APR1400 DESIGN CONTROL DOCUMENT TIER 2

CHAPTER 14 VERIFICATION PROGRAMS

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ACRONYM AND ABBREVIATION LIST

AAC	alternate alternating current
AAFAS	alternate auxiliary feedwater actuation signal
AB	auxiliary building
AC	alternating current
ACI	American Concrete Institute
ACU	air cleaning unit
ADV	atmospheric dump valve
AEA	Atomic Energy Act
AFAS	auxiliary feedwater actuation signal
AFW	auxiliary feedwater
AFWS	auxiliary feedwater system
AFWST	auxiliary feedwater storage tank
AHU	air handling unit
ALARA	as low as is reasonably achievable
ALMS	acoustic leak monitoring system
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOO	anticipated operational occurrence
AOP	abnormal operating procedure
AOV	air-operated valve
APR	Advanced Power Reactor
ARO	all rods out
ASI	axial shape index
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
BAC	boric acid concentrator
BAST	boric acid storage tank
BABT	boric acid batching tank
BAMP	boric acid makeup pump

BOP	balance of plant
BPPCC	boundary point power correlation coefficient
ВТР	Branch Technical Position
САР	chemical addition pump
САТ	chemical addition tank
CCF	common cause failure
CCS	component control system
CCW	component cooling water
CCWLLSTAS	component cooling water low-low surge tank actuation signal
CCWS	component cooling water system
CEA	control element assembly
CEDM	control element drive mechanism
CEDMCS	control element drive mechanism control system
CFR	Code of Federal Regulations
CFS	cavity flooding system
CHCS	containment hydrogen control system
CHRS	containment hydrogen recombiner system
CIAS	containment isolation actuation signal
COL	combined license
COLA	combined license application
COLSS	core operating limit supervisory system
СРС	core protection calculator
CPCS	core protection calculator system
CPIAS	containment purge isolation actuation signal
CRE	control room envelope
CREVAS	control room emergency ventilation actuation signal
CS	containment spray
CSAS	containment spray actuation signal
CSS	containment spray system
CVAP	comprehensive vibration assessment program
CVCS	chemical and volume control system

CW	circulating water
CWS	circulating water system
DAC	design acceptance criteria
DBA	design basis accident
DCD	Design Control Document
DIS	diverse indication system
DMA	diverse manual actuation
DNB	departure from nucleate boiling
DNBR	departure from nucleate boiling ratio
DPS	diverse protection system
DRCS	digital rod control system
DVI	direct vessel injection
EAB	exclusion area boundary
ECSBS	emergency containment spray backup system
ECWS	essential chilled water system
EWS	engineering workstation
EDG	emergency diesel generator
EDT	equipment drain tank
EHC	electro-hydraulic control
EOF	emergency operation facility
ESF	engineered safety features
ESFAS	engineered safety features actuation system
ESF-CCS	engineered safety features – component control system
ESW	essential service water
ESWS	essential service water system
ETS	emergency trip system
FHEVAS	fuel handling area emergency ventilation actuation signal
FIDAS	fixed in-core detector amplifier system
FP	fire protection
FPDIL	full power dependent insertion limit
FPS	fire protection system

FSCEA	full-strength CEA
FWCS	feedwater control system
GCB	generator circuit breaker
GDC	general design criteria (of 10 CFR Part 50, Appendix A)
GRS	gaseous radwaste subsystem
GSERMS	gas stripper effluent radiation monitor subsystem
GTG	gas turbine generator
GWMS	gaseous waste management system
HEPA	high efficiency particulate air
HFE	human factors engineering
HFT	hot functional test
HHAS	high humidity actuation signal
HI	hydrogen igniter
HMS	hydrogen mitigation system
HRAS	high radiation actuation signal
HVAC	heating, ventilation, and air conditioning
HVT	holdup volume tank
НХ	heat exchanger
I&C	instrumentation and control
IEEE	Institute of Electrical and Electronics Engineers
IFPD	information flat panel display
IPS	information processing system
IRWST	in-containment refueling water storage tank
ITAAC	inspections, tests, analyses, and acceptance criteria
ITC	isothermal temperature coefficient
ITP	initial test program
ITP	interface and test processor
IVMS	internal vibration monitoring system
LBB	leak before break
LC	load center
LEL	lower electrical limit

LHR	linear heat rate
LOCA	loss of coolant accident
LOOP	loss of offsite power
LPD	local power density
LPMS	loose parts monitoring system
LPZ	low population zone
LTOP	low temperature overpressure protection
LWMS	liquid waste management system
LWR	light water reactor
MCC	motor control center
MCR	main control room
MFIV	main feedwater isolation valve
MG	motor-generator
MG Set	motor-generator set
MLV	mechanical lockout solenoid valve
MOV	motor-operated valve
MSADV	main steam atmospheric dump valve
MSH	makeup supply header
MSIS	main steam isolation signal
MSIV	main steam isolation valve
MSR	moisture separator reheater
MSS	main steam system
MSSV	main steam safety valve
MT	main transformer
MTC	moderator temperature coefficient
МТР	maintenance and test panel
MTV	mechanical trip valve
NAPS	nuclear application programs server
NEI	Nuclear Energy Institute
NIMS	nuclear steam supply system integrity monitoring system
NPSH	net positive suction head

NRC	United States Nuclear Regulatory Commission
NSSS	nuclear steam supply system
NUREG	NRC technical report designation
ОМ	operation monitor
OSC	operational support center
PAR	passive autocatalytic recombiner
PAT	power ascension test
РСВ	power circuit breaker
PDIL	power dependent insertion limit
PERMSS	process and effluent radiation monitoring and sampling system
PHIX	pre-holdup ion-exchanger
PLCS	pressurizer level control system
POSRV	pilot operated safety relief valve
PPCS	pressurizer pressure control system
PPS	plant protection system
PRA	probabilistic risk assessment
PRMS	Process radiation monitoring subsystem
QIAS	qualified indication and alarm system
RAP	reliability assurance program
RCP	reactor coolant pump
RCPVMS	reactor coolant pump vibration monitoring system
RCS	reactor coolant system
RDP	reactor drain pump
RDT	reactor drain tank
RMW	reactor makeup water
RMWP	reactor makeup water pump
RMWT	reactor makeup water tank
RPF	radial peaking factor
RPS	reactor protection system
RRS	required response spectra
RSC	remote shutdown console

RSF	rod shadowing factor
RSR	remote shutdown room
RTD	resistance temperature detector
RTP	rated thermal power
RTSS	reactor trip switchgear system
RV	reactor vessel
SAM	shape annealing matrix
SAT	standby auxiliary transformer
SBCS	steam bypass control system
SBO	station blackout
SC	shutdown cooling
SCP	shutdown cooling pump
SCS	shutdown cooling system
SDCHX	shutdown cooling heat exchanger
SFPCCS	spent fuel pool cooling and cleanup system
SG	steam generator
SGBS	steam generator blowdown system
SI	safety injection
SIAS	safety injection actuation signal
SIS	safety injection system
SIT	1) safety injection tank
	2) structural integrity test
SKN	Shin-Kori nuclear power plant
SOE	sequence of event
SRO	senior reactor operator
SRP	Standard Review Plan
SSC	structures, systems, and components
SSE	safe shutdown earthquake
SWGR	switchgear
SWMS	solid waste management system
TBV	turbine bypass valve

TCS	turbine control system
T/G	turbine-generator
TGBCCW	turbine generator building closed cooling water
TGBOCWS	turbine generator building open cooling water system
TLI	turbine load index
TMI	Three Mile Island
TSC	technical support center
TSF	temperature shadowing factor
TSP	tri-sodium phosphate
UHS	ultimate heat sink
VCT	volume control tank
UAT	unit auxiliary transformer
V&V	verification and validation

CHAPTER 14 – VERIFICATION PROGRAMS

14.1 Specific Information to Be Addressed for the Initial Plant Test Program

The initial plant test program of the APR1400 addresses the major testing phases and satisfies the relevant requirements of these regulations:

- a. 10 CFR 30.53(c) (Reference 1) as it relates to testing radiation detection equipment and monitoring instruments
- b. 10 CFR 50.34(b)(6)(iii) (Reference 2) as it relates to information associated with preoperational testing and initial operations
- c. 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1 (Reference 3) as it relates to testing important to safety SSCs that are within the scope of the Quality Assurance Program (QAP) and the Initial Test Program (ITP)
- d. 10 CFR Part 50, Appendix B, Section XI, (Reference 4) as it relates to test programs demonstrating that structures, systems, and components (SSCs) perform satisfactorily
- e. 10 CFR Part 50, Appendix J, Section III.A.4, (Reference 5) as it relates to the preoperational leakage rate testing of the reactor primary containment and related systems and components penetrating the primary containment pressure boundary
- f. 10 CFR 52.79(a)(28) (Reference 6) as it relates to preoperational testing and initial operations
- g. 10 CFR Part 52, Subpart A, Subpart B, and Subpart C (Reference 7), as they relate to the inspections, tests, analyses, and acceptance criteria (ITAAC)

The following 12 areas associated with the initial plant test program are addressed in Section 14.2:

- a. Summary of test program and objectives
- b. Organization and staffing
- c. Test procedures

- d. Conduct of the test program
- e. Review, evaluation, and approval of test results
- f. Test records
- g. Test program conformance with Regulatory Guides
- h. Utilization of reactor operating and testing experience in the development of the test program
- i. Trial use of plant operating and emergency procedures
- j. Initial fuel loading and initial criticality
- k. Test program schedule and sequence
- 1. Individual test descriptions
- 14.1.1 <u>Combined License Information</u>

No COL information is required with regard to Section 14.1.

