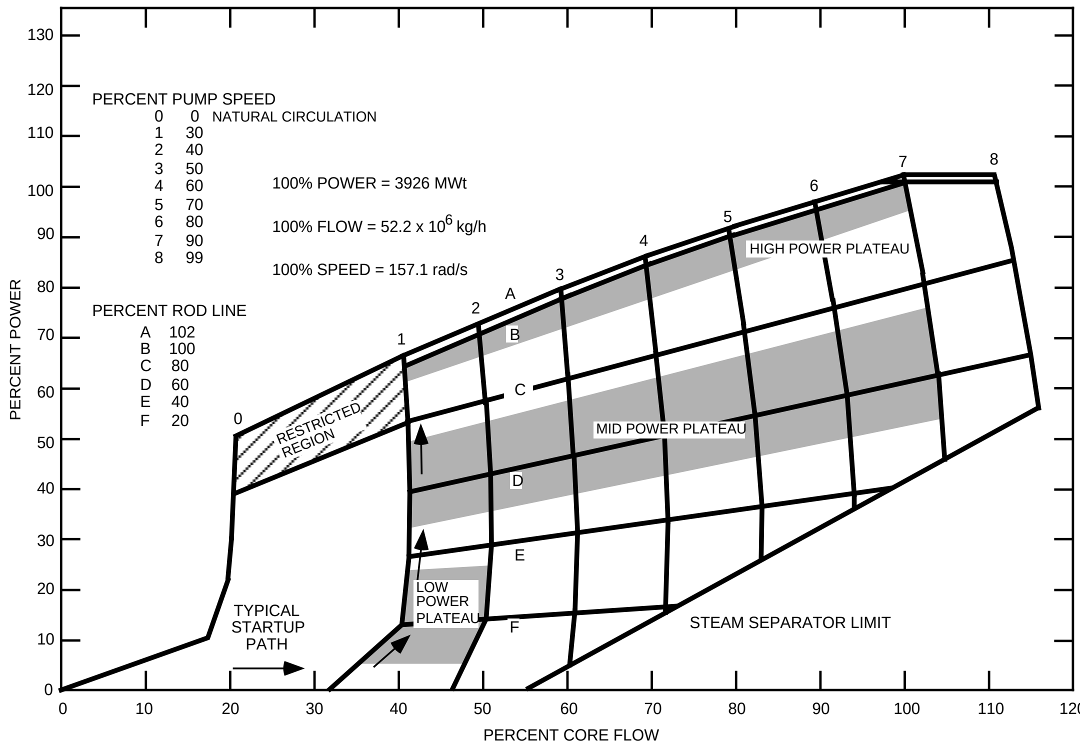
Table 14.2-1 Startup Test Matrix (Continued)

Power Ascension Test	OV	HU	LP	MP	HP	Notes
	Testing Plateau					
Concrete Temperature Surveys		✔	✔	✔	✔	
Steam Separator/Dryer Performance Test				✔		From high flow/lower power corner just above the most limiting region of P-F map

✔ = Testing required in plateau; alternative test conditions or exceptions identified in detailed testing specification; see Notes column for explanation

✖ = Testing to be done in conjunction with other testing, or at specific testing conditions, generally within indicated plateau; see Notes column for explanation

OV = Open Vessel HU = Nuclear Heatup LP = Low Power MP = Mid Power HP = High Power



Testing Plateau	Description*
Open Vessel (OV)	With the RPV head removed, from initiation of fuel loading to cold conditions with a fully loaded core
Nuclear Heat-Up (HU)	During nuclear heat-up, from ambient conditions and 0 kPa to rated temperature and pressure within the RPV, with reactor power typically less than 5% of rated
Low Power (LP)	Between 5% and 25% rated thermal power, with the reactor internal pumps (RIPs) within 10% of minimum speed
Mid Power (MP)	Between approximately 50% and 75% power rod lines, with the RIPs operating between minimum and rated speeds, with the lower power corner within the capacity of the bypass valves.
High Power (HP)	Along and just below (+0, -5%) the 100% power rod line, from minimum RIP speed to rated core flow

* Descriptions of testing plateaus are offered for illustrative purposes and general guidance only, as some tests are intended to be conducted outside the general testing plateaus described. Neither the above descriptions, nor the corresponding boundary lines on the power-flow map, are meant to be absolute limits. Any operating limits will be specified in the plant license. Any other testing restrictions will be specified either within the plant administrative procedures covering the power ascension test program or within the individual test procedure for a given test.

Figure 14.2-1 Power-Flow Operating Map and Testing Plateau Definitions

14.3 Tier 1 Selection Criteria and Processes

This section of Tier 2 provides the selection criteria and processes used to develop the Tier 1 information. The Tier 1 information provides the principal design bases and design characteristics that are certified by the 10 CFR Part 52 rulemaking process and included in the formal ABWR design certification rule.

This top-level design information in Tier 1 is extracted directly from the more detailed ABWR design information presented in Tier 2 (which is part of the certification application). Limiting the Tier 1 contents to top-level information reflects the tiered approach to design certification endorsed by the Commission (Staff Requirements Memorandum February 15, 1991 regarding SECY-90-377; 10 CFR Part 52 Statement of Considerations 54 Fed.Reg. 15372, 154377, (1989). See also SECY-90-241, 90-377 and SECY-91-178.)

The objective of this section is to define the bases and methods that were used to develop Tier 1. This section contains no new technical information regarding the ABWR design.

Tier 1 consists of the following:

(1) An introduction section which defines terms used in Tier 1 as well as listing general provisions that are applicable to all Tier 1 entries. The intent of these entries is to avoid ambiguities and misinterpretations by providing front-end guidance to users of Tier 1.

(2) Design descriptions for: a) systems that are fully within the scope of the ABWR design certification, and b) the in-scope portion of those systems that are only partially within the scope of the ABWR design certification. The intent of the Tier 1 design descriptions is to delineate the principal design bases and principal design characteristics that are referenced in the design certification rule. The design descriptions are accompanied by the inspections, tests, analyses and acceptance criteria (ITAAC) required by 10 CFR 52.47(a) (1) (vi) to be part of the design certification application. The ITAAC define verification activities that are to be performed for a facility with the objective of confirming that the plant is built and will operate in accordance with the design certification. Successful completion of these certified design ITAAC, together with the combined license (COL) applicant's ITAAC for the site-specific portions of the plant, will be the basis for the NRC finding under 10 CFR Part 52.103(g).

(3) Tier 1 design descriptions and their associated ITAAC for design and construction activities that are applicable to more than one system. Design related processes have been included in Tier 1 for:

(a) Aspects of the ABWR design likely to undergo rapid, beneficial technological developments in the lifetime of the design certification. Certifying the design processes associated with these areas of the design rather than specific design details permits future license applicants referencing the ABWR design certification to take advantage of the best technology available at the time of COL application and facility construction. Example: design of programmable, microprocessor-based instrumentation and control systems.

(b) Aspects of the design which are dependant upon characteristics of as-procured, as-installed systems, structures and components. These characteristics are not available at the time of certification and therefore cannot be used to develop and certify design details. Example: design of piping systems which are dependent upon detailed routing and equipment information.

(4) Interface requirements as defined by 10 CFR Part 52.47(a) (1) (vii). Interface requirements are those requirements which must be met by the site-specific portions of the complete nuclear power plant that are not within the scope of the certified design. These requirements define characteristics of the site-specific features which must be provided in order for the certified design to comply with certification commitments. Interface requirements are defined for: a) systems entirely outside the scope of the design certification and b) the out-of-scope portions of those systems that are only partially within the scope of the design certification. The COL applicant will provide ITAAC for the site-specific design features that implement the interface requirements; therefore, Tier 1 does not include ITAAC for interface requirements.

(5) Site parameters used as the basis for ABWR design presented in Tier 2. These parameters represent a bounding envelope of site conditions for any license application referencing the ABWR design certification. No ITAAC are necessary for the site parameters entries because compliance with site parameters will be verified as part of issuance of a license for a plant that references the ABWR design certification.

(6) Appendices listing acronyms and legends used in the body of Tier 1. (This material is self-explanatory and is not discussed any further in this section.)

The following is a description of the criteria and methods by which specific technical entries for Tier 1 were selected. The structure of the description is based on the Tier 1 report structure.

The criteria and methods that are discussed in the following sections are guidelines only. For some matters, the contents of Tier 1 may not directly correspond to these guidelines, because special considerations related to the matters may have warranted a different approach. For such matters, a case-by-case determination was made regarding how or whether the matters should be addressed in Tier 1. These determinations were based upon the principles inherent in Part 52 and its underlying purposes.

14.3.1 Tier 1 Section: 1.0 Introduction

This section includes two subsections:

1.1 Definitions

1.2 General Provisions

Selection Criteria — Tier 1, Section 1.1 is used to define terms which are used throughout Tier 1 and could (potentially) be subject to various interpretations. Selection of entries was based on a simple judgement that a particular word / phrase merits definition - with particular emphasis on terms associated with implementation of the ITAAC. Tier 1, Section 1.2 contains a mixture of provisions that were selected on the basis that the provision was necessary to either a) define technical requirements applicable to multiple systems in Tier 1 or to b) to provide clarification and guidance for future users of Tier 1.

Selection Methodology — Entries in the Definition section were largely made on the basis of a self-evident need for a term to be defined. These terms were accumulated during the preparation and review of Tier 1. Entries in the General Provisions section also were arrived at as part of Tier 1 development and review process. Each entry has a unique background, but the overall intent is to clearly state the broad guidelines and interpretations that guided Tier 1 preparation for the ABWR and should be understood by Tier 1 users.

Example Entries — Typical terms defined in Tier 1, Section 1.1 are “as-built,” “Division,” “Type Test.” Issues requiring Tier 1, Section 1.2 treatment include guidance on interpretation of figures provided in the body of Tier 1 and defining the scope of what is included if a system configuration check is specified in an ITAAC entry.

14.3.2 Tier 1 Section: 2.0 Certified Design Material for ABWR Systems

This section of Tier 1 has the design description and ITAAC material for the individual ABWR Systems and has an entry for every system that is either fully or partially within the scope of the ABWR design certification. Consequently, there is a Tier 1, Section 2.0 entry for every ABWR system identified in Tier 2, Section 1.2. The intent of this comprehensive listing of ABWR systems is to define at the Tier 1 level the full scope of the certified design. (As discussed below, the Tier 1 entry for many systems with no safety significance is limited to the system name only and does not include any design description or ITAAC material.)

Since preparation of system design descriptions and the associated ITAAC are sequential, separate processes, they are discussed separately in the next two subsections.

14.3.2.1 Design Descriptions

The Tier 1 design descriptions for each ABWR system address the top-level design features and performance standards which pertain to the safety of the plant and include descriptive text and supporting figures. The intent of Tier 1 design descriptions is to define the ABWR design characteristics which are referenced in the design certification rule as a result of the certification provisions of 10 CFR Part 52.

Selection Criteria — The following criteria were considered in determining which information warranted inclusion in the certified design descriptions.

(1) The information in the Tier 1 design descriptions is to be selected from the technical information presented in Tier 2 and should not contain information that is not in Tier 2. This reflects the approach that Tier 1 contains top-level design information and is based on the Commission directive in the Statement of Considerations for Part 52 (54 Fed. Reg. 15372,15377 (1989)) that there “be less detail in a certification than in an application for certification.” In this context, the certification is Tier 1 and the application for certification includes Tier 2.

(2) The Tier 1 design descriptions contain only information from Tier 2 that is most significant to safety. Tier 2 contains a wide spectrum of information on various aspects of the ABWR design, and not all of this information warrants inclusion in the Tier 1 design descriptions. This selection criterion reflect the Commission directive in the Statement of Considerations for Part 52 (Fed. Reg. 15372, 15377 (1989)) that the certified design should “encompass roughly the same design features that Section 50.59 prohibits changing without prior NRC approval.” In determining what Tier 2 information is most significant to safety, several factors were considered, including the following:

(a) Whether the feature or function in question is necessary to satisfy the NRC’s regulations in Parts 20, 50, 52, 73 and 100.

(b) Whether the feature or function in question pertains to a safety-related structure, system, or component.

(c) Whether the feature or function in question is specified in the NRC's Standard Review Plan as being necessary to perform a safety-significant function.

(d) Whether the feature or function in question represents an important assumption or insight from the probabilistic risk assessment.

(e) Whether the feature or function in question is important in preventing or mitigating severe accidents.

(f) Whether the feature or function in question has had a significant impact on the safety or operation of existing nuclear power plants.

(g) Whether the feature or function in question is typically the subject of a provision in the Technical Specifications.

The absence or existence of any of one of these factors was not conclusive in determining which information is significant to safety. Instead, these factors, together with the other factors listed in this section, were taken into account in making this determination.

(3) In general, only the safety-related features and functions of structures, systems and components are discussed in the Tier 1 design descriptions. Structures, systems, and components that are not classified as safety-related are discussed in the Tier 1 design descriptions only to the extent that they perform safety-significant functions or have features to prevent a significant adverse impact upon the safety-related functions of other structures, systems, or components. This criterion follows from the principle that only features and functions that are safety-significant warrant treatment in Tier 1. Non-safety features and functions of safety-related structures, systems, and components are not generally discussed in the Tier 1 design descriptions.

(4) In general, the Tier 1 design descriptions for structures, systems, and components are limited to a discussion of design features and functions. The design bases of structures, systems, and components, and explanations of their importance to safety, are provided in Tier 2 and are not included in the Tier 1 design descriptions. The purpose of the Tier 1 design descriptions is to define the certified design. Justification that the design meets regulatory requirements is presented in Tier 2. For example, the design descriptions for the emergency core cooling systems state the flow capacity of the systems; the descriptions do not provide information that demonstrates these flow capacities are sufficient to maintain post-accident fuel clad temperatures within 10 CFR 50 Appendix K limits.

(5) The Tier 1 design descriptions focus on the physical characteristics of the facility. The Tier 1 design descriptions do not contain programmatic requirements related to operating conditions or to operations, maintenance, or other programs because these matters are controlled by other means such as the Technical Specifications. For example, the design descriptions do not describe operator actions needed to control systems.

(6) The design descriptions in Tier 1, Section 2.0 discuss the configuration and performance characteristics that the structures, systems, and components should have after construction is completed. In general, the Tier 1 design descriptions do not discuss the processes that will be used for designing and constructing a plant that references the ABWR design certification. This is acceptable because the safety-function of a structure, system, or component is dependent upon its final as-built condition and not the processes used to achieve that condition. There are some exceptions to this criterion. These are:

  (a) the welding, dynamic qualification (including seismic and other design bases dynamic loads), environmental qualification and valve testing requirements addressed in Tier 1, Section 1.2 and

  (b) the various design and qualification processes defined in Tier 1, Section 3.

  In addition, the programmatic aspects of the design and construction processes (training, qualification of welders, etc.) are part of the licensee's programs and are subject to commitments made at the time of COL issuance. Consequently, these issues are not addressed in Tier 1.

(7) In general, the Tier 1 design descriptions address fixed design features expected to be in place for the lifetime of the facility. This is acceptable because portable equipment and replaceable items are controlled through operational related programs. Since Tier 1 pertains to the design, it is not appropriate for it to include a discussion of these items. One exception to this general approach pertains to nuclear fuel, fuel channels, and control rods. These components are discussed in the Tier 1 design descriptions due to their importance to safety and the desire to control their overall design throughout the lifetime of a plant that references the certified ABWR design.

(8) The Tier 1 design descriptions do not (usually) discuss component types (e.g., valve and instrument types), component internals, or component manufacturers. This approach is based on the premise that the safety function of a particular design element can be performed by a variety of component types and internals from different manufacturers. Consequently, a Tier 1 entry that defines particular component type / manufacturer would have no safety-related benefits and would unnecessarily restrict the procurement options of future applicants and licensees. Tier 1 does contain exceptions to this general

criterion, and these exceptions occur when the type of component is of safety-significance. For example, Tier 1, Section 2.1.2 specifies that the ABWR safety-relief valves shall be of the direct-acting type with pneumatic operators. This precludes the use of reverse acting valves controlled by pilot valves.

(9) The Tier 1 design descriptions do not contain any proprietary information because of the need to comply with requirements associated with publication of rules.

(10) In order to allow the applicant or licensee of a plant that references the ABWR design certification to take advantage of improvements in technology, the Tier 1 design descriptions in general do not prescribe design features that are the subject of rapidly evolving technology. Examples are: design of the main control room and instrumentation and control systems. This issue is discussed further in Tier 2, Section 14.3.3.

(11) Tier 1 design descriptions are intended to be self-contained and does not make direct reference to Tier 2, industrial standards, regulatory requirements or other documents. (There are some exceptions involving the ASME Code and the Code of Federal Regulations.) If these sources contain technical information of sufficient safety-significance to warrant Tier 1 treatment, the information has been extracted from the source and included directly in the appropriate system design description.

This approach is appropriate because it is unambiguous and it avoids potential questions regarding how much of a referenced document is encompassed in, and becomes part of, the Tier 1.

(12) Selection of the technical terminology to be used in Tier 1 was guided by the principle that the terminology should be as consistent as possible with that used in Tier 2 and the body of regulatory requirements and industrial standards applicable to the nuclear industry. This approach is intended to minimize problems in interpreting the intent of Tier 1 commitments.

Selection Methodology — Using the criteria listed above, Tier 1 description material was developed for each system by reviewing Tier 2 material relating to that system. Tier 1 utilizes a system-by-system report structure which is different than the structure of Tier 2. Consequently, developing the Tier 1 design description entry for any one system was based on review of the multiple Tier 2 chapters having technical information related to that system. For example, preparing a system design description could involve reviewing the following chapters.

Tier 2 Chapter	Potentially Relevant Material
1	Official system / structure name.
	Design features to address Three Mile Island (TMI) items.
	Design features to address station blackout considerations.
3	System and component classification information.
	Structural design.
4,5,6,9,10,11	Design features and configuration of mechanical / hydraulic / pneumatic systems.
6	System characteristics assumed for design basis loss-of-coolant accidents.
7	System control features and logic.
8	System power supply configuration.
12	System features related to radiation protection.
15	System characteristics assumed as part of the plant transient event analysis - including anticipated transients without scram.
16	System and component features necessary to support plant compliance with Technical Specifications.
19	Important design features identified by the plant probabilistic risk analysis (PRA).
	System and component design features associated with resolution of Unresolved Safety Issues (USI) and Generic Safety Issues (GSI).
	Important design features associated with mitigation of severe (beyond design basis) accidents.

This listing is not necessarily complete. It is provided as an example of potential Tier 2 sources of important system / component design information that should be included in

Tier 1 design descriptions for the ABWR systems. Of particular importance was the need to review those sections of Tier 2 which document plant safety evaluations for which acceptable plant performance is dependent upon contributions from multiple ABWR systems. Specifically, detailed reviews were conducted of the following in chapters of Tier 2 ; the flooding analyses in Chapter 3, the analysis of overpressure protection in Chapter 5, containment analyses in Chapter 6, the core cooling analyses in Chapters 6 and 15, the analysis of fire protection in Chapter 9, the safety analysis of transients and the anticipated transients without scram in Chapter 15, the radiological analyses in Chapter 15, resolution of generic safety issues and Three Mile Island issues in Chapters 1 and 19, and the PRA and severe accident analyses in Chapter 19. These reviews were a key factor in identifying the important, safety-related system design information warranting discussion in the design descriptions. Tier 2 Tables 14.3.-1 through 14.3-10 summarize the information identified by these reviews. Tier 2 Tables 19.8-1 through 19.8-7 summarize the important design features identified by the PRA and severe accident analyses.

Example Entries — Because the safety significance of the ABWR systems varies considerably, application of the criteria listed above results in a graded treatment of the systems. This leads to considerable variations in the scope of the design description entries. The following lists the types of ABWR systems and is a summary of the overall consequences of this graded treatment:

System Type	Scope of Design Description
Safety-related systems that contribute to plant performance during design basis accidents (e.g., emergency core cooling systems).	Major safety-related features and performance characteristics.
Non-safety-related systems involved in beyond-design-basis events (e.g., combustion turbine generator contribution to station blackout).	Brief discussion of design features and performance characteristics affecting the safety of the plant’s response to the event(s).

System Type	Scope of Design Description
Non-safety-related systems potentially impacting safety (e.g. potential missiles from the main turbine).	Brief discussion of design features which prevent or mitigate the potential safety concern.
Non-safety-related systems which affect overall plant design (e.g., Drywell Cooling System).	Case-by-case evaluation. A brief discussion of the system if warranted by overall standardization goals.
Non-safety-related systems with no relationship to safety or any influence on overall plant design (e.g., House Boiler System).	No discussion except identification of the system title.
System for which the Tier 1 entry has been included in another system (e.g., the Unit Auxiliary Transformer is addressed in the Electrical Power Distribution System).	No additional discussion except identification of the system title.

For safety-related systems, application of the above criteria resulted in design description entries which include the following information, as applicable: The system's name and scope; the system's purpose; the system's safety-related modes of operation; the system's classification (i.e., safety-related, seismic category, and ASME Code Class); the system's location; the basic configuration of the system's safety-significant components (usually shown by means of a figure); the type of electrical power provided for the system; the electrical independence and physical separation of divisions within the system; the system's important instruments, controls, and alarms to the extent located in the Main Control Room or Remote Shutdown System; identification of which of the important Class 1E electrical equipment within the system is qualified for a harsh environment; motor-operated valves within the system that have an active safety-related function; and any other features of functions that are significant to safety.

The Tier 1 design descriptions for non-safety-related systems also include the information listed above but only to the extent that the information is relevant to the system and is significant to safety. Since much of this information is not relevant to non-safety-related systems, the Tier 1 design descriptions for non-safety-related systems are generally substantially less extensive than the descriptions for safety-related systems. As discussed above, there are many systems for which no design description entries (and therefore no ITAAC) are included in Tier 1 and the entry is limited to the system title.

14.3.2.2 Inspections, Tests, Analyses and Acceptance Criteria (ITAAC)

A table of ITAAC entries is provided for each system which has design description entries. The intent of these ITAAC is to define activities that will be undertaken to verify the as-built system conforms with the design features and characteristics defined in the design description for that system. ITAAC are provided in tables with the following three-column format:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria

Each design commitment in the left-hand column of the ITAAC tables has an associated inspections, tests or analyses (ITA) requirement specified in the middle column. The acceptance criteria for the ITA are defined in the right-hand column.

Selection Criteria: — The following were considered when determining which information warranted inclusion in the Tier 1 ITAAC entries:

(1) The scope and content of the ITAAC correspond to the scope and content of the Tier 1 design descriptions. There are no ITAAC for aspects of the design not addressed in the design description. This is appropriate because the objective of the ITAAC design certification entries is to verify that the as-built facility has the design features and performance characteristics defined in the Tier 1 design descriptions.

With only a few special-case exceptions (nuclear fuel, fuel channels and control rods), each ABWR system with any design description text has an ITAAC table with one or more entries. This reflects the assessment that (in general) any design feature meriting a Tier 1 description also merits an ITAAC entry to verify that the feature has been included in the as-built facility.