- 14.1.2 <u>References</u>
- 1. 10 CFR 30.53, "Tests," U.S. Nuclear Regulatory Commission.
- 2. 10 CFR 50.34, "Contents of Applications; Technical Information," U.S. Nuclear Regulatory Commission.
- 3. 10 CFR Part 50, Appendix A General Design Criteria (GDC) 1, "General Requirements," U. S. Nuclear Regulatory Commission.
- 4. 10 CFR Part 50, Appendix B, Criterion XI, "Test Control," U.S. Nuclear Regulatory Commission.
- 5. 10 CFR Part 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors," U.S. Nuclear Regulatory Commission.
- 6. 10 CFR 52.79, "Contents of applications; technical information in final safety analysis report," U.S. Nuclear Regulatory Commission.

 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," U.S. Nuclear Regulatory Commission.

14.2 <u>Initial Plant Test Program</u>

14.2.1 <u>Summary of Test Program and Objectives</u>

The purpose of this section is to describe the initial test program (ITP) that is performed during initial startup of the APR1400 plant.

The ITP includes testing activities commencing with the completion of construction and installation and ending with the completion of power ascension testing. The results of the testing demonstrate that components and systems operate in accordance with design requirements and meet the requirements of 10 CFR Part 50, Appendix B, Criterion XI (Reference 1). The results confirm that performance levels meet operational safety requirements and verify the adequacy of component and system design and system operability over their operating ranges. The program also aids in establishing baseline performance data and serves to verify that normal operating and emergency procedures accomplish their intended purposes. The ITP consists of operational tests and initial startup tests as the following four phases:

- a. Phase I: Preoperational testing
- b. Phase II: Fuel loading and post-core hot functional testing
- c. Phase III: Initial criticality and low-power physics testing
- d. Phase IV: Power ascension testing

The scope of the testing program includes SSCs that meet one or more of the following criteria:

- a. SSCs used for shutdown and cool down of the reactor under normal plant conditions and for maintaining the reactor in a safe condition for an extended shutdown period
- b. SSCs used for shutdown and cool down of the reactor under transient (infrequent or moderately frequent events) conditions and postulated accident conditions and for maintaining the reactor in a safe condition for an extended shutdown period following such conditions,

- c. SSCs used to establish conformance with safety limits or limiting conditions for operation that are included in the Technical Specifications,
- d. SSCs classified as engineered safety features or relied on to support or ensure the operation of engineered safety features within design limits,
- e. SSCs that function during a design basis event and are credited in the Chapter 15 accident analysis,
- f. SSCs that are used to process, store, control, or limit the release of radioactive materials,
- g. SSCs that are relied upon to maintain their structural integrity during normal operation, anticipated transients,

simulated test parameters, and design-basis event conditions to avoid damage to safety-related SSCs.

The capability of manual controls to control safety-related equipment and shutdown the reactor in the main control room is verified in the ITP for each component and system in Subsection 14.2.12.

14.2.1.1 <u>Phase I – Preoperational Testing</u>

Phase I of the startup test program consists of two parts.

In Part I, preoperational testing is conducted to demonstrate that structures, systems, and components (SSCs) operate in accordance with design operating modes throughout the full design operating range. Where required, simulated signals or inputs are used to demonstrate the full range of the systems that are used during normal operation. Systems that are not used during normal plant operation but must be in a state of readiness to perform safety functions are checked under various modes and test conditions prior to fuel loading.

Whenever practicable, the tests are performed under the conditions expected when the systems are required to function. When the conditions cannot be attained or appropriately simulated at during the test, the system is tested to the extent practicable under the given conditions with additional testing when appropriate conditions can be attained.

Preoperational testing provides reasonable assurance that systems and equipment perform in accordance with the safety analysis report. Test results are analyzed to verify that systems and components are performing satisfactorily and if not, to provide a basis for recommended corrective action.

In Part II, integrated system tests are conducted on completion of the preoperational testing. The integrated system tests, typically referred to as pre-core hot functional test (HFT), are performed to verify proper systems operation prior to fuel loading.

The preoperational tests are listed in Table 14.2-1 and described in Subsection 14.2.12.1. A list of pre-core hot functional tests is also provided in Table 14.2-1. All inspections, tests, analyses, and acceptance criteria (ITAAC) items should be satisfied during this phase before the initial fuel loading.

14.2.1.2 Phase II – Fuel Loading and Post-Core Hot Functional Testing

Initial fuel loading starts after completion of the preoperational testing. Phase II testing of the ITP provides a systematic process for safely accomplishing and verifying the initial fuel loadings. Fuel loading is described in Subsection 14.2.10.1.

The post-core hot functional tests are performed following the completion of initial fuel loading operations and prior to initial criticality. The objectives of these tests are to provide additional assurance that plant systems necessary for normal plant operation function as expected and to obtain performance data on core-related systems and components. Normal plant operating procedures, to the extent practicable, are used to bring the plant from cold shutdown conditions through hot shutdown to hot zero-power (HZP) conditions. Testing normally proceeds directly to initial criticality and the beginning of low-power physics testing. A list of post-core hot functional tests is provided in Table 14.2-2, and a description of each test is provided in Subsection 14.2.12.2.

14.2.1.3 Phase III – Initial Criticality and Low-Power Physics Testing

The initial criticality phase of the startup test program provides reasonable assurance that initial criticality is achieved in a safe and controlled manner. The procedures that are followed to achieve initial criticality are described in Subsection 14.2.10.2.

After initial criticality has been achieved, a series of low-power physics tests is conducted to verify selected core design parameters. These tests serve to substantiate that the Safety

Analysis and Technical Specifications assumptions and limits have been met. They also demonstrate that core characteristics are within the expected limits and provide data for benchmarking the design methodology used for predicting the core characteristics later in the life of the plant. A list of the low-power physics tests is provided in Table 14.2-3, and a description of each test is provided in Subsection 14.2.12.3.

14.2.1.4 Phase IV – Power Ascension Testing

A series of power ascension tests (PATs) is conducted to bring the reactor to full power. A list of the PATs is provided in Table 14.2-4, and a description of each test is provided in Subsection 14.2.12.4. Each test is performed at different reactor power plateaus of approximately 20, 50, 80, and 100 percent as shown in Table 14.2-5. The purpose of these tests is to demonstrate that the facility operates in accordance with its design during steady-state conditions and, to the extent practicable, during anticipated transients.

14.2.2 <u>Organization and Staffing</u>

The specific staff, staff responsibilities, authorities, and personnel qualifications for performing the APR1400 initial test program are the responsibility of the combined license (COL) applicant. This test organization is responsible for the planning, executing, and documentation of the plant initial testing and related activities that occur between the completion of plant, system, and component construction and commencement of plant commercial operation. Transfer and retention of experience and knowledge gained during initial testing for the subsequent commercial operation of the plant is an objective of the test program.

The COL applicant is to develop the site-specific organization and staffing level appropriate for its facility to implement the initial test program. The COL's plant operating and plant technical staff should participate, to the extent practical, in developing and conducting the Initial Test Program and evaluating the test results (COL 14.2(1)).

14.2.3 <u>Test Procedures</u>

The plant operator provides reasonable assurance of the preparation and designates the approval process for Phases I through IV test procedures. Detailed procedure guidelines and procedures provided by the appropriate design organization are used to develop various system test procedures. Thus, test procedures are based on requirements of system designers and applicable NRC Regulatory Guides (RGs).