(2) One inspection, test, or analysis may verify one or more provisions in the Tier 1 design description. In particular, an ITAAC which calls for a system functional test or an inspection of basic configuration may verify a number of provisions in Tier 1 design description. Therefore, there is not necessarily a one-to-one correspondence between the ITAAC and the Tier 1 design descriptions.

(3) The inspections, tests, and analyses are to be completed (and the acceptance criteria satisfied) prior to fuel loading. Therefore, the ITAAC do not include any inspections, tests, or analyses that are dependent upon conditions that only exist after fuel load.

(4) Because the Tier 1 design descriptions are limited to fixed design features expected to be in place for the lifetime of the facility, the ITAAC also are limited to a verification of fixtures in the plant. For example, there are no ITAAC for nuclear fuel, fuel channels and control rods because they are frequently changed by a licensee. (In the specific case of nuclear fuel, fuel channels and control rods, ITAAC also are not possible for these components because they are not installed in the plant until after authorization is given for fuel load.)

(5) In general, the ITAAC verify the as-built configuration and performance characteristics of structures, systems and components as identified in the Tier 1 design descriptions. With limited exceptions,(e.g., welding), the ITAAC do not address typical construction processes for the reasons discussed in item (6) of Tier 2, Section 14.3.2.1. As necessary, ITAAC coverage of the exceptions is by:

    (a) The provisions of Tier 1, Section 1.2, Items (1) through (4) that are invoked by configuration verification entries in individual system ITAAC tables.

    (b) The ITAAC entries in Tier 1, Section 3.

Selection Methodology — Using the criteria listed above, ITAAC table entries were developed for each system. This was achieved by evaluating the design features and performance characteristics defined in the Tier 1 design descriptions and preparing an ITAAC table entry for each design description entry that satisfied the above selection criteria. As a result of this process there is a close correlation (although not necessarily one-for-one for the reasons noted in item (2) above) between the left-hand column of the ITAAC table and the corresponding design description entry.

Having established the design features for which ITAAC are appropriate, the ITAAC table was completed by selecting the method to be used for verification (either a test, an inspection or an analysis (ITA)) and the acceptance criteria (AC) against which the as-built feature / performance will be measured. The emphasis when selecting an ITAAC verification method was to utilize in-site testing of the as-built facility wherever possible.

However, the selection of these items was dependent upon the plant feature to be verified but was guided by the following:

ITA approach	Application
Inspection	To be used when verification can be accomplished by visual observations, physical examinations, review of records based on visual observations or physical examinations that compare the as-built structure, system or component condition to one or more Tier 1 design description commitments.
Test	To be used when verification can be accomplished by the actuation or operation, or establishment of specified conditions, to evaluate the performance or integrity of the as-built structures, system or components. The type of tests identified in the ITAAC tables are not limited to in-situ testing of the completed facility but also include (as appropriate) other activities such as factory testing, special test facility programs, and laboratory testing.
Analysis	To be used when verification can be accomplished by calculation, mathematical computation or engineering or technical evaluations of the as-built structures, systems or components. (In this case, engineering or technical evaluations could include, but are not limited to, comparisons with operating experience or design of similar structures, systems or components.)

The proposed verification activity is identified in the middle column of the ITAAC table. Where appropriate, Tier 2 provides details regarding implementation of the verification activity. For example, Tier 2, Appendix 6D defines how results from High Pressure Core Flooder (HPCF) tests (which are also discussed in Tier 1, Section 2.4.2) will be converted from the test conditions to the design basis conditions for the HPCF System. This information is not referenced in Tier 1 and is not part of Tier 1; it is considered as providing only one of potentially several acceptable methods for completing the ITA.

Selection of acceptance criteria (AC) is dependent upon the specific design characteristic being verified by the ITAAC table entry: in most cases the appropriate AC is self-evident and is based upon the Tier 1 design descriptions. For many of the ABWR ITAAC, the AC is a statement that the as-built facility has the design feature or performance characteristic identified in the design description. A central guiding principle for AC preparation is the recognition that the criteria should be objective and unambiguous. The use of objective and unambiguous terms for the AC will minimize opportunities for multiple, subjective (and potentially conflicting) interpretations as to whether an AC has, or has not, been met. In some cases, the ITAAC acceptance criteria contain numerical parameters from Tier 2 that are not specifically identified in the Tier 1 design description or the Design Commitment column of the ITAAC table. This is acceptable because the design description defines the important design feature/performance that merits Tier 1 treatment whereas the acceptance criterion defines a measurement standard for determining if the as-built facility is in compliance with the Tier 1 design description commitment. Where appropriate, Tier 2 has identified detailed criteria applicable to the same design feature or function that is the subject of more general acceptance criteria in the ITAAC table. For example, Tier 2 Appendix 18E provides detailed guidance on human factors which is also the subject of the AC in Tier 1, Section3.1. This Tier 2 material is not considered part of Tier 1but does provide one of potentially several methods for satisfying the ITAAC.

For numerical AC, ranges and/or tolerances are included. This is necessary and acceptable because:

(a) Specification of a single-value AC is impractical since minute/trivial deviations would represent noncompliance.

(b) Tolerances recognize that legitimate site variations can occur in complex construction projects.

(c) Minor variations in plant parameters within the tolerance bounds have no impact on plant safety.

Examples Entries — Tier 2, Table 14.3-11 is a partial listing of the entries in the ITAAC table for the Standby Liquid Control System; this table is representative of ITAAC for other ABWR systems.

14.3.3 Tier 1 Section: 3.0 Additional Design Material

Entries in this section of Tier 1 have the same structure as the system material discussed in Section 14.3.2; i.e., design description text and figures and a table of ITAAC entries. The objective of this Tier 1 material is to address selected design and construction activities which are applicable to more than one system and cannot conveniently be covered in the system-by-system information presented in Tier 1, Section 2.0. There are five entries in Tier 1, Section 3.0, and the following summarizes the scope and bases for these entries. For each, the design description text defines the applicability of the entry.

14.3.3.1 Human Factors Engineering

The human factors engineering (HFE) entry defines the processes by which the details of the human-system interface (HSI) will be developed, designed and evaluated. The processes defined in this entry require the use of analyses based on human factors principles and apply to the main control room (MCR), including areas which provide the displays, controls and alarms required for normal, abnormal and emergency plant conditions. They also apply to the Remote Shutdown System (RSS).

For MCR and RSS detailed HSI design implementation, the certification of processes (rather than specific design features) is necessitated and justified by the following:

(1) The technology of equipment associated with HSI implementation is rapidly evolving (and improving) and certification of implementation processes permits future licensees to take advantage of beneficial technological advances available at the time of application. An example is the rapid advances that have taken (and are taking) place in flat panel display technology.

(2) Detailed implementation of the HSI is dependent upon the details of the as-procured, as-installed equipment. For example, different manufacturers use different techniques to monitor equipment performance. Since this equipment is not available at the time of design certification, it is not possible to develop HSI implementation details. This can be only be accomplished by a licensee when specific equipment characteristics are known.

(3) The fundamental design work for the ABWR HSI has been completed and is described in Tier 2. This includes commitments to a set of standard design features as well as a minimum inventory of fixed alarms, displays and controls necessary for the operators to implement the emergency operating procedures and to carry out those human actions shown to be important by the plant PRA. This design information, coupled with the comprehensive commitments to detailed HSI implementation processes based on currently accepted HFE practices, provides confidence that the execution of these processes will result in acceptable MCR and RSS detail designs that properly implement all of the applicable requirements.

Selection of specific technical material for the HFE design descriptions and ITAAC entries in the Tier 1 utilized the same selection criteria and methodology as described above for Tier 1, Section 2.0 system entries.

14.3.3.2 Radiation Protection

The radiation protection section of Tier 1 defines the processes by which it will be confirmed that the as-built facility has radiation protection features that maintain exposures for both plant personnel and the general public below allowable limits. The material applies to the radiological shielding and ventilation design of buildings within the scope of the ABWR certified design.

Certification of plant radiation protection features via process definition rather than via certification of specific design features is necessitated and justified by the following:

(1) Actual radiological source terms are dependent upon the characteristics of the as-built, as-installed equipment. For example, such parameters as equipment sizes, geometry, and valve stem leakage rates influence source terms. Consequently, final radiological evaluation cannot be completed prior to availability of this as-built data and therefore cannot be used to finalize radiological protection design features at the time of design certification.

(2) Radiological studies using representative/ reasonable assumptions have been completed and reported in Tier 2, Chapter 12. These preliminary studies show the ABWR radiological protection features are such that acceptance criteria related to occupational and general public exposure are met. This provides high confidence that the processes defined in the radiological Tier 1 entry can be successfully executed within the envelope of the ABWR certified design. This confidence is based in part on the recognition that technology associated with radiation sources and protection is well understood and is unlikely to experience any major changes during the lifetime of the design certification.

Selection of entries in Tier 1 utilized the same selection criteria and methodology as discussed above for Tier 1, Section 2.0 system entries.

14.3.3.3 Piping Design

The piping design section of Tier 1 defines the processes by which ABWR piping will be designed and evaluated. The material applies to piping systems that are classified as nuclear safety-related. In general, these piping systems are designated as Seismic Category I and are further classified as ASME Code Class 1, 2 or 3. The section also addresses the consequential effects of pipe rupture such as jet impingement, potential missile generation, pressure/temperature effects etc.

Certification of plant safety-related piping systems via design processes rather than via certification of specific design features is necessitated and justified by the following:

(1) Piping design is based on detailed piping arrangement information as well as the geometry and dynamic characteristics of the as-procured equipment that forms part of the piping system. This detailed plant-specific information is unavailable at the time of design certification and cannot therefore be used to develop detailed design information. This precludes certification of specific piping designs.

(2) An extensive definition of design methodologies is contained in Tier 2, Chapter 3. These methodologies are not considered to be part of Tier 1 but are one of several methods for executing the design process steps defined in

the piping design. In addition, sample design calculations have been performed with these methods to provide confidence that they are complete and yield acceptable design information.

(3) Piping design for nuclear plants is a well understood process based on straightforward engineering principles. This, together with Tier 2 methodology definition and sample calculations, provides confidence that future design work by individual applicants/licensees will result in acceptable designs that properly implement the applicable requirements.

The technical material in the piping design Tier 1 entry was selected using the criteria and methodology as discussed above for Tier 1, Section 2.0 system entries.

14.3.3.4 Instrumentation and Control

This Tier 1 section has multiple entries addressing the following issues associated with plant instrumentation and control (I&C):

(a) System design description and ITAAC for the Safety System Logic and Control (SSLC) System.

(b) I&C Development and Qualification Processes.

(c) Design descriptions and ITAAC for ABWR design features that provide diverse backup as protection against common-mode failure in the SSLC.

Items a and c address design features of the various ABWR systems and were developed using the selection criteria and methodology described in Tier 2, Sections 14.3.2.1 and 14.3.2.2.

14.3.3.4.1 I&C Development and Qualification Processes

This section of Tier 1 defines the hardware and software development processes to be used in the design, testing and installation of I&C equipment. This includes:

(1) Software and hardware development processes and plans to be used for safety-related systems using programmable microprocessor-based control equipment.

(2) A program to assess and mitigate the effects of electromagnetic interference (EMI) on the ABWR I&C equipment.

(3) A program to establish setpoints for safety-related instrument channels.

(4) A program to qualify safety-related I&C equipment for in-service environmental conditions.

Certification of these aspects of the ABWR design via processes/programs rather that via certification of specific design feature is necessitated and justified by the following:

(1) Software Development

(a) Development of specific software is dependent upon the detailed, as-procured characteristics of the hardware to be used-- especially the microprocessors to be used for the programmable digital control features. Consequently, software development cannot be completed at the time of design certification without selecting the specific implementation hardware. In addition to the technology issue discussed below, this would be incompatible with the principle that certification should not define vendor-specific (i.e., as-procured) design characteristics for components.

(b) All aspects of digital, microprocessor based control technology are expected to undergo significant changes as the technology continues to evolve. These future changes are expected to be beneficial and involve both the software and the hardware. Certification of specific software details at this time would preclude future COL applicants from taking advantage of these technology advances.

(c) Development of software for programming of real-time microprocessor based controllers is a well understood process which is being continual upgraded by application of such techniques as automated development of requirements and automated verification activities. These trends, coupled with ongoing industry efforts to establish standards for software development, provide confidence that future execution of this Tier 1 entry will result in I&C equipment fully in compliance with ABWR requirements and all Tier 2 commitments.

(d) The software development process is discussed in detail in Appendix 7B. This material is not considered part of Tier 1; however, it provides one of several acceptable methods for implementing the ITAAC in the Tier 1.

(2) EMI, Setpoints and Equipment Qualification

Activities associated with these aspects of I&C hardware are dependent upon the characteristics of the as-built, as-installed equipment and cannot therefore be completed as part of the design certification. For example:

(a) Confirmation that I&C hardware has acceptable protection against the effects of EMI is dependent upon the details of the design and the EMI field in which it is located. The latter depends upon the detailed plant design and arrangement and is therefore not available at the time of certification.

(b) Setpoint methodology requires consideration of such factors as instrument accuracy, calibration accuracy, and drift, as well as the signal transmission characteristics of the as-installed data handling equipment -- all characteristics of the as-procured hardware and thus not available at the time of certification.

(c) Equipment qualification is based on the environmental conditions that will be experienced in service (pressure, temperature, radiation, etc.). These conditions are dependent upon the as-built design of the plant. Furthermore, qualification processes must reflect the as-procured hardware design; e.g., the materials of construction, the location of non-metallic components vis-a-vis radioactive sources, etc. None of this information is available at the time of design certification.

Because of these considerations, it is appropriate that the Tier 1 entries for these I&C hardware-related subjects be in the forms of commitments to plans and processes.

14.3.3.5 Initial Test Program

The ABWR Initial Test Program (ITP) defines testing activities that will be conducted following completion of construction and construction-related inspections and tests. The ITP extends through to the start of commercial operation of the facility. This program is extensively discussed in Tier 2, Chapter 14 and centers heavily on testing of the ABWR safety-related systems.

A summary of the ITP has been included in Tier 1, Section 3.5. This summary includes an overview of the ITP structure together with commitments related to test documentation and administration controls. This information has been included in Tier 1 because of the importance of the ITP in defining comprehensive pre- and post-fuel load testing for the as-built facility to demonstrate compliance with the design certification. Key pre-fuel load ITP testing for individual systems is defined in the system ITAAC in Tier 1, Sections 2 and 3.

No ITAAC entries have been included in Tier 1 for the ITP. This is acceptable because:

(a) Many of the ITP activities involve testing with the reactor at various power levels and thus cannot be completed prior to fuel load (Part 52 requires ITAAC to be completed prior to fuel load).

(b) Testing activities specified as part of the ITAAC in Tier 1, Sections 2 and 3 must be performed prior to fuel load. Since these ITAAC testing activities address the design features and characteristics of key safety significance, additional ITAAC for the ITP as defined inTier 1, Section

3.5. are not necessary to assure that the as-built plant conforms with the ABWR certified design.

14.3.4 Tier 1 Section: 4.0 Interface Requirements

This section of Tier 1 provides interface requirements for those system of a complete power-generating facility that are either totally or partially not within the scope of the ABWR design as defined in the certification application (Tier 2). For the ABWR, these systems are listed in Tier 2, Section 1.1.2. Generally structures, systems and components that are part of, or within, the Reactor Building, Service Building, Control Building, Turbine Building and Radwaste Building are in the ABWR scope. Those portions of the plant outside of these buildings are not generally in the ABWR scope. This scope split occurs because design of the plant features located outside the main buildings is dependent upon site-specific characteristics which are unknown at the time of certification (e.g., the source of plant cooling water, the characteristics of the electrical grid to which the plant is connected, etc.). The basis for this interface requirements entry in Tier 1 is the discussion in 10 CFR Part 52.47(a) (1) (vii). An applicant for a license that references the ABWR design certification must provide site-specific systems with design features/characteristics that comply with the interface requirements.

An entry is provided in Section 4.0 of Tier 1 for each of the systems listed in Section 1.2; for systems that have no interface requirements of sufficient safety-significance to warrant Tier 1 treatment, the entry is limited to the system title only. For systems that are partially within the scope of the ABWR, interface requirements are listed in either Tier 1, Section 4.0 or in a separate sub-part of the Tier 1, Section 2.0 entry which addresses the in-scope portion of the system. In all cases, the Tier 1 entries for these systems are limited to defining interface requirements. Conceptual designs for the out-of-scope interfacing systems are required by 10 CFR Part 52.47(a)(1)(ix); these designs are presented in Tier 2 but are not addressed in Tier 1. This is appropriate because the applicant will provide site-specific designs that meet the interface requirement; these site-specific designs may not correspond to the conceptual designs described in Tier 2 . Tier 1 does not define any ITAAC associated with the interface requirements. This is acceptable because ITAAC for the plant structures, systems, and components outside the scope of the ABWR design certification will be provided on a site-specific, design-specific basis by the individual COL applicants who reference the ABWR design certification. (Part of the review process at the time of the license application will be to assess compliance of the site-specific designs with the interface requirements.)

10 CFR Part 52.47(a)(1)(viii) specifies that design certification applications contains justification that the requirements are verifiable through inspection, testing or analysis and that the method to be used for verification be included as part of the ITAAC. The introductory text of Tier 1, Section 4.0 addresses these issues by stating the interface requirements are similar in nature to the design commitments in Tier 1, Section 2.0 for which ITAAC have been developed. This represents justification that a COL applicant will be able to develop ITAAC to verify compliance with the design features or

characteristics that implement the interface requirements. The methods to be used for these verifications will be specified in the COL ITAAC and will be similar to the methods in the Tier 1, Section 2.0 ITAAC for comparable / similar design characteristics.

Selection Criteria — The selection criteria listed in Tier 2, Section 14.3.2.1 were used to guide selection of interface requirements defined in Tier 1, Section 4.0 (or in the Section 2.0 entries referenced from Tier 1, Section 4.0). The intent is that the interface requirements in Tier 1 define key, safety-significant design attributes and performance characteristics of the site-specific, out-of-scope portion of the plant which must be provided in order for the certified portions of the ABWR to comply with the design commitments in Tier 1. It is an objective of this section that it address interfaces between in- scope and out-of-scope portions of the plant that are unique to the ABWR design; it is not intended that it be a comprehensive listing of all design requirements applicable to the out-of-scope portions of the plant. The latter will be provided for NRC review when the COL applicant submits a site-specific safety analysis report that will include a discussion of the site-specific design features.

Selection Methodology — The interface requirements included in the Tier 1 were selected from the interface requirements listed in Tier 2 for fully or partially out-of-scope systems. For example: Tier 2, Section 8.2.3 defines interface requirements for the Offsite Power Systems. These sections and similar interface requirement sections for other systems were reviewed, and Tier 1, Section 4.0 entries selected using the criteria discussed above.

Example Entry — Table 14.3-12 shows the UHS interface requirements inTier 1, Section 4 and is representative of entries for other systems.

14.3.5 Tier 1 Section: 5.0 Site Parameters

This section of Tier 1 defines the site parameters which were used as a basis for the design defined in the ABWR certification application. These entries respond to the 10 CFR 52.47(a)(1)(iii) requirement that the design certification documentation include site parameter information. The plant must be designed and built using the parameters in Tier 1, Section 5.0. Furthermore, it is intended that applicants referencing the ABWR design certification demonstrate that these parameters for the selected site are within the certification envelope.

Site-specific external threats that relate to the acceptability of the design (and not to the acceptability of the site) are not considered site parameters and are addressed as interface requirements in the appropriate system entry in Tier 1, Section 4. For example, the Technical Support Center (TSC) HVAC System requires that toxic gas monitors be located in the outside air intake if the site is adjacent to toxic gas sources with the potential for releases of significance to plant operating personnel in the TSC.

Section 5.0 of Tier 1 does not include any ITAAC and is limited to defining the ABWR site parameters. This is an appropriate approach because compliance of the site with these parameters must be demonstrated by a license applicant prior to issuance of the license.

Selection Criteria — Tier 2, Section 2.0, Table 2.0-1 provides the envelope of site design parameters used for the ABWR design. The corresponding Tier 1, Section 5.0 is based on using Tier 2 Table 2.0-1 in its entirely except as modified to meet the Tier 1 content criteria discussed in this Tier 2 section (i.e., 14.3). For example, references in the Tier 2 table to specific Regulatory Guides have been deleted from the Tier 1 table because of the guideline that Tier 1 does not contain direct references to codes and standards. Tier 1, Section 5 is limited to a tabular entry; no supporting text material is required.

14.3.6 Summary

A central element of the design certification processes deriving from 10 CFR Part 52 centers on selection and documentation of the technical information to be included in the rule as the ABWR certified design. The certified design description is a subset of the comprehensive set of design information presented in Tier 2. It includes:

(a) the key, important safety-significant aspects of the overall design described in the certification application (Tier 2),

(b) the inspections, tests, analyses and acceptance criteria (ITAAC) that will be used to verify the as-built facility conforms with the ABWR certified design, and

(c) interface requirements and site parameters.

The information presented in Tier 1 has been prepared using the selection criteria and methodology described in this Tier 2 section and is intended to satisfy the above Part 52 requirements for Rule content. In particular, the ITAAC entries in Tier 1, Sections 2 and 3 will confirm that key design performance characteristics and design features are in place and that the as-built facility will operate in accordance with the design certification.