The COL applicant is to prepare the site-specific preoperational and startup test specifications and test procedures and/or guidelines that is to be used for the conduct of the plant startup program plant initial test program. The preoperational and startup test procedures should have controls in place to ensure that test procedures include appropriate prerequisites, objectives, safety precautions, initial test conditions, methods to direct and control test performance and test acceptance criteria by which the test is evaluated. Testing performed at other than design operating conditions for systems is to be reconciled either through the test acceptance criteria or post-test data analysis. These procedures are to be submitted at least 60 days prior to their intended use to the NRC staff for review as described in Subsection 14.2.11 (COL 14.2(2)).

The COL applicant is to prepare a startup administrative manual (SAM) which contains administrative controls that govern the conduct of each major phase of the ITP. This description should include the administrative controls used to ensure that necessary prerequisites are satisfied for each major phase and for individual tests. The COL applicant should also describe the methods to be followed in initiating plant modifications or maintenance tasks that are deemed to be necessary to conduct the ITP. This description should include methods used to ensure retesting following such modifications or maintenance. In addition, the description should discuss the involvement of design organizations with the COL applicant in reviewing and approving proposed plant modifications. The COL applicant should also describe in the SAM adherence to approved test procedures during the conduct of the ITP as well as the methods for effecting changes to approved test procedures (COL 14.2(3)).

The COL applicant is to develop the test procedure including a listing of the high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program (COL 14.2(4)).

The COL applicant is to develop the test procedure including a listing of the different flow modes to which the systems will be subjected during the vibration, thermal expansion, and dynamic effects testing program to confirm that the piping systems, restraints, components, and supports have been adequately designed to withstand flow-induced dynamic loadings under the steady-state and operational transient conditions anticipated during service (COL 14.2(5)).

The COL applicant is to develop the test procedure including a description of the thermal motion monitoring program for verification of snubber movement, adequate clearances and

gaps, the acceptance criteria, and the method regarding how motion will be measured (COL 14.2(6)).

14.2.3.1 <u>Test Procedure Preparation</u>

Detailed test procedures for Phase I through IV tests are prepared by the site operator. Each test procedure is prepared using pertinent reference material provided by the appropriate design and vendor organizations, the Final Safety Analysis Report, the Technical Specifications, and the applicable NRC Regulatory Guides (RGs). A test procedure is prepared for each system test to be performed during the four phases of the test program. Each system test procedure contains (at a minimum) the following major topic areas:

- a. Test objectives
- b. Acceptance criteria
- c. References
- d. Prerequisites
- e. Precautions and notes
- f. Test equipment
- g. Initial conditions
- h. Detailed procedure (including data collection)
- i. Restoration
- j. Attachments

Test procedures are reviewed as specified by the site-specific administrative control procedures. At the completion of these reviews, any required changes are incorporated into each test procedure by the originating organization.

14.2.3.2 Special Test Procedures

Special test procedures may become necessary during the Phase I through IV test program for investigative purposes. The preparation, review, and approval of these special procedures are governed by site-specific administrative control procedures. Special test procedures that deal with nuclear safety are processed under the same controls as normal startup test procedures.

14.2.4 <u>Conduct of Test Program</u>

The COL applicant is to plan and subsequently execute the plant startup program approved for the site-specific facility.

When a Phases I through IV system test procedure has been released for performance, a startup manager is assigned responsibility for:

- a. Satisfactorily completing prerequisites and noting any allowable exceptions in accordance with administrative procedures
- b. Verifying that the testing is performed as required by the procedure

The test is then performed by operating personnel or others in accordance with the approved test procedure.

The operations shift supervisor is responsible for the safe operation of the plant during testing and may stop any system test in progress and place the plant in a safe condition.

Required data resulting from the test are compiled within the test procedure in specified data blanks, on specially prepared data sheets, or as otherwise specified by administrative control procedures. Personnel completing data forms or checklists sign and date the forms. Upon test completion, the test data are compared with the test acceptance criteria, and any discrepancies noted are resolved in accordance with applicable administrative procedures.

After a procedure has been approved, the procedure is changed in accordance with the provisions of the administrative procedures.

14.2.5 <u>Review, Evaluation, and Approval of Test Results</u>

The COL applicant is to review and evaluate individual test results in a test report made available to NRC personnel after preoperational and startup tests are completed. The specific test acceptance criteria for determining success or failure of a test shall be included in the test report approval of the test results. The test report should also include test results associated with any license conditions in the plant specific Initial Test Program (COL 14.2(7)).

The COL applicant is responsible for establishing hold points at selected milestones throughout the power ascension test phase to ensure that designated personnel or groups evaluate and approve relevant test results before proceeding to the next power ascension test phase. At a minimum, the COL applicant should establish hold points at approximately 25-percent, 50-percent, and 75-percent power-level test conditions for pressurized-water reactors (COL 14.2(8)).

Individual test results are reviewed and approved as provided in the site-specific administrative procedures. Completed procedures and test reports are reviewed for acceptance. The specific acceptance criteria for determining the success or failure of the test are included as part of the procedure and are used during the review. Test deficiencies or results that do not meet acceptance criteria are identified to the affected and responsible design organizations, and corrective actions and retests, as required, are performed.

Test results for each phase of the test program are reviewed and verified as complete (as required) and satisfactory before testing in the next phase is started. Preoperational testing on a system is not normally started until all applicable prerequisite tests have been completed, reviewed, and approved. Prior to initial fuel loading and the commencement of initial criticality, a comprehensive review of required completed preoperational procedures is to be conducted by the COL applicant startup test organization. This review is to provide reasonable assurance that the required plant systems and structures are capable of supporting the initial fuel loading and subsequent startup testing.

14.2.6 <u>Test Records</u>

The COL applicant is responsible for retaining preoperational and startup test procedures and test results as part of the plant's historical records in accordance with 10 CFR 50.36, "Technical Specification," 10 CFR 50.71, "Maintenance of Records, Making of Reports,"

10 CFR 50, Appendix B, Criterion XVII, "Test Records," and RG 1.28, "Quality Assurance Program Criteria (Design and Construction)." (COL 14.2(9))

The preoperational and startup testing procedures and test results are to be retained for the life of the plant by the COL applicant (COL 14.2(9)). The startup Test reports should include test results associated with license conditions in the plant specific ITP.

A summary of the startup testing is to be included in a startup report. This summary should include the following information;

- a. A description of the method and objectives for each test
- b. A comparison of applicable test data with the related acceptance criteria, including the system's responses to major plant transients (such as reactor trip and turbine trip)
- c. Design-and construction-related deficiencies discovered during testing, system modifications and corrective actions required to correct those deficiencies, and the schedule for implementing these modifications and corrective actions
- d. Justification for acceptance of systems or components that are not in conformance with design predictions or performance requirements
- e. Conclusions about system or component adequacy

14.2.7 <u>Conformance of Test Programs with NRC Regulatory Guides</u>

Subsection 1.9.1 and Table 1.9-1 address the conformance of test programs with the applicable NRC RGs. Table 14.2-7 is a matrix of the applicable guidance in NRC RG 1.68 (Reference 3) Appendix A (Initial Test Program) and the test descriptions listed in Subsection 14.2.12 to conform the key test parameters systematically.

The intent of the NRC RGs listed below is followed with the noted differences.

14.2.7.1 NRC Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Reactor Power Plants"

The following exceptions and/or clarifications address only the significant differences between the proposed test program and the applicable Regulatory Position. Minor

terminology differences, testing not applicable to the plant design, and testing that is part of required surveillance tests are not addressed. The applicable portions of NRC RG 1.68 (Reference 3) are referenced.

14.2.7.1.1 Reference Appendix A, Section 1.h. 5

Cold water interlocks are not applicable to the APR1400 design. This testing is not performed because it is not applicable.

14.2.7.1.2 Reference Appendix A, Section 1.i. 21

A containment penetration cooling system is not a design requirement for the APR1400. This testing is not performed because it is not applicable.

14.2.7.1.3 <u>Reference Appendix A, Section 1.k. 2</u>

Personnel monitors and radiation survey instruments are site-specific items that are addressed by the site operator. The site operator defines the appropriate testing to demonstrate proper operation of personnel monitors and radiation survey instruments.

14.2.7.1.4 <u>Reference Appendix A, Section 1.0.14.g</u>

A shield cooling system is not a design requirement for the APR1400. This testing is not performed because it is not applicable.

14.2.7.1.5 Reference Appendix A, Section 4.i

Demonstration of the operability of control rod withdrawal and insertion sequences and control rod inhibit or block functions is performed during precritical functional testing. The reactor power level range during which such features must be operable is modeled using simulated signals, as required.