Table 14.3-1 Core Cooling Analysis

Tier 2 Entry	Parameter	Tier 2 Value
6.3.3.5	Following a LOCA the RHR System is Automatically Directed to the LPFL Mode	----
6.3.3.7.4	The Safety Related Systems Will Operate as Designed with the Loss of All Offsite AC Power	----
Table 6.3-1	Low Pressure Flooder System	
	Vessel Pressure at which Flow May Commence (MPaD -- vessel to drywell)	1.55
	Min. Rated Flow (m^3/h per pump)	954
	At vessel Pressure (MPaD -- vessel to drywell)	0.275
	Initiating Signals	
	Low Water Level	----
	or	
	High Drywell Pressure	----
	Maximum Allowable Time Delay from Low Pressure Permissive Signal to Injection Valve Fully Open (s)	36.0
Table 6.3-1	Reactor Core Isolation Cooling System	
	Vessel Pressure at which Flow May Commence (MPaD-- vessel to the air space of the compartment containing the water source for the pump suction)	8.12
	Min. Rated Flow (m^3/h)	182
	At Vessel Pressures (MPaD-- vessel to the air space of the to compartment containing the water source for the pump suction)	8.12 to 1.03
	Initiating Signals	
	Low Water Level	----
	or	
	High Drywell Pressure	----
	Maximum Allowable Time Delay from Initiating Signal to Rated Flow Available and Injection Valve Fully Open (s)	29.0
Table 6.3-1	High Pressure Core Flooder System	
	Vessel Pressure at which Flow May Commence (MPaD -- vessel to the air space of the compartment containing the water source for the pump suction)	8.12
	Minimum Rated Flows (m^3/h per subsystem)	182 to 727

Table 14.3-1 Core Cooling Analysis (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	At Vessel Pressures (MPaD -- vessel to the air space of the compartment containing the water source for the pump suction)	8.12 to 0.686
	Initiating Signals	
	Low Water Level	----
	or	
	High Drywell Pressure	----
	Maximum Allowable Time Delay from Initiating Signal to Rated Flow Available and Injection Valve Fully Open and Power Available at the Emergency Busses (s).	16.0
	Maximum Emergency Diesel Generator Startup Time (s)	20.0
Table 6.3-1	Automatic Depressurization System	
	Total Number of Relief Valves with ADS Function	8
	Min. Flow Capacity (kg/h x 10^6)	2.903
	At Vessel Pressure (MPaG)	7.76
	Initiating Signals	
	Low Water Level	---
	and	
	High Drywell Pressure	----
	or	
	High Drywell Pressure Bypass Timer Timed Out	----
	Time Delay (s)	480
	Delay Time from All Initiating Signals Completed to the Time Valves are Open (s)	29.0
Table 6.3-3	The RHR Subsystems are Divisionally Separated	----
	The HPCF Subsystems are Divisionally Separated	----
	RCIC Operation Does not Required AC Power	----
	A Single Failure Will not Prevent the Operation of More Than One ADS Valve	----
Table 6.3-4	LOCA Break Sizes	
	Steamline (cm^2)	985
	Feedwater Line (cm^2)	839
	RHR Shutdown Cooling Suction Line (cm^2)	792
	RHR Injection Line (cm^2)	205

Table 14.3-1 Core Cooling Analysis (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	High Pressure Core Flooder (cm^2)	92
	Bottom head Drain Line (cm^2)	20.3
Table 15.6-4	MSIV Closure Initiated by High Steam Flow	----
	Scram Initiated by MSIV Closure	----
Table 15.6-15	Scram Initiated by Low Water Level 3	----

Table 14.3-2 Containment Pressure/Temperature Response

Tier 2 Entry	Parameter	Tier 2 Value
6.2.1.1.3.3.1.1	Minimum MSIV Closing Time (s)	3.0
	High Pressure Core Flooder System	
	Minimum Rated Flows (m^3/h per subsystem)	182 to 727
	At Vessel Pressures (MPaD -- vessel to the air space of the compartment containing the water source for the pump suction)	8.12 to 0.686
	Low Pressure Flooder System	
	Vessel Pressure at which Flow May Commence (MPaD -- vessel to drywell)	1.55
	Min. Rated Flow (m^3/h per pump)	954
	At Vessel Pressure (MPaD -- vessel to drywell)	0.275
	Reactor Core Isolation Cooling System	
	Min. Rated Flow (m^3/h)	182
	At Vessel Pressures (MPaD -- vessel to the air space of the compartment containing the water source for the pump suction)	8.12 to 1.03
6.2.1.1.3.3.2	Maximum MSIV Closing Time (s)	5.0
	Total Surface of Drywell Connecting Vents (m^2)	11.3
	Vacuum Breakers	
	Quantity	8
	Total Flow Area (m^2)	1.53
Table 6.2-2	Drywell	
	Leak Rate (%/Day)	0.5
	Wetwell	
	Leak Rate (%/Day)	0.5
	Min. Suppression Pool Water Volume (m^3)	3580
	Vent System	
	Number of Vents	30
	Nominal Vent Diameter (m)	0.7
	Total Horizontal Vent Area (m^2)	11.6
Table 6.2.2-a	Containment Spray	
	Number of RHR Subsystems (Pump Plus Heat Exchanger)	2

Table 14.3-2 Containment Pressure/Temperature Response (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Wetwell Spray Flow Rate per RHR Subsystem (kg/h x 10^5)	1.14
	Containment Cooling System	
	Number of RHR Subsystems (Pump Plus Heat Exchanger)	3
	Pump Capacity (m^3/h per pump)	954
	Overall Heat Transfer Coefficient (kJ/S•°C)	370.5
Table 6.3-4	LOCA Break Sizes	
	Steamline (cm^2)	985
	Feedwater Line (cm^2)	839
	RHR Shutdown Cooling Suction Line (cm^2)	792
	RHR Injection Line (cm^2)	205
	High Pressure Core Flooder (cm^2)	92
	Bottom head Drain Line (cm^2)	20.3

Table 14.3-3 Transient Analysis

Tier 2 Entry	Parameter	Tier 2 Value
Table 15.0-1	Reactor Internal Recirculation Pumps	
	Number of Pumps	10
	Pump Trip Inertia (kg•m^2)	
	Trip Mitigation (maximum)	26.5
	Accident (minimum)	17.5
	Relief Valve (Relief Function)	
	Capacity (% NBR Steam Flow at 7.89 MPaG)	91.3
	Number of Valves	18
	Opening Time (s) (valve stroke time only. Does not include 0.1 s delay to energize solenoid)	0.15
	High Flux Trip Scram	----
	APRM Simulated Thermal Power Trip Scram	----
	Total Steamline Volume (m^3)	113.2
Table 15.0-6	FMCRD Scram Times	
	10% Rod Insertion (s)	0.46
	40% Rod Insertion (s)	1.208
	60% Rod Insertion (s)	1.727
	100% Rod Insertion (s)	3.719
15.1.1.2.2	High Simulated Thermal Power Trip Scram	----
Table 15.1-5	High Water Level 8 Initiates	
	Feedwater Pump Trip	----
Table 15.1-5	Turbine Stop Valve Position Switches Initiate	
	Reactor Scram	----
	Trip of 4 RIPs	----
Table 15.1-7	Low Water Level 2 Initiates	
	Trip of 6 RIPs	----
	RCIC System	----
	Maximum Startup Time ((s) -- includes 1.0 s for instrument delay)	30
	MSIV Closure on Low Turbine Inlet Pressure	----
15.1.3.3.1	MSIV Closure Time (s -- maximum isolation valve closing time plus 0.5 s for instrument delay)	5.0

Table 14.3-3 Transient Analysis (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
Table 15.1-9	SRNM High Neutron Flux Scram	
15.2.1.3.1	TCV Full Stroke Servo Closure(s)	2.5
Table 15.2-1a	Low Water Level 3 Initiates Trip of 4 RIPs	----
Table 15.2-2	High Dome Pressure Initiates Trip of 4 RIPs	----
Table 15.2-3	T/G Load Rejection Initiates	
	Turbine Control Valve Fast Closure	----
	Turbine Bypass System Operation on High Pressure	----
	Fast Control Valve Closure Initiates	
	Scram	----
	Trip of 4 RIPs	----
15.2.2.3.1	TCV Full Stroke Fast Closure (s -- from normal operating position)	0.08
Table 15.2-6	Turbine Trip Initiates	
	Turbine Control Valve Fast Closure	----
	Turbine Bypass System Operation on High Pressure	-----
15.2.3.3.1	Turbine Stop Valve Full Stroke Closure (s)	0.10
Table 15.2-9	MSIV Position Switches Initiate	
	Scram	----
15.2.4.3.1	Minimum MSIV Closure Time (s)	3.0
Table 15.2-14	Low Condenser Vacuum Initiates	
	MSIV Closure	----
15.2.6.1.1.2	RIP M/G Set	
	Number of RIPs	6
	Length of Time Hold Original Speed (s)	1.0
	RIP Coastdown	
	Rate (% per s)	10
	Length of Time (s)	2.0
	Time of RIP Trip (s)	3.0
Table 15.2-17	Low Water Level 3 Initiates Reactor Scram	----
15.2.7.2.21	Meets Single-failure Criterion	----
15.2.9	RHR System has 3 Independent Divisions	----
15.3.1.1.1	No More Than 3 RIPs on One Electrical Power Bus	----
15.3.1.2.2.2	Rapid Core Flow Coastdown Initiates Reactor Scram	----

Table 14.3-3 Transient Analysis (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Mode Switch in the **Refuel** Position	
15.4.1.1.2.2	Refueling Platform Cannot be Moved Over the Core If a Control Rod is Withdrawn and Fuel is on the Hoist	----
15.4.1.1.2.3	Only One or Two Control Rods Associated with the Same HCU Can Be Withdrawn	----
15.4.1.2.1	On Short Flux Period SRNMs Generate	
	Reactor Scram	----
15.4.1.2.3.2	FMCRD Withdrawal Speed (mm/s)	30
15.4.2.1	At Power the ATLM of the RCIS Prevents Rod Withdrawal Based on MCPR and APLHGR Limits	----
15.4.4.1.1	Overcurrent Protection Logic on the Electrical Bus Which Supplies the Power to the RIPs	----
15.4.9.1	FMCRD Designed to Prevent Rod Ejection	----
15.4.10.1	FMCRD Designed to Prevent Separation of Control Blade and Drive	----

Table 14.3-4 Radiological Analysis

Tier 2 Entry	Parameter	Tier 2 Value
Table 15.6-5	Maximum MSIV Closure Time (s) (Assumes 0.5 s for instrument delay.)	5.0
Table 15.6-8	Primary Containment Leakage Rate (% per day)	0.5
	MSIV Total Leakage Rate for All Lines (L/M) @ Standard Conditions	66.1
	SGTS	
	Filter Efficiency Assumed for LOCA (%)	97
	Drawdown Time (min)	20
	Control Room	
	Recirculation Rates	
	Min. Charcoal Efficiency (%)	95
Table 15.7-8	SGTS Filter Efficiency Assumed for Fuel Handling Accident (%)	99

Table 14.3-5 Overpressure Protection

Tier 2 Entry	Parameter	Tier 2 Value
5.2.2.1.4	Direct Scram Signal Generated By:	
	Position Switches on	
	MSIVs	----
	Turbine Stop Valves	----
	Pressure Switches on	
	TCV Hydraulic Actuation System Dump Valve	----
Table 5.2-2	Scram Signal on	
	High Flux	----
	Recirculation Pump Trip on	
	High Vessel Pressure	----
Table 5.2-3	Safety/Relief Valve	
	Spring Set Pressure	
	2 SRVs MPaG	7.92
	Capacity per valve (kg/h) (103% Spring Set Pressure)	395000
	4 SRVs (MPaG)	7.99
	Capacity per valve (kg/h) (103% Spring Set Pressure)	399000
	4 SRVs (MPaG)	8.06
	Capacity per valve (kg/h) (103% Spring Set Pressure)	402000
	4 SRVs (MPaG)	8.13
	Capacity per valve (kg/h) (103% Spring Set Pressure)	406000
	4 SRVs (MPaG)	8.20
	Capacity per valve (kg/h) (103% Spring Set Pressure)	409000
	No. of Valves	18
Figure 5.2-1	SRV Safety Function Opening Time (s)	0.3

Table 14.3-6 Flooding Protection

Tier 2 Entry	Parameter	Tier 2 Value
	Reactor and Control Building Flood Protection (from External Sources)	
Table 3.4-1	All Penetrations Below Grade Watertight	----
	Pipe Penetrations Below Design Flood Level Will Be Sealed Against Hydrostatic Head Inside Tunnel or Connecting Building	
	Watertight Doors installed on All Access Ways Below Design Flood Level	
3.4.1.1.1	Min. Wall Thicknesses Below Design Flood Level (m)	0.61
	Piping Tunnels Below Grade do not Penetrate Exterior Walls	----
	Reactor Building Flood Protection (from Internal Sources)	
3.4.1.1.2	All Piping, Vessels and Head Exchangers with Flooding Potential are Seismically Analyzed	
	Standby Liquid Control System	----
	Residual Heat Removal System	----
	High Pressure Core Flooder System	----
	Reactor Core Isolation Cooling System	----
	Reactor Building Cooling Water System	----
	HVAC Emergency Cooling Water Sys.	----
	Reactor Service Water System	----
	Fire Protection System	----
	Oil Storage and Transfer System	----
	Main Steamlines (Inside Reactor Bldg)	----
	Feedwater lines (Inside Reactor Bldg)	----
	Water Sensitive Safety-Related Equipment Raised Off the Floor (mm)	
	All Rooms With a Potential for Flooding Are Supplied With Floor Drains	----
	MSIVs Automatically Close on High Temperature in Main Steamline Tunnel	----