14.2.7.1.6 <u>Reference Appendix A, Section 4.s</u>

Reactor internal vibration test is excluded from the comprehensive vibration assessment program described in Subsection 3.9.2.4 because the APR1400 is classified as a non-prototype category I plant according to NRC RG 1.20 (Reference 9).

14.2.7.1.7 <u>Reference Appendix A, Section 5.a</u>

Power reactivity coefficients are measured at 20, 50, 80, and 100 percent power levels. Testing can be reduced to only the 50 and 100 percent power levels if measurements of temperature reactivity coefficients at essentially zero reactor power are within the acceptance criteria established for non-first-of-a-kind plants.

14.2.7.1.8 Reference Appendix A, Section 5.i

Since the plant protection system (CPCs and CEACs) detects the CEA positions by means of two independent sets of reed switches and uses this information in determining margin to trip, it is not necessary to rely on in-core or ex-core nuclear instrumentation to detect control element misalignment or drop. Thus, this testing is not performed.

14.2.7.1.9 Reference Appendix A, Section 5.kk

This section requires that the dynamic response of the plant to the most severe reduction in feedwater temperature be demonstrated from 50 to 90 percent power. The reduction in feedwater temperature results in only minor changes to RCS temperature and pressure, and reactor power. In addition, the performance of this test would result in unnecessary thermal cycling of the steam generator economizer valves. Performance of the load rejection test and turbine trip test from full power provides sufficient information to verify design adequacy. Therefore, the plant response to reduction in feedwater temperatures is not demonstrated.

14.2.7.1.10 Reference Appendix A, Section 5.mm

This section requires that the dynamic response of the plant to automatic closure of all main steam isolation valves (MSIVs) be demonstrated from full power. Performance of this test could result in the opening of main steam atmospheric dump valves at automatic control mode and primary and secondary safety valves. Instead, the dynamic response of the plant can be obtained during the performance of the turbine trip test when the turbine stop valves are closed. The turbine trip test from full power results in essentially similar dynamic plant response and should provide reasonable assurance that primary and secondary safety valves do not lift open during the test. For these reasons, the plant response to automatic closure of all MSIVs from full power is not demonstrated.

14.2.7.1.11 Reference Appendix C, Section 3

This section requires that a neutron count rate of at least 0.5 count per second be registered on the startup channels before the startup begins. The design criterion calls for a neutron count rate of 0.5 count per second with all CEAs fully withdrawn and a multiplication of 0.98. Therefore, prior to the initiation of the initial approach to criticality, the startup channels may record significantly less than 0.5 count per second, but prior to exceeding a multiplication of 0.98, the desired neutron count rate of 0.5 count per second is achieved.

14.2.7.1.12 Reference Appendix C, Section 4

The standard test plateau power levels of 20, 50, 80, and 100 percent are used instead of the recommended power levels of 25, 50, 75, and 100 percent.

14.2.7.1.13 <u>Reference Section C, Regulatory Position 4</u>

This section requires inclusion of acceptance criteria that account for uncertainties. The test summaries in Subsections 14.2.12.2.2 and 14.2.12.1.46 are essential to the demonstration of conformance to the requirements for structures, components, and features important to safety.

14.2.7.2 NRC Regulatory Guide 1.68.3, "Preoperational Testing of Instrument and Control Air Systems"

The APR 1400 will comply with NRC RG 1.68.3 except for C.7, C.8 and C.9 In regard of Regulatory Position C.7 and C.8 of RG 1.68.3, individual safety-related components served by instrument air that must fail to a safe position will be tested within the testing requirements for the individual safety-related systems.

The service air backup supply line is connected to a cross-connect line between the air receiver and the filtering unit for instrument air system, and the backup air flows to a set of dryers and a filtering unit and results in the same quality air. Also, an isolation valve and check valves are provided on the cross-connect line to permit isolation of the systems. Ingress of lower-quality air is therefore not possible. Consequently, Regulatory Position C.9 of NRC RG 1.68.3 does not apply.

14.2.7.3 NRC Regulatory Guide 1.79, "Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors"

The intent of NRC RG 1.79 (Reference 6), Section C.1.c(2) is satisfied by opening the valves under maximum differential pressure (RCS at ambient pressure) using normal electrical power only. Conditions at the valve motor are independent of the power source for this test. The breaker response and the response of the valves to the "confirmatory open" signal are verified during the integrated safety injection actuation system test.

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

The COL applicant has the benefit of experience acquired with the successful and safe startup of the reference plant, SKN #3, APR1400 PWR plant. The reactor operating and testing experience gained from the reference plant and other reactor types is factored into the design and test system information of plant equipment and systems that are demonstrated during the preoperational and startup test programs.

The COL applicant is to describe its program for reviewing available information on reactor operating and testing experiences and discusses how it used this information in developing the initial test program. The description is to include the sources and types of information reviewed, the conclusions or findings, and the effect of the review on the initial test program (COL 14.2(10)).

14.2.8.1 <u>First-of-a-Kind Test</u>

First-of-a-kind (FOAK) tests are defined as new, unique, or special tests for new design features in plants. The functional testing requirements necessary to verify FOAK test performance should be identified if these design features are used in the APR1400 in the United States. These tests are performed only for the first plant.

Palo Verde Nuclear Generation Station (PVNG) Unit 1 is considered the prototype FOAK plant for the APR1400 design. In accordance with the guidance in RG 1.20, the APR1400 is classified as a non-protype category I plant. PVNG Unit 1 is the valid prototype plant for the APR1400 for the vibration monitoring system tests and the natural circulation test. The APR1400 does not have any First of a Kind Tests.

14.2.9 Trial Use of Plant Operating and Emergency Procedures

The COL applicant is to provide a schedule for the development of plant procedures, as well as a description of how, and to what extent, the plant operating, emergency, and surveillance procedures are use-tested during the initial test program (COL 14.2(11)).

The use of these procedures is intended:

- a. To demonstrate the adequacy of the specific procedure or to identify changes that may be required
- b. To increase the level of knowledge of plant personnel on the systems being tested

A test procedure using a normal, abnormal, or emergency operating procedure references the procedure directly or extracts a series of steps from the procedure in the way that accomplishes the operator training goals while safely and efficiently performing the specified testing.

A COL applicant that references the APR1400 design certification is to identify the operator training to be conducted as part of the low-power testing program related to the resolution of TMI Action Plan Item I.G.1, as described in (1) NUREG-0660 – NRC Action Plans Developed as a Result of the TMI-2 Accident, Revision 1, August 1980 and (2) NUREG-0737 – Clarification of TMI Action Plan Requirements (COL 14.2(12)).

14.2.10 Initial Fuel Loading and Initial Criticality

14.2.10.1 <u>Initial Fuel Loading</u>

Direction, coordination, and control of the initial fuel loading evolution are the responsibility of the site operator. The designers provide technical assistance during the initial fuel loading evolution.

The fuel loading evolution is controlled by use of approved plant procedures, which are used to establish plant conditions, control access, establish security, control maintenance activities, and provide instructions pertaining to the use of fuel handling equipment. Initial fuel loading is directed from the main control room. The evolution is supervised by a licensed senior reactor operator.

The successful completion of all ITAAC is a prerequisite for fuel load and a condition of the license. Therefore, the ITAAC is verified to be completed prior to the fuel loading. The initial fuel loading is supervised by a licensed Senior Reactor Operator (SRO) with no concurrent duties. Initial fuel loading is directed from the main control room.

In the unlikely event that mechanical damage to a fuel assembly is sustained during fuel loading operations, an alternate core loading scheme, whose characteristics closely approximate those of the initially prescribed core configuration, is determined and approved prior to implementation.

The fuel assemblies are installed in the reactor vessel in water containing dissolved boric acid in a quantity calculated to maintain a core effective multiplication constant at less than, or equal to, the Technical Specifications value. The refueling pool is not anticipated to be completely filled. However, the water level in the reactor vessel is maintained above the installed fuel assemblies at all times.

The shutdown cooling system is in service to provide coolant circulation to provide reasonable assurance of adequate mixing and a means of controlling water temperature. The in-containment refueling water storage tank (IRWST) is in service and contains borated water at a volume and concentration conforming to the Technical Specifications. Applicable administrative controls are used to prevent unauthorized alteration of system lineups or change to the boron concentration in the reactor coolant system (RCS).

Minimum instrumentation for fuel loading consists of two temporary source-range channels installed in the reactor vessel or one temporary channel and one permanently installed excore nuclear channel in the event that one of the temporary channels becomes inoperative. Both temporary and permanent channels are required for calibration and for response check with a neutron source. The temporary channels display neutron count rate on a count rate meter installed in the containment and are monitored by personnel conducting the fuel loading operation. The permanent channel displays neutron count rate on a meter and strip chart recorder located in the main control room and is monitored by licensed operators. In addition, at least one temporary channel and one permanent channel are equipped with audible rate indicators in two locations, a temporary channel in the containment and a permanent or temporary channel in the main control room.