Table 14.3-6 Flooding Protection (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
3.4.1.1.2.1.1	Evaluation of Floor 100 (B3F)	
	Watertight Doors on Compartments Containing ECCS Equipment	----
	Watertight Doors have Open/Close Status Indicator Lights and Alarms in MCR	----
3.4.1.1.2.1.2	Evaluation of Floor 200 (B2F)	
	RHR Pressure Lines Inside Pipe Chases	----
	Minimum Floor Spread Area (m^2)	300
3.4.1.1.2.1.3	Evaluation of Floor 300 (B1F)	
	(No Additional Requirements)	
3.4.1.1.2.1.4	Evaluation of Floor 400 (1F)	
	RHR, HPCF and RCIC Lines in Pipe Chases	----
	Foam Sprinkler System in Diesel Generator Areas	----
3.4.1.1.2.1.5	Evaluation of Floor 500 (2F)	
	Divisional DG Equipment Areas are Separated and Mechanically Isolated from Each Other	----
	FPC Pools Seismic Category I	----
	Steamline Tunnel Area Isolated by Sealed Doors and Firewalls	----
3.4.1.1.2.1.6	Evaluation of Floor 600 (3F)	
	Foam Sprinkler System in (Fuel Storage) Day Tank Areas	----
3.4.1.1.2.1.7	Evaluation of Floor 700 (M4F)	
	(No Additional Requirements)	
3.4.1.1.2.1.8	Evaluation of Floor 800 (4F)	
	Each RCW Surge Tank A,B & C and Its Associated Piping Is in a Separate Compartment	----
3.4.1.1.2.2	Control Building Flood Protection (from Internal Sources)	
	No Openings into the Control Building from the Steam Tunnel	----
	Steam Tunnel Sealed At the Reactor Building End	----
	All Rooms with a Potential for Flooding Are Supplied With Floor Drains	----

Table 14.3-6 Flooding Protection (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	High Water Level Sensors in RCW/RSW Heat Exchanger Room	
	Powered by Class 1E Power Supply	----
	Automatically Close RSW Isolation Valves and Stop Pumps	----
	Water Tight Doors on RCW/RSW Heat Exchanger Rooms	----
	Redundant Mechanical Functions are Physically Separated	----
	Water Sensitive Safety-Related Equipment Raised Off the Floor (mm)	200
3.4.1.1.2.3	Radwaste Building Flood Protection (from Internal Sources)	
	Seismic Category I Substructure	----
3.4.1.1.2.4	Service Building Flood Protection (from Internal Sources)	
	Watertight Doors on Access Corridors	----
	Turbine Building Flood Protection (from Internal Sources)	
	Normally Closed Alarmed Door in Passage From Service Building	----
	High Water Level in Condenser Pit Automatically Shuts Down Circulating Water System	----

Table 14.3-7 Fire Protection

Tier 2 Entry	Parameter	Tier 2 Value
9A.2.4	Electrical Cable Fire-stops Have Fire Rating Equal to Rating of Barrier They Penetrate	----
	Control, Power or Instrument Cables of Systems Having Similar Safety Related or Shutdown Functions are Located in Separate Fire-resistive Enclosures.	----
	A Minimum of Two Fire Suppression Means is Available to Each Fire Area	----
9A.4.1.1.1	Drywell Inerted During Plant Operation	----
	Drywell Has Primary Containment Supply/Exhaust System	----
9A.4.1.1.2	Wetwell Inerted During Plant Operation	----
	Wetwell Has Spray System	----
Appendix 9A	Systems Having Similar Safety Related or Shutdown Functions are Located in Separate Fire-resistive Enclosures.	----
Appendix 9A	A Means of Fire Detection, Alarming and Suppression is Provided and Accessible.	----
	Fire Stops Are Provided for Cable Tray and Piping Penetrations Through Rated Fire Barriers	----
	Alternate Means of Access and Egress are Provided by a Separate Stair Tower, Elevator or Corridor	----

Table 14.3-8 ATWS Analysis

Tier 2 Entry	Parameter	Tier 2 Value
	Nominal Initial Operating Conditions	
Table 15E-2	Minimum Suppression Pool Volume (m^3)	3580
	Equipment Performance Characteristics	
15.8.2	Minimum SLCS Capacity(L/min)	378
Table 15E-3	Minimum Closure Time of MSIV (s)	3.0
	Relief Valve	
	Capacity (%NBR Steam Flow at 7.89 MPaG)	91.3
	Number of Valves	18
	Opening Time (s) (Valve stroke time only. Does not include 0.1s delay to energize solenoid.)	0.15
Table 15E-3	Reactor Core Isolation Cooling System	
	Min. Rated Flow (kg/h)	50.4
	At Vessel Pressures (MPaD -- vessel to the air space of the compartment containing the water source for the pump suction)	8.12 to 1.03
	Initiates on Low Water Level	----
	Maximum Allowable Time Delay from Initiating Signal to Rated Flow Available and Injection Valve Fully Open (s)	29.0
	High Pressure Core Flooder System	
	Number of Subsystems	2
	Minimum Rated Flows (kg/s per subsystem)	50.4 to 201.6
	At Vessel Pressures (MPaD -- vessel to the air space of the compartment containing the water source for the pump suction)	8.12 to 0.69
	Initiates on Low Water Level	----
	Injection Terminated on High Water Level	----
	Maximum Allowable Time Delay from Initiating Signal to Rated Flow Available and Injection Valve Fully Open (Does not include diesel start time and Loading sequence --s)	20.0
	Nominal Recirculation Pump System Inertia (kg•m^2)	21.5
	Maximum Electro-Hydraulic Control Rod Insertion Time (s)	135

Table 14.3-8 ATWS Analysis (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Total Minimum RHR Pool Cooling Capacity For 3 Subsystems (MJ/s•°C)	1.11
	MSIV Closure Initiated on Low Water Level	----
	MSIV Closure Initiated on Low Main Steamline Inlet Pressure to Turbine	----
	ATWS Logic and Setpoints	
15E.4	ARI and FMCRD Run-in Initiated on	
	High Dome Pressure	----
	or	
	Low Water Level 2	----
	SLCS Initiated on an ATWS Trip Signal	----
	ATWS Trip Signals for SLCS Initiation	
	High Dome Pressure	----
	and	
	SRNM ATWS permissive	----
	Analytical Time Delay (minutes)	3
	or	
	Low Water Level 2	----
	and	
	SRNM ATWS permissive	----
	Analytical Time Delay (minutes)	3
	or	
	Manual ARI/FMCRD Run-in Signals	----
	and	
	SRNM ATWS permissive	----
	Analytical Time Delay (minutes)	3
	RPT (RIPs not Connected to M/G Set) Initiated on	
	High Dome Pressure	----
	ATWS Logic and Setpoints	
15E.4	RPT (RIPs Connected to M/G Set) Initiated on	
	Low Water Level 2	----
	Recirculation Runback Initiated on	
	Any Scram Signal	----

Table 14.3-8 ATWS Analysis (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	or	
	Any ARI/FMCRD Run-in Signal	----
	Feedwater Runback Initiated on an ATWS Trip Signal	----
	ATWS Trip Signals for Feedwater Runback	
	High Dome Pressure	----
	and	
	SRNM ATWS permissive	----
	Analytical Time Delay (minutes)	2
	ADS Inhibit	----
	Automatic Initiation of ADS is Inhibited Unless	
	Low Reactor Water Level 1.5	----
	and	
	APRM ATWS permissive	----

Table 14.3-9 Generic Safety Issues

Tier 2 Entry	Parameter	Tier 2 Value
19B.2-2	A-1: Water Hammer	
	Steam Supply System Designed to Accommodate Steam Hammer	----
	MSL Designed for Dynamic Loadings Due to Fast Closing of the Turbine Stop Valves	----
	RCIC System	
	MUWC to Keep System Filled	----
	HPCF System	
	MUWC to Keep System Filled	----
	RHR System	
	Jockey Pump to Keep System Filled	----
19B.2-3	A-7: MARK I Long-Term Program	
	Vacuum Breakers	
	Swing Check Type Valves	----
	Open Passively on Negative Differential Pressure	----
	Require No External Power to Actuate	----
	Installed Horizontally Through Pedestal Wall	----
19B.2-4	A-8: MARK II Containment Pool Dynamic Loads Long-Term Program	
	(Refer to response to 19B.2-3)	
19B.2-5	A-9: ATWS	
	Alternate Rod Insertion Feature Diverse and Independent From RPS	----
	Electric Insertion of FMCRD Feature Diverse and Independent From RPS	----
	Recirculation Pump Trip on ATWS Signal	----
	Automatic Initiation of SLC on ATWS Signal	----
19B.2-8	A-24: Qualification of Class 1E Safety Related Equipment	
	All Class 1E Electrical Equipment is Environmentally, Dynamically and Seismically Qualified	----
19B.2.-9	A-25: Non-Safety Loads on Class 1E Power Sources	
	Non-Class 1E Loads not Connected to Class 1E Loads Except FMCRD Loads	----
	Class 1E Load Breakers in Division I Between Class 1E Power and Non-Class 1E FMCRD Loads	----

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
19B.2-10	A-31: Residual Heat Removal (RHR) Shutdown Requirements	
	RHR System Composed of 3 Electrically And Mechanically Independent Divisions	----
	Shutdown Cooling Can Be Manually Initiated from the Control Room	----
	RHR System Can Be powered from Both Offsite and Standby Emergency Electrical Power	----
19B.2-11	A-35: Adequacy of Offsite Power Systems	
	Equipment Qualified for Operation with Voltage up to 10% Less than Normal	----
19B.2.12	A-36: Control of Heavy Loads Near Spent Fuel	
	Equipment Handling Components Meet Single Failure Criteria	----
	Redundant Safety Interlocks and Limit Switches Prevent Heavy Loads Over Spent Fuel	----
19B.2.13	A-39: Determination of Safety Relief Valve Pool Dynamic Loads and Temperature Limits	
	Each S/RV Discharge Pipe Fitted with an X-Quencher	----
19B.2-16	A-44: Station Blackout	
	Sources of Electrical Power	
	No. of Standby Turbine Generators	1
	No. of Emergency Diesel Generators	3
19B.2-17	A-47: Safety Implications of Control Systems	
	Feedwater Controller	
	Trip Feedpumps on High Water Level	----
	Fault Tolerant Through Redundant Micro-processors and Self Diagnostics	----
19B.2-18	A-48: Hydrogen Control Measures and Effects of Hydrogen Burns on Safety Equipment	
	Containment Inerted During Normal Operation	----
	Permanently Installed Hydrogen Recombiners	----
19B.2-20	B-17: Criteria for Safety-Related Operator Actions	
	RHR Heat Exchanger in LPCI Injection Loop	----
19B.2-22	B-55: Improved Reliability of Target Rock Safety/Relief Valves	
	ABWR Uses a Direct Acting S/RV Design	----