Continuous area radiation monitoring is provided during fuel handling and fuel loading operations. Permanently installed radiation monitors display radiation levels in the main control room and are monitored by licensed operators.

14.2.10.1.1 <u>Safe Loading Criteria</u>

Criteria for the safe loading of fuel require that loading operations stop immediately if:

- a. The neutron count rate from either temporary nuclear channel unexpectedly doubles during any single loading step, excluding an anticipated change due to detector and/or source movement or spatial effects (i.e., fuel assembly coupling source with a detector).
- b. The neutron count rate on any individual nuclear channel increases by a factor of 5 during any single loading step, excluding anticipated changes due to detector and/or source movement or spatial effects (i.e., fuel assembly coupling source with a detector).

A fuel assembly is not ungrappled from the refueling machine until stable count rates have been obtained. In the event that an unexplained increase in count rate is observed on any nuclear channel, the last fuel assembly loaded is withdrawn. The procedure and loading operation are reviewed and evaluated before proceeding to provide reasonable assurance of the safe loading of fuel.

14.2.10.1.2 <u>Fuel Loading Procedure</u>

An approved detailed test procedure is followed during the initial fuel loading to provide reasonable assurance that the evolution is completed in a safe and controlled manner. This procedure specifies applicable precautions and limitations, prerequisites, initial conditions, and the necessary procedural steps. The test description for initial fuel loading is in subsection 14.2.12.2.1.

14.2.10.2 Initial Criticality

All systems required for startup or protection of the plant, including the plant protection system, safety injection system and containment spray system, are operable and in a state of readiness.

A predicted boron concentration for criticality is determined for the precritical CEA configuration specified in the procedure. This configuration requires all CEA groups to be fully withdrawn with the exception of the last regulating group, which remains far enough into the core to provide effective control when criticality is achieved. This position is specified in the procedure. The RCS boron concentration is then reduced to achieve criticality, at which time the regulating group is used to control the chain reaction.

Core response during CEA group withdrawal and RCS boric acid concentration reduction is monitored in the main control room by observing the change in neutron count rate as indicated by the permanent wide-range nuclear instrumentation.

Neutron count rate is plotted as a function of CEA group position and RCS boron concentration during the approach to criticality. Primary safety reliance is based on inverse count rate ratio monitoring as an indication of the nearness and rate of approach to criticality during CEA group withdrawal and during the dilution of the reactor coolant boric acid concentration. The approach to criticality is controlled and specific holding points are specified in the procedure. The results of the inverse count rate monitoring and the indications on installed instrumentation are reviewed and evaluated before proceeding to the next prescribed hold point.

14.2.10.2.1Safe Criticality Criteria

The criteria for providing reasonable assurance of a safe and controlled approach to criticality are as follows:

- a. The high-flux trip setpoints are reduced to a value consistent with the Technical Specification limits.
- b. A sustained startup rate of 1 decade per minute is not exceeded.
- c. The CEA withdrawal or boron dilution is suspended if unexplainable changes in neutron count rates are observed.
- d. The CEA withdrawal or boron dilution is suspended if the extrapolated inverse count rate ratio predicts criticality outside the tolerance specified in the procedure.
- e. The Technical Specifications are met.

- f. Criticality is anticipated at any time if positive reactivity is added by CEA withdrawal or boron dilution.
- g. A minimum of 1 decade of overlap is observed between the startup and log safety channels of the ex-core nuclear instruments.

14.2.11 <u>Test Program Schedule</u>

The COL applicant is to develop a sequence and schedule for the development of the plant operating and emergency procedures should allow sufficient time for trial use of these procedures during the Initial Test Program. The sequence and schedule for plant startup is to be developed by the COL applicant to allow sufficient time to systematically perform the required testing in each phase (COL 14.2(13)).

The schedule for plant startup is to be developed by the COL applicant to allow sufficient time to systematically perform the required testing in each phase. The applicant is to allow at least 9 months for conducting preoperational testing and at least 7 months for conducting startup testing, including fuel loading, low-power tests, and power-ascension tests.

The scheduling of individual tests or test sequences is done so that systems and components that are required to prevent or mitigate the consequences of postulated accidents are tested prior to fuel loading. Tests that require a substantial core power level for proper performance are performed at the lowest power level commensurate with obtaining acceptable test data.

Phase I test procedures are scheduled to be approved and available for review by the NRC inspectors at least 60 days prior to their scheduled performance date. The Phase II through Phase IV test program administrative control procedures, the majority of the individual test procedures, and the following milestone controlling procedures: Fuel loading, post-core HFT, initial criticality, low-power physics test, and power ascension, are scheduled to be approved and available for review at least 60 days prior to fuel load. The remaining individual test procedures are scheduled for approval and available for review by the NRC inspectors at least 60 days prior to their intended performance date.

14.2.11.1 <u>Testing Sequence</u>

The COL applicant is to specify the testing sequence to provide reasonable assurance that safety of the plant is not compromised during the test program. The test sequence provides reasonable assurance that the conduct of a specific test does not place the plant in a condition for which untested systems would be relied on for safety.

Phase I testing is planned to be completed prior to commencing initial fuel loading. If Phase I tests or portions of such tests cannot be completed prior to commencement of fuel loading, provisions for carryover testing are planned and approved in accordance with the site-specific administrative procedures.

In the event that carryover testing is required, the site operator lists each test and identify which portions of each test are to be delayed until after fuel loading. Technical justification for delaying these portions is documented together with a schedule (power level) for completing each carryover test. The justification is approved by the plant review board. The documentation for carryover testing is made available for NRC staff review and approval, as required, prior to commencing fuel loading.

14.2.12 <u>Test Descriptions</u>

14.2.12.1 <u>Preoperational Tests</u>

The individual preoperational tests identified in this subsection contain general system testing requirements. Safety system pump and valve testing is addressed in Subsection 3.9.6.

14.2.12.1.1 Reactor Coolant Pump Motor Initial Operation Test

- 1.0 OBJECTIVES
 - 1.1 To verify that the RCP motors operate properly
 - 1.2 To verify that the RCP motor breakers operate properly
 - 1.3 To verify that the RCP motor interlocks operate properly
 - 1.4 To verify that the RCP motor alarms and indication operate properly
- 1.5 To verify that the RCP controlled bleed-off and cooler valves operate properly
- 1.6 To verify that the RCP oil lift systems operate properly
- 1.7 To verify that the RCP forward and reverse rotation switches operate properly
- 1.8 To verify that the RCP motor space heater operate properly
- 1.9 To verify that the RCP snubber position switch operate properly

2.0 PREREQUISITES

- 2.1 RCP motor instrumentation has been calibrated.
- 2.2 Each RCP motor and its respective pump are uncoupled.
- 2.3 Support systems required for operation of each RCP motor are operational.

3.0 TEST METHOD

- 3.1 Start CCW flow to the RCP motor and observe indicating lights and alarms.
- 3.2 Using a torque wrench and phase rotation meter, rotate RCP motor and verify proper wiring of motor leads and torque required to rotate the motor.
- 3.3 Jog RCP motor and verify proper rotation.
- 3.4 Start RCP motor and verify proper operation. Record motor operating data.
- 3.5 Determine oil level setpoints of oil reservoirs by draining oil from motor reservoirs and subsequently refilling.
- 3.6 Simulate oil lift pumps and CCW system starting interlocks, preventing RCP motor operation, and observe effects.

4.0 DATA REQUIRED

- 4.1 Motor operating data
- 4.2 Torque needed to rotate the RCP motors
- 4.3 Setpoints at which indications, alarms, and interlocks occur

- 5.1 The RCP motors, support systems, alarms, indications, and interlocks perform as described in Subsection 5.4.1.
- 5.2 RCP subsystem valves can be opened and closed by their respective control switch and their statuses are indicated as specified
- 5.3 RCP subsystem valve stroke times (open and close) are within the design values
- 5.4 RCP subsystem valves are maintained in their failed position after loss of power and they are maintained failed position after restoration of power
- 5.5 RCP oil lift pumps stop on loss of control power and remain stopped upon restoration of control power
- 5.6 RCP motor subsystem alarms are verified as specified
- 5.7 The RCP motor operates as required, within normal limits
- 5.8 The RCP motor start interlocks function is verified as specified
- 5.9 Operation of the RCP motor breakers are verified as specified
- 5.10 The oil lift system supplies oil at greater than the design value
- 5.11 If 13.8KV bus power is lost, the RCP breaker opens
- 5.12 The RCP motor space heaters energize when the RCP motor is off, and de-energize when the RCP motor is on

14.2.12.1.2 Reactor Coolant System Test

1.0 OBJECTIVES

- 1.1 To verify proper operation of the RCS valves
- 1.2 To verify alarm setpoints for instruments within the test boundary and for instrument which are not previously verified in 14.2.12.1.1
- 1.3 To perform the initial venting of the RCPs and RCS
- 1.4 To perform the initial operation of RCPs

2.0 PREREQUISITES

- 2.1 Construction activities on the RCS, RCPs, and RCS sample isolation system have been completed.
- 2.2 RCP and RCS instrumentation has been calibrated.
- 2.3 Component cooling water is available.
- 2.4 RCP motor initial operation preoperational test has been completed.
- 2.5 Support systems required for operation of the RCPs and RCS sample isolation valves are operational.

3.0 TEST METHOD

- 3.1 Simulate the temperature, pressure, and flow signals from each RCP and verify alarm setpoints.
- 3.2 Simulate the temperature signals from each RCS RTD that has an alarm function and verify alarm setpoints.
- 3.3 Perform initial venting of RCPs, pressurizer, and reactor vessel.
- 3.4 Perform initial run of RCPs. Vent the RCS after each run is complete.

4.0 DATA REQUIRED

- 4.1 Setpoints at which alarms occur
- 4.2 RCP performance data

- 5.1 RCS and RCP performance and alarms are as described in Subsections 5.4.1
- 5.2 RCS valves can be opened and closed by their respective hand switches and their statuses are indicated at the indication locations as specified
- 5.3 POSRV related valves can be opened and closed by their respective hand switches and statuses are indicated as specified
- 5.4 RCS valves stroke times (open and close) are verified as specified
- 5.5 POSRV related valves stroke times (open and close) are verified as specified
- 5.6 RCS valves fail to the required position upon loss of power and go to the proper position upon restoration of power
- 5.7 POSRV related valves fail to the required position on loss of power and go to the position indicated upon restoration of power
- 5.8 RCS instruments alarms are verified as specified
- 5.9 POSRV related line instrument alarms are verified as specified
- 5.10 The RCPs and RCS venting is performed successfully
- 5.11 The RCPs operate as required with all operating parameters within design limits and normal operating ranges

14.2.12.1.3 Pressurizer Pilot-Operated Safety Relief Valve Test

1.0 OBJECTIVES

- 1.1 To verify the temperature alarm setpoint for leak detection
- 1.2 To verify the Set Pressure of the POSRV spring loaded pilot valve
- 1.3 To verify the POSRV main valve operation with the POSRV spring loaded pilot valve
- 1.4 To verify the POSRV main valve operation with the POSRV motor operated pilot valve
- 1.5 To verify no leakage of each valve

2.0 PREREQUISITES

- 2.1 Construction activities on the pressurizer have been completed and all associated instrumentation has been checked and calibrated.
- 2.2 RCS is at vendor-recommended condition for valve testing.
- 2.3 Field testing device with associated support equipment and calibration data are available.

3.0 TEST METHOD

- 3.1 Using the field testing device, manipulate the operating pressure on the POSRV pilot valve until the POSRV starts to open.
- 3.2 Determine opening/closing pressure from the field testing device correlation data.
- 3.3 Determine opening dead times, stroke times and closing times.
- 3.4 Adjust valve opening/closing characteristics if necessary and retest.

4.0 DATA REQUIRED

4.1 Pressurizer pressure and temperature

- 4.2 Pressure applied to the field testing device to lift the POSRV off its seat
- 4.3 Opening dead times, stroke times and closing times.
- 4.4 Leak detection temperatures

5.0 ACCEPTANCE CRITERIA

- 5.1 POSRVs perform as described in Subsection 5.4.14.
- 5.2 Leak detection high temperature alarm of valves actuates at the designed setpoint including alarm uncertainty
- 5.3 The POSRV spring loaded pilot valves lift at the setpoint
- 5.4 The opening and closing times of the POSRV main valve with the POSRV spring loaded pilot valve are within the designed values respectively including dead time
- 5.5 The opening time, stroke time, and closing time of the POSRV main valve with the POSRV motor operated pilot valves are within the designed values respectively.
- 5.6 Valves have no leakage by confirming no alarm temperature indicator

14.2.12.1.4 Pressurizer Pressure and Level Control Systems Test

- 1.0 OBJECTIVES
 - 1.1 To verify the proper operation of the PPCS and PLCS

2.0 PREREQUISITES

- 2.1 Construction activities on the PPCS and PLCS have been completed.
- 2.2 PPCS and PLCS software is installed and instrumentation has been calibrated.
- 2.3 Support systems required for operation of components in the PPCS and PLCS are operational.

3.0 TEST METHOD

- 3.1 Close and open backup heater breakers from the main control room. Observe breaker operation and indicating light response.
- 3.2 Simulate a decreasing pressurizer pressure and verify proper outputs to the heater control circuits. Verify alarm setpoints.
- 3.3 Simulate an increasing pressurizer pressure and verify proper outputs to the heater and spray valves control valve circuits. Verify alarm setpoints.
- 3.4 Simulate a low-level error in the pressurizer and verify proper outputs to the charging control valve circuit. Verify alarm setpoints.
- 3.5 Simulate a high-level error in the pressurizer and verify proper outputs to the pressurizer backup heater and the letdown orifice isolation valve control circuits. Verify alarm setpoints.
- 3.6 Simulate signals to pressurizer pressure and level controllers and verify proper outputs.
- 3.7 Simulate a low-low pressurizer level and verify proper system outputs.
- 3.8 Simulate a low pressurizer level and verify proper output signals to the letdown orifice isolation valve control circuits.

4.0 DATA REQUIRED

- 4.1 Simulated pressurizer level, pressure signals, and outputs to pressurizer heaters control circuits
- 4.2 Simulated pressurizer pressure signals and outputs to spray valve control circuits
- 4.3 Simulated pressurizer level signals and outputs to charging control valve circuits
- 4.4 Simulated pressurizer level to letdown orifice isolation valve control circuits

4.5 Setpoints at which alarm, indications, and interlocks occur

5.0 ACCEPTANCE CRITERIA

- 5.1 Pressurizer pressure and level control systems perform as described in Subsection 7.7.1.1 b.
- 5.2 Pressurizer pressure in each channel is within the design value under specified reference conditions and pressurizer pressure signals are validated within the design value
- 5.3 Pressurizer pressure alarm and control signals are verified as designed
- 5.4 Pressurizer spray valve demand signal is verified as designed
- 5.5 Proportional heater power demand signal is verified as designed
- 5.6 Pressurizer level in each channel is within the design value under specified reference conditions and pressurizer level signal is validated within the design value
- 5.7 Pressurizer level setpoints are verified as designed
- 5.8 Pressurizer level alarm and control signals are verified as designed
- 5.9 Pressurizer level error alarm and control signals are verified as designed
- 5.10 Charging control valve demand signal are verified as designed

14.2.12.1.5 Chemical and Volume Control System Letdown Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify the CVCS letdown subsystem valve operations, position indications and responses to failed condition, and to measure stroke times.
 - 1.2 To verify the CVCS letdown subsystem valve interlocks and control functions.
 - 1.3 To verify the CVCS letdown subsystem alarms.

2.0 PREREQUISITES

- 2.1 Construction activities on the CVCS letdown subsystem have been completed.
- 2.2 Letdown subsystem instrumentation has been calibrated.
- 2.3 Support systems required for the operation of the CVCS letdown subsystem power-operated valves are operational.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control positions, observe valve operation and position indications and, where required, measure opening and closing times.
- 3.2 Simulate SIAS/CIAS and observe isolation valve response.
- 3.3 Simulate letdown temperature and pressure, and observe the response of power-operated valves. Observe alarm and interlock operation.
- 3.4 Verify design flow rates.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing time where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power
- 4.4 Response of isolation valves to SIAS/CIAS
- 4.5 Response of power-operated valves to simulated letdown temperature and pressure
- 4.6 Setpoints at which alarms, indications, and interlocks occur

5.0 ACCEPTANCE CRITERIA

- 5.1 The CVCS letdown subsystem performs as described in Subsection 9.3.4.2.1.
- 5.2 CVCS letdown subsystem valves can open and close by their respective hand switches and status is indicated at the indication location(s)
- 5.3 CVCS letdown subsystem valves stroke time (open and close) are within the design values
- 5.4 CVCS letdown subsystem valves fail to the required position on loss of air or power, and go to the position indicated upon restoration of power. Upon restoration of air, the valves go to the pre-failed position
- 5.5 CVCS letdown subsystem valve interlocks is verified
- 5.6 Alarm and signal performance CVCS letdown subsystem alarms and signal are verified

14.2.12.1.6 <u>Volume Control Tank Subsystem Test</u>

1.0 OBJECTIVES

- 1.1 To verify valve operations, position indications, responses to failed condition, and to measure stroke times.
- 1.2 To verify that the VCT can be pressurized from the hydrogen and nitrogen systems
- 1.3 To verify the VCT level control program
- 1.4 To verify the VCT pressure and temperature alarms
- 1.5 To verify that the VCT can be vented to the GWMS

2.0 PREREQUISITES

- 2.1 Construction activities on the VCT subsystem have been completed.
- 2.2 VCT subsystem instrumentation has been calibrated.