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
19B.2-23	B-56: Diesel Reliability	
	Independent Diesel Generators	3
	Combustion Turbine Generator	1
19B.2-24	B-61: Allowable ECCS Equipment Outage Periods	
	ECCS Capable of Being Tested During Plant Operation	
	RCIC	----
	HPCF	----
	RHR	----
19B.2-25	B-63: Isolation of Low Pressure Systems Connected to the Reactor Coolant Pressure Boundary	
	Boundary Valves Designed, Fabricated and Tested According to ASME B&PV Code, Section III	
	RHR System	----
	HPCF System	----
	RCIC System	----
	CRD System	----
	SLC System	----
	CUW System	----
	Nuclear Boiler System	----
	Reactor Recirculation System	----
19B.2-26	B-66: Control Room Infiltration Measurements	
	Normal AC Filtration Units	
	Number of Divisions	2
	Mechanically and Electrically Separate	----
	Number of Outdoor Air Intake	2
	Automatic Switch-over to Emergency Units on High Radiation in Air Intake	----
	Emergency Filtration Units	
	Number of Units	2
	Mechanically and Electrically Separate	----
	Provisions to Detection	
	Smoke	----
	Airborne Radioactive Material	----

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Provisions to Remove Smoke and Airborne Radioactive Material	----
19B.2-27	C-1: Assurance of Continuous Long Term Capability of Hermetic Seals on Instrumentation and Electrical Equipment	
	Safety-related Electrical Equipment is Environmentally Qualified in Accordance with NRC Guidance Including NUREG-0588	----
19B.2-28	C-10: Effective Operation of Containment Sprays in a LOCA	
	SGTS	
	Redundant	----
	Filters Gaseous Effluent from Primary and Secondary Containment	----
	No. of RHR Subsystems Which Provide Containment Spray	2
	Sprays Manually Initiated by Operator	----
	Sprays Automatically Terminated When LPFL Injection Valve Open	----
	High Drywell Pressure Interlock On Drywell Spray Operation	----
19B.2-30	15: Radiation Effects on Reactor Vessel Supports	
	Vessel Support Skirt Located Below Core Beltline	----
	Wide Water Flow Region Between Shroud and Vessel Wall	----
19B.2-32	25: Automatic Air Header Dump on BWR Scram System	
	Scram Initiated by Low Pressure in the Common Header Supplying the Charging Water to the Scram Accumulators	----
19B.2-33	40: Safety Concerns Associated with Pipe Breaks in the BWR Scram System	
	Ball-check Valve in the FMCRD Flange Housing at Connection of the Insert Line with the Drive Scram Port	----
19B.2-35	51: Proposed Requirements for Improving the Reliability of Open Cycle Service Water Systems	
	A Closed Cooling Water System Will Be Utilized which Transfers Heat Loads Via Heat Exchanger to Service Water System	----
	The Safety-Related Portions of the RCW and RSW Will Operate as Designed	

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Assuming Loss of All Offsite Power	----
	Assuming Any Single Failure	----
19B.2-36	057: Effects of Fire Protection Systems Actuation on Safety-Related Equipment	
	A Means of Fire Detection is Provided	----
	All Rooms in the Reactor and Control Buildings with a Potential for Flooding Are Supplied With Floor Drains	----
	Safety-Related Equipment Raised Off the Floor	----
	Safety-Related Divisions	
	Number	3
	Mechanically and Electrically Independent	----
19B.2-37	67.3.3: Improved Accident Monitoring	
	Plant Post Accident Monitoring Variables	
	Neutron Flux	----
	Control Rod Position	----
	Boron Concentration	----
	Reactor Coolant System Pressure	----
	Drywell Pressure	----
	Drywell Sump Level	----
	Coolant Level in Reactor	----
	Suppression Pool Water Level	----
	Containment Area Radiation	----
	Primary Containment Pressure	----
	Primary Containment Isolation Valve Position	----
	Coolant Gama	----
	Coolant Radiation	----
	RHR Flow	----
	HPCF Flow	----
	RHR Heat Exchanger Outlet Temp	----
	RCIC Flow	----
	SLC Pressure	----
	SLCS Storage Tank Level	----
	SRV Position	----

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Feedwater Flow	----
	Standby Energy Status	----
	Suppression Pool Water Temp	----
	Drywell Air Temperature	----
	Drywell/Containment Hydrogen Concentration	----
	Drywell/Containment Oxygen Concentration	----
	Primary Containment Air Temp	----
	Secondary Containment Airspace (effluent) Radiation Noble Gas	----
	Containment Effluent Radioactivity - Noble Gas	----
	Condensate Storage Tank Level	----
	Cooling Water Temperature to ESF System Components	----
	Cooling Water Flow to ESF System Components	----
	Emergency Ventilation Damper Position	----
	Service Area Radiation Exposure Rate	----
	Purge Flows - Noble Gases and Vent Flow Rate	----
	Identified Release points - Particulates and Halogens	----
	Airborne Radio Halogens and Particulates	----
19B.2-38	75: Generic Implications of ATWS Events at Salem Nuclear Plant	
	Separate Scram Groups	4
	Solid State Load Drivers Per Scram Group	8
	Contactors for Manual Scram Per Scram Group	2
19B.2-40	83: Control Room Habitability	
	Control Room HVAC Filtration System	----
	Control Room Designed to Withstand Effects of Natural Phenomena	----
	Fire Alarm System Provided	----
	Fire Hoses and Portable Fire Extinquishers Available	----
19B.2-42	87: Failure of HPCI Steam Line Without Isolation	
	Opening and/or Closing of Installed MOVs Used for Isolation of CUW and RCIC Will be Conducted Under Preoperational Differential Pressure, Fluid Flow and Temperature Conditions	----

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Flow Restrictor in CUW Main Suction Line	----
	Bottom Head Drainline Tees into CUW Suction Line at an Elevation Above TAF	----
19B.2-44	103: Design For Probable Maximum Precipitation	
	Design Maximum Rainfall Rate (cm/h)	49.3
	Design Maximum Short Term Rate (cm/5 min)	15.7
19B.2-45	105: Interfacing System LOCA at BWRs	
	Design Pressure of Some Low Pressure Components Upgraded to 2.82 MPaG	
	RHR System	----
	HPCF System	----
	RCIC System	----
	CRD System	----
	SLC System	----
	CUW System	----
19B.2-48	118: Tendon Anchorage Failure	
	Primary Containment Structure is of a Reinforced Concrete Design	----
19B.2-49	120: On-Line Testability of Protection Systems	
	Manual and Automatic Testability of RPS, LDIS and ECCS Initiation Logic During Reactor Operation	----
19B.2-50	121: Hydrogen Control for Large, Dry PWR Containment	
	(Not Applicable to BWRs and Pressure Suppression Containment)	
	Containment Inerted During Normal Operation	----
19B.2-52	128: Electrical Power Reliability	
	Four Separate and Independent Class 1E dc Divisions	
	No Power Supplied to Non-Class 1E Loads	
19B.2-53	142: Leakage Through Electrical Isolators in Instrument Circuits	
	Fiber Optic Isolation Devices Used for Electrical Isolation of Logic Level and Analog Signals	----
19B.2-54	143: Availability of Chilled Water Systems and Room Cooling	

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Safety-Related HECW System Provides Chilled Water to Main Control Room Air Conditioning, DG zone Coolers and Control Building Essential Electrical Equipment	----
	Essential Equipment HVAC System Provides Controlled Temperature Environment for Safety-Related Equipment Under Accident Conditions	----
19B.2-57	153: Loss of Essential Service Water in Light-Water Reactors	
	RSW Divisions	
	Total Number	3
	Physically and Electrically Separate	----
	RCW Heat Exchangers per Division	3
19B.2.59	A-17: Systems Interaction in Nuclear Power Plants	
	Redundant Safety-Related Equipment and Systems Divisionally Separated	----
	Redundant Electrical Power Systems Divisionally Separated	----
	Divisions Designed Against Intra-Divisional Flooding	----
19B.2.60	A-29: Nuclear power Plant Design for the Reduction of Vulnerability to Industrial Sabotage	
	Redundant Safety-Related Equipment and Systems Divisionally Separated	----
	Redundant Electrical Power Systems Divisionally Separated	----
	Controlled Access to Safety-Related Areas	----
19B.2.61.1	C-8 Main Steam Line Leakage Control System	
	Main Steamlines and All Branch Lines are Designed to Withstand SSE	----
	Non-Safety Main Steam and Bypass Lines at the Turbine Designed to Maintain Structural Integrity Following SSE	----
	Condenser Anchorage Designed to Survive SSE	----
19B.2.62	029: Bolting Degradation or Failure in Nuclear Power Plants	
	RCPB Component Fabricated, Tested and Installed in Accordance with ASME Code, Sections III and XI	----
19B.2.63	82: Beyond Design Basis Accidents in Spent Fuel Pools	
	Spent Fuel Pool	
	Seismic Category 1	----

Table 14.3-9 Generic Safety Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Low Water Level Alarm	----
	Over-Flow Weirs to Skimmer	----
	Check Valve in Discharge Line	----

Table 14.3-10 TMI Issues

Tier 2 Entry	Parameter	Tier 2 Value
19A.2.17	I.D.3 Safety System Status Monitoring	
	Automatic Indication of Bypassed and Inoperable Status of Safety Systems	----
19B.2.65	I.D.5(2) Plant Status and Post-Accident Monitoring	
	Post-Accident Information Available to the Operator is in Compliance with RG 1.97	----
19B.2.66	I.D.5(3) On-Line Reactor Surveillance System	
	ABWR Design Incorporates a Reactor Vessel Loose Parts Monitoring System	----
1A.2.5	II.B.1 Reactor Coolant System Vents	
	Steam-Driven RCIC	1
	Power-Operated Relief Valves	
	Number	18
	Dual Position Indication	
	Position Sensors	----
	SRV Discharge Temperature Elements	----
	Remotely Operable from the Control Room	----
1A.2.6	II.B.2 Plant Shielding to Provide Access to Vital Areas and Protect Safety Equipment for Post-Accident Operation	
	Vital Areas as per NUREG-0737 Accessible Post-LOCA	
	Continuous Occupancy	----
	Non-Continuous Occupancy	----
1A.2.7	II.B.3 Post-Accident Sampling	
	Able to Obtain Samples Under Accident Conditions	----
19A.2.21	II.B.8 Rulemaking Proceeding on Degraded Core Accidents	
	Inerted Primary Containment	----
	Permanently-Installed Recombiners	----
1A.2.9	II.D.1 Testing Requirements	
	SRVs Qualified for Steam Discharge	----
	Redundant Logic to Respond to High Water Level Conditions	----
	RHR Shutdown Cooling Systems	
	Number	3
	Separate Vessel Penetration and Suction Lines	----

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
1A.2.10	II.D.3 Relief and Safety Valve Position Indication	
	Dual Position Indication	
	Position Sensors	----
	SRV Discharge Temperature Elements	----
1A.2.13	II.E.4.1 Dedicated Penetrations	
	Recombiners in Secondary Containment	
	Number	2
	Permanently Installed	----
1A.2.14	II.E.4.2 Isolation Dependability	
	Diverse Containment Isolation Signals	----
	Non-Essential Systems	
	Automatically Isolated On Containment Isolation Signal	----
	Redundant Isolation Valves	----
	Resetting Isolation Signal Does Not Automatically Reopen Isolation Valves	----
	Containment Purge and Vent Valves	
	Close on Isolation Signals	----
	Fail Closed	----
	Close on High Radiation	----
19A.2.27	II.E.4.4 Purging	
	Drywell Has Primary Containment Supply/Exhaust System	----
1A.2.15	II.F.1 Additional Accident Monitoring Instrumentation	
	Plant Post Accident Monitoring Variables	
	Neutron Flux	----
	Control Rod Position	----
	Boron Concentration	----
	Reactor Coolant System Pressure	----
	Drywell Pressure	----
	Drywell Sump Level	----
	Coolant Level in Reactor	----
	Suppression Pool Water Level	----
	Containment Area Radiation	----