- 2.3 Reactor makeup water (RMW) is available to the VCT.
- 2.4 Support systems required for operation of the VCT are complete and operational.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control positions. Observe valve operation and position indication and, where required, measure opening and closing times.
- 3.2 Partially fill the VCT with RMW and pressurize the VCT using the nitrogen pressurization system. Observe the operation to maintain the pressure.
- 3.3 Vent the VCT and repressurize using the hydrogen pressurization system. Observe the operation to maintain the pressure. (The hydrogen system is temporarily connected to a nitrogen supply).
- 3.4 Drain and refill the VCT with RMW. Observe level alarms and interlocks.
- 3.5 Simulate VCT temperature and pressure limits and observe alarms.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power
- 4.4 VCT pressurization data
- 4.5 VCT level program data
- 4.6 Values of parameters at which alarms and interlocks occur

5.0 ACCEPTANCE CRITERIA

5.1 The VCT subsystem performs as described in Subsection 9.3.4.2.1.

- 5.2 CVCS VCT subsystem valves can be opened and close by their respective hand switches and status is indicated at the indication location(s)
- 5.3 CVCS VCT subsystem valve stroke time (open and close) is within the design value
- 5.4 CVCS VCT subsystem valves fail to the required position on loss of air or power, and go to the position indicated upon restoration of power. Upon restoration of air, the valves go to the pre-failed position
- 5.5 CVCS VCT subsystem valve interlocks and control are verified
- 5.6 VCT level alarms, interlocks, temperature and pressure alarms are verified

14.2.12.1.7 Chemical and Volume Control System Charging Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify the total developed head of the charging pumps
 - 1.2 To verify proper operation of the charging pumps, and response to manual controls and loss of power
 - 1.3 To verify proper operation of the auxiliary charging pump packing lube water system including alarms
 - 1.4 To verify proper operation of the auxiliary charging pump, and response to manual controls and loss of power
 - 1.5 To verify proper operation of the auxiliary charging pump lubricating oil systems including alarms
 - 1.6 To verify valve operation, position indication, response to failed conditions, and to measure stroke times in charging, seal injection and RCP controlled bleed off subsystems
 - 1.7 To verify charging and seal injection system flowpaths

- 1.8 To demonstrate proper operation of charging, seal injection and RCP controlled bleedoff pressure and flow alarms
- 1.9 To verify the proper operations of seal injection flow instrumentation channels including signal output, indication and alarm locations, and controls of seal injection control valves
- 1.10 To verify the proper response to CSAS of RCP controlled bleedoff containment isolation valves
- 1.11 To verify the proper operation of seal injection filter differential pressure instrumentation channel including signal output, indication and alarm location.
- 1.12 To verify the proper operations of RCP controlled bleedoff header pressure instrumentation channel including signal output, indication and alarm location, and alarm setpoints
- 1.13 To verify the CVCS charging and seal injection subsystem valve interlocks and control function
- 1.14 To verify the miniflow and balancing leakoff flow of the charging pumps
- 1.15 To balance the system flow using charging restricting orifices
- 1.16 To verify auxiliary charging pump power transfer from BUS A to BUS B or vice versa

2.0 PREREQUISITES

- 2.1 Construction activities on the CVCS charging subsystem have been completed.
- 2.2 The CVCS charging subsystem is operational to supply charging pump suction.
- 2.3 The VCT subsystem is operational to supply charging pump suction.
- 2.4 The RV is ready to receive water from the charging headers.

- 2.5 The pressurizer is ready to receive water from the auxiliary spray line.
- 2.6 RCPs are operational.
- 2.7 Support systems required for operation of the CVCS charging subsystem are operational.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control positions. Observe valve operation and position indication and, where required, measure opening and closing times.
- 3.2 Manually start each charging pump. Observe charging pump operation, including charging pump alarms and interlocks.
- 3.3 Observe the charging control valve responses to manual demand signals.
- 3.4 With a charging pump running, open the seal injection lines and observe the flow.
- 3.5 With a charging pump running, open the auxiliary spray valve and observe flow.
- 3.6 Verify the operation of the RCP seal injection flow control valves.
- 3.7 Verify performance, including head and flow characteristics, of the charging pumps.
- 3.8 With the auxiliary charging pump running, open the seal injection lines and observe the flow through auxiliary charging pump discharge check valve.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power

- 4.4 Charging pump and oil lubrication system performance
- 4.5 Charging pump running data
- 4.6 Response of charging control valves to manual demand signals
- 4.7 Setpoints at which alarms and interlocks occur
- 4.8 Seal injection flow rates
- 4.9 Auxiliary spray flow rates
- 4.10 Charging pump head vs. flow
- 4.11 Auxiliary charging pump running data

- 5.1 The CVCS charging subsystem performs as described in Subsection 9.3.4.2.1.
- 5.2 At rated flow condition, charging pumps miniflow is within the design value
- 5.3 Shut-off head of charging pumps is less than design limit
- 5.4 Rated head of charging pumps is within design range
- 5.5 Auxiliary charging pump is capable of providing a flow of minimum design value through auxiliary charging pump discharge check valve.
- 5.6 Suction trip pressure of charging pumps and auxiliary charging pump is verified as specified
- 5.7 Maximum charging flow in each flow paths is within design range
- 5.8 The charging pump and auxiliary charging pump stops on the load shed signal
- 5.9 The suction pressure shall be greater than design value while the following suction flow paths allow the operation of a charging pump

- 5.10 The suction pressure shall be greater than design value while the following suction flow paths allow the operation of the auxiliary charging pump
- 5.11 Pressure and flow alarms and setpoint in the charging, seal injection and RCP controlled bleedoff lines should meet the required value
- 5.12 Low, high and high-high flow in the seal injection is within design values
- 5.13 CVCS charging and seal injection subsystem valves can be opened and closed by their respective hand switches as specified
- 5.14 CVCS charging and seal injection subsystem valve stroke time (open and close) should meet the required time
- 5.15 CVCS charging and seal injection subsystem valve interlocks and control function are verified as specified
- 5.16 The flow is verified to be established through the charging and seal injection flow paths
- 5.17 CVCS charging, seal injection, and RCP controlled bleedoff lines instrumentation channels are operated properly as specified.
- 5.18 The RCP controlled bleedoff containment isolation valves are closed on CSAS

14.2.12.1.8 Chemical Addition Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify proper operation of CAP
 - 1.2 To verify the flow path from the MSH to the charging line through the CAT
 - 1.3 To verify the flow path from the CAT to LWMS

2.0 PREREQUISITES

- 2.1 Support systems required for operation of the chemical addition subsystem are complete and operational.
- 2.2 The chemical addition tank has been filled from the makeup system with a predetermined amount of RMW.
- 2.3 The charging subsystem is in operation.
- 2.4 Associated instrumentation has been calibrated.

3.0 TEST METHOD

- 3.1 Start the CAP and observe the chemical addition tank level and chemical addition flow rate.
- 3.2 Drain the chemical addition tank to the liquid waste management system and observe the chemical addition tank level.

4.0 DATA REQUIRED

- 4.1 Chemical addition tank levels
- 4.2 Chemical addition flow rates

- 5.1 Chemical addition to charging pump suction line is demonstrated when test method 3.1 is completed with a decreasing chemical addition tank level.
- 5.2 A flow path to the liquid waste management system is demonstrated when test method 3.2 is completed with a decreasing chemical addition tank level.
- 5.3 The chemical addition subsystem performs as described in Subsection 9.3.4.2.7.

5.4 The CAP maximum discharge flow is within required range at the adjusted stroke with a charging pump suction pressure of specified condition

14.2.12.1.9 Reactor Drain Tank Subsystem Test

1.0 OBJECTIVES

- 1.1 To verify the RDT subsystem valve operation and position indication
- 1.2 To verify the RDT subsystem interlocks with valve operation
- 1.3 To verify the RDT temperature, level, pressure indications, alarms and interlocks
- 1.4 To verify the reactor drain filter differential pressure indication and alarm
- 1.5 To demonstrate the operation of the RDPs, including the ability to drain RDT and interlocks to the RDP operation

2.0 PREREQUISITES

- 2.1 Construction activities on the RDT subsystem have been completed.
- 2.2 RDT subsystem instrumentation has been calibrated.
- 2.3 The EDT subsystem is ready to accept water from the RDT.
- 2.4 The plant nitrogen system is operational.
- 2.5 Support systems required for operation of the RDT subsystem are operational.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control positions, observe valve operation and position indication and, where required, measure opening and closing times.
- 3.2 Simulate a CIAS and observe isolation valve response.

- 3.3 Using the N_2 system, pressurize the RDT and observe indications and alarms.
- 3.4 Line up the RDT and drain the RDT using each RDT pump. Observe RDP flow rate and pressure indicators.
- 3.5 Simulate RDT temperature, pressure, and level, and observe indicators, alarms and interlocks.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indications
- 4.3 Response of valves to simulated failed conditions
- 4.4 Position response of valves to loss of motive power
- 4.5 RDT level, pressure, and temperature
- 4.6 Setpoints of alarms and interlocks

- 5.1 The RDT subsystem performs as described in Subsections 9.3.4.2.2, 9.3.4.2.8.1, and 9.3.4.2.8.3
- 5.2 RDT subsystem valves can be opened and closed by their respective hand switches and status is indicated at the indication locations
- 5.3 RDT subsystem valve should meet the required open and closed stroke times
- 5.4 RDT subsystem valves fail to the required position on loss of air and power and go to the position indicated upon restoration of air and power
- 5.5 RDT subsystem valve interlocks and alarms are verified
- 5.6 The developing head of RDP are within design range to process the RDT to the EDT

5.7 RDP interlocks are verified

14.2.12.1.10 Equipment Drain Tank Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify the EDT subsystem valve operation and position indication
 - 1.2 To verify the EDT subsystem interlocks with valve operation
 - 1.3 To verify the EDT temperature, level, pressure indications, alarms and interlocks
 - 1.4 To demonstrate the operation of the RDPs, including the ability to drain reactor drain tank and interlocks to the RDP operation
 - 1.5 To verify the EDT temperature, level, pressure indications, alarms and interlocks

2.0 PREREQUISITES

- 2.1 Construction activities on the EDT subsystem have been completed.
- 2.2 EDT subsystem instrumentation has been calibrated.
- 2.3 The plant nitrogen system is operational.
- 3.0 TEST METHOD
 - 3.1 Operate power-operated valves from all appropriate control positions and observe valve operation and position indication.
 - 3.2 Using the N_2 system, pressurize the EDT and observe indications and alarms.
 - 3.3 Simulate EDT temperature, pressure, and level and observe indicators, alarms, and interlocks.
- 4.0 DATA REQUIRED
 - 4.1 Valve position indications

- 4.2 Position response of valves to loss of motive power
- 4.3 EDT level, pressure, and temperature
- 4.4 Setpoints at which alarms and interlocks occur

5.0 ACCEPTANCE CRITERIA

- 5.1 The EDT subsystem performs as described in Subsections 9.3.4.2.2 and 9.3.3.2.4.
- 5.2 EDT subsystem valves can be opened and closed by their respective hand switches and status is indicated at the indication location(s).
- 5.3 EDT subsystem valve should meet the required open and closed stroke times.
- 5.4 EDT subsystem valves fail to the required position on loss of air and power and go to the position indicated upon restoration of air and power.
- 5.5 EDT subsystem valve interlocks and alarms are verified.
- 5.6 RDP interlocks are verified

14.2.12.1.11 Boric Acid Batching Tank Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify proper operation of BABT heaters.
 - 1.2 To verify proper operation of the BABT mixer.
 - 1.3 To verify the flow paths from BABT to BAST and from BABT to EDT

2.0 PREREQUISITES

- 2.1 Construction activities on the boric acid batching tank subsystem have been completed.
- 2.2 Support systems required for operation of the BABT are complete and operational.

2.3 The BAST and RMWT subsystems are operational.

3.0 TEST METHOD

- 3.1 Fill the BABT with water from the RMW system.
- 3.2 Line up the BABT to the BAST. Start a boric acid makeup pump and observe the batching tank level.
- 3.3 Refill the BABT, energize heaters and measure the length of time required to heat the tank.
- 3.4 Dissolve boric acid powder, and start the batch tank mixer. Take samples as the tank is drained to the EDT and determine the boric acid concentration.

4.0 DATA REQUIRED

- 4.1 Batching tank heater performance data
- 4.2 Heatup rate
- 4.3 Boric acid concentration
- 4.4 Boric acid batching eductor flow rate

- 5.1 The BABT subsystem performs as described in Subsection 9.3.4.2.3.
- 5.2 The BABT heaters should maintain the water temperature by energizing and de-energizing
- 5.3 The BABT heaters and mixer operate to allow the increasing of water temperature and the mixing rate of boric acid batches
- 5.4 Boric acid batching flow is adjustable within required range

14.2.12.1.12 Concentrated Boric Acid Subsystem Test

1.0 OBJECTIVES

- 1.1 To verify BAST temperature alarms, level alarms and interlock setpoints
- 1.2 To set BAMP minimum and full recirculation flow
- 1.3 To verify BAMP performance including head versus flow curve
- 1.4 To verify BAMP operation alarm and interlock setpoints
- 1.5 To verify boric acid filter differential pressure, alarm setpoint
- 1.6 To verify flow path from IRWST to IRWST via BAMP
- 1.7 To verify valve operations, position indications, responses to failed condition and measure stroke times

2.0 PREREQUISITES

- 2.1 Construction activities of the concentrated boric acid and BAST subsystems have been completed.
- 2.2 Concentrated boric acid subsystem instrumentation has been calibrated.
- 2.3 The reactor coolant charging subsystem is complete and operational.
- 2.4 The VCT subsystem is complete and operational.
- 2.5 The BABT subsystem is complete and operational.
- 2.6 Support systems required for operation of the concentrated boric acid and BAST systems are complete and operational.

3.0 TEST METHOD

3.1 Operate power-operated valves from all appropriate control positions, observe valve operation and position indication and, when required, measure opening and closing times.

- 3.2 Fill the BAST with RMW from the BABT subsystem and observe level alarm setpoints.
- 3.3 Operate each BAMP and observe pump performance.
- 3.4 Operate BAMPs using all interconnections between BAMPs and BAST.
- 3.5 Line up the boric acid makeup to charging pump suction and verify ability of the BAMPs to supply adequate flow to the charging pumps.
- 3.6 Line up the BAST to charging pump suction and verify that adequate flow is delivered to the charging pumps.
- 3.7 Simulate high and low BAST levels and observe indications, alarms, and controls.
- 3.8 Simulate BAST temperature and observe indications and alarms.
- 3.9 Line up the BAMPs to the VCT and verify that the makeup system is capable of supplying boric acid makeup to the VCT and charging pump suction at the selected rates and quantities in all modes of operation. Observe alarms and interlocks.
- 3.10 Verify performance, including head and flow characteristics, for the BAMPs.
- 3.11 Check power-operated valves fail to the position upon loss of motive power.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power
- 4.4 BAMP performance data
- 4.5 Makeup system performance data

- 4.6 Setpoints at which alarms, automatic actuations, and interlocks occur
- 4.7 Pump head vs. flow

- 5.1 The concentrated boric acid subsystem performs as described in Subsections 9.3.4, 9.3.4.2.3, and 9.3.4.2.8.1.
- 5.2 BAST subsystem valves can be opened and closed by their respective hand switches and status is indicated at the indication locations.
- 5.3 BAST subsystem valves should meet required stroke time (open and close)
- 5.4 BAST subsystem valves fail to the required position on loss of air or power, and go to the position indicated upon restoration of power. Upon restoration of air, the valves go to the pre-failed position
- 5.5 BAST subsystem valve interlocks and control are verified
- 5.6 BAST level alarms, interlocks and temperature alarm are verified
- 5.7 BAMPs discharge pressure low alarm activates at required condition and stop the running BAMP after required time and starts the alternate BAMP
- 5.8 BAMPs performance should meet required rated flow at the rated head
- 5.9 BAMPs cannot be operated simultaneously
- 5.10 Makeup controller operations are verified
- 5.11 High differential pressure alarm in boric acid filter