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Primary Containment Pressure	----
	Primary Containment Isolation Valve Position	----
	Coolant Gama	----
	Coolant Radiation	----
	RHR Flow	----
	HPCF Flow	----
	RHR Heat Exchanger Outlet Temp	----
	RCIC Flow	----
	SLC Pressure	----
	SLCS Storage Tank Level	----
	SRV Position	----
	Feedwater Flow	----
	Standby Energy Status	----
	Suppression Pool Water Temp	----
	Drywell Air Temperature	----
	Drywell/Containment Hydrogen Concentration	----
	Drywell/Containment Oxygen Concentration	----
	Primary Containment Air Temp	----
	Secondary Containment Airspace (effluent) Radiation Noble Gas	----
	Containment Effluent Radioactivity - Noble Gas	----
	Condensate Storage Tank Level	----
	Cooling Water Temperature to ESF System Components	----
	Cooling Water Flow to ESF System Components	----
	Service Area Radiation Exposure Rate	----
	Purge Flows - Noble Gases and Vent Flow Rate	----
	Identified Release points - Particulates and Halogens	----
	Airborne Radio Halogens and Particulates	----
1A.2.16	II.F.2 Identification of and Recovery from Conditions Leading to Inadequate Core Cooling	
	Reactor Wide Range Water Level	
	Number of Divisions	4
	Number of Sensors per Division	2

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Number of Sets of Sensing Lines per Division	1
	Trip Logic per Set of Sensors	2 / 4
	Number of Sets of Sensors	2
1A.2.17	II.F.3 Instrumentation for Monitoring Accident Conditions	----
1A.2.18	II.K.1(5) Safety-Related Valve Position Description	----
1A.2.20	Describe Automatic and Manual Actions for Proper Functioning of Auxiliary Heat Removal Systems when FW System not Operable	
	Reactor Scram on Low Water Level	----
	RCIC System	
	Initiates on Low Water Level	----
	Terminates Injection on High Water Level	----
	Restarts on Low Water Level	----
	RPV Pressure Controlled by	
	Main Turbine Bypass Valves	----
	Safety Relief Valves	----
	Discharge to Suppression Pool	----
	RHR Systems has Manual Pool Cooling Mode	----
	HPCF Systems	
	Initiates on Low Water Level	----
	ADS	
	Initiates on Low Water Level	----
	RHR - LPFL Mode	
	Initiates on Low Water Level	----
1A.2.21	II.K1(23) Describe Uses and Types of RV Level Indication for Automatic and Manual Initiation of Safety Systems	
	Shutdown Water-Level Measurement	
	Range	
	Top of RPV	----
	Bottom of Dryer Skirt	----
	Narrow Water-Level Measurement	
	Range	
	Above Main Steam Outlet Nozzle	----
	Bottom of Dryer Skirt	----

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Low Water Level 3 Automatic Initiation	
	Reactor Scram	----
	RHR Shutdown Cooling Isolation	----
	Containment Isolation	----
	Wide Water-Level Measurement	
	Range	
	Above Main Steam Outlet Nozzle	----
	Top of Active Fuel	----
	Low Water Level 2 Automatic Initiation	
	RCIC	----
	CUW Isolation	----
	Low Water Level 1.5 Automatic Initiation	
	HPCF	----
	MSIV Closure	----
	Drywell Cooling System Isolation	----
	Low Water Level 1 Automatic Initiation	
	ADS	----
	RHR-LPFL	----
	Fuel-Zone Water-Level Measurement Range	
	Above Main Steam Outlet Nozzle	----
	Above RIP Deck	----
1A.2.22	II.K.3(13) Separation of HPCS and RCIC System Initiation Levels	
	RCIC System	
	Initiates on Low Water Level	----
	Terminates Injection on High Water Level	----
	Restarts on Low Water Level	----
	HPCF System	
	Initiates on Low Water Level	----
	Terminates Injection on High Water Level	----
	Restarts on Low Water Level	----
1A.2.23	II.K.3(15) Modify Break Detection Logic to Prevent Spurious Isolation of HPCI and RCIC Systems	

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	RCIC has a Bypass Start System	----
1A.2.24	II.K.3(16) Reduction of Challenges and Failures of Safety Relief Valves - Feasibility Study and System Modification	
	Elimination of Pilot Operated Relief Valves	----
	Redundant Solid State Logic	----
	Pressure Relief Mode Operation is Direct Opening Against Spring Force	----
1A.2.26	II.K.3(18) Modification of ADS Logic-Feasibility Study and Modification for Increased Diversity of Some Event Sequences	
	High Drywell Pressure Bypass Timer (minutes)	8
	Initiates on Low Water Level	----
1A.2.28	II.K.3(22) Automatic Switchover of RCIC System Suction - Verify Procedures and Modify Design	
	RCIC Automatically Switches Pump Suction Source From CSP to Suppression Pool	----
	Switchover Signals	
	Low CSP Water Level	----
	or	
	High Suppression Pool Level	----
1A.2.29	II.K.3(24) Confirm Adequacy of Space Cooling Study for HPCI and RCIC Systems	
	Individual Room Safety Grade Cooling Units	
	RCIC	----
	HPCF	----
	Separate Essential Electrical Power Supples	
	RCIC	----
	HPCF	----
1A.2.30	II.K.3(25) Effect of Loss of AC Power on Pump Seals	
	RCW and RSW Pumps Automatically Loaded to D / Gs Following LOPP	----
19B.2.71	II.K.3(27) Provide Common Reference Level for Vessel Instrumentation	
	For ABWR the Common Reference for the Reactor Vessel Water Level is at the Top of the Active Fuel	----

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
1A.2.31	II.K.3(28) Study and Verify Qualification of Accumulators on ADS Valves	
	Accumulator Sized to Provide One ADS Actuation with Drywell at Design Pressure	----
	Seismic Category I Pneumatic Piping within Primary Containment	----
1A.2.33.3	II.K.3(46) Response to List of Concerns from ACRS Consultant	
	High Pressure Injection ECCS	
	RCIC	1
	HPCF	2
	Automatic Depressurization on Low Vessel Water Level	----
	ECCS Injection Directly into Vessel	
	HPCF	2
	RHR-LPFL	2
	ECCS Injection Into Feedwater Lines	
	RCIC	1
	RHR-LPFL	1
	ECCS Injection Lines Maintained Filled with Water	
	RCIC	----
	HPCF	----
	RHR-LPFL	----
	High Pressure ECCS Designed to Take Suction from Suppression Pool	
	RCIC	----
	HPCF	----
	High Pressure ECCS have a Designed Test Mode which Takes Suction from and Discharges to the Suppression Pool	
	RCIC	----
	HPCF	----
	High Pressure ECCS have a Designed Low Flow Bypass Mode which Discharges to the Suppression Pool	
	RCIC	----
	HPCF	----

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	RCIC and HPCF Do not Share Any Common Suction Piping with RHR	
	RCIC	----
	HPCF	----
	ECCS Have Minimum Flow Protection for All Operating Modes	
	RCIC	----
	HPCF	----
	RHR	----
	Number of RCW Divisions	3
	Individual ECCS Pumps Can be Isolated Without Affecting Other ECCS Pumps	
	RCIC	----
	HPCF	----
	RHR	----
	ABWR has Water Level Measurement Directly on the Vessel	----
	Containment Sprays are Manually Initiated	----
	Essential Equipment Inside the Containment is Qualified for Harsh Environment	----
	ADS Automatically Depressurizes the Vessel on Low Water Level	----
	ABWR has Manual Vessel Depressurization Capability	----
1A.2.34	III.D.1.1(1) Review Information Submitted by Licensee Pertaining to Reducing Leakage from Operating Systems	
	Inboard and Outboard Isolation Valves on All Lines Which Penetrate Primary Containment	----
	ABWR has a Leak Detection and Isolation System	----
	MSIV Closure on:	
	High Temperature in Steam Tunnel	----
	High Temperature in Turbine Building	----
	High Radiation in HVAC Air Exhaust Results In:	
	Closure of HVAC Air Ducts to Reactor Building	----
	Closure of Containment Purge and Vent Lines	----

Table 14.3-10 TMI Issues (Continued)

Tier 2 Entry	Parameter	Tier 2 Value
	Activation of Standby Gas Treatment System	----
1A.2.36	III.D.3.4 Control Room Habitability	
	HVAC System	
	Redundant Safety Grade Systems with Outdoor Air Intakes	----
	Able to Maintain 3.2 mm WG Positive Pressure in Habitable Control Room	----
	Radiation and Smoke Sensors in Intake Lines to Isolate Outdoor Air Intake	----
	Habitable Control Room Shielding	
	Min. Thickness of Concrete Between Habitable Control Room Area and Steam Lines (meters)	1.6
	Control Room Constructed Below Grade Level	----

Table 14.3-11 Example of Tier 1 ITAAC Entry: Standby Liquid Control (SLC) System

	Inspections, Tests, Analyses and Acceptance Criteria	
Design Commitment	**Inspections, Tests, Analysis**	**Acceptance Criteria**
1. The Basic configuration of the SLC System is shown in Figure 2.2.4.	1. Inspections of the as-built system will be conducted.	1. The as-built SLC System conforms with the basic configuration shown in Figure 2.2.4.
2. The ASME Code components of the SLC System retain their pressure boundary integrity under internal pressures that will be experienced during service.	2. A hydrostatic Test will be conducted on those Code components of the SLC System that are required to be hydrostatically tested by the ASME Code.	2. The results of the hydrostatic test of the ASME Code components of the SLC System conform with the requirements in the ASME Code, Section III.
3.	3.	3.
a. A test tank and associated piping and valves permit testing of the SLC System during plant operation. The tank is supplied with demineralized water, which is pumped in either a closed loop or is injected into the reactor.	a. Tests will be conducted on each division of the as-built SLC System using installed controls, power supplies and other auxiliaries. The following tests will be conducted: (1) Demineralized water will be pumped against a pressure greater than or equal to 8.72 MPaA in a closed loop on the test tank. (2) Demineralized water will be injected from the test tank into the reactor.	a. (1) Demineralized water is pumped with a flow rate greater than or equal to 189 L/min in the closed loop. (2) Demineralized water is injected from the test tanks into the reactor.
b. The SLC System delivers at least 378 l/min of solution with both pumps operating when the reactor pressure is less than or equal to 8.72 MPaA.	b. Tests will be conducted on the as-built SLC System using installed controls, power supplies and other auxiliaries. Demineralized water will be injected from the storage tank into the reactor with both pumps running against a discharge pressure of greater than of equal to 8.72 MPaA.	b. The SLC System injects greater than or equal to 378 L/min into the reactor with both pumps running against a discharge pressure of greater than or equal to 8.72 MPaA.

Table 14.3-12 Interface Requirements for the Ultimate Heat Sink

1.	Provide cooling water to the RSW System for normal plant operation and to permit safe shutdown and cooldown of the plant and maintain the plant in a safe shutdown condition for design basis events.
2.	Makeup water for the UHS shall not be required for at least 30 days following a design basis accident.
3.	Any active safety-related systems, structures, or components within the UHS shall have three divisions powered by their respective Class 1E divisions. Each division shall be physically separated and electrically independent of the other divisions.
4.	UHS System Divisions A and B components shall have control interfaces with the Remote Shutdown System (RSS) as required to support UHS operation during RSS design basis conditions.
5.	Be classified as Seismic Category I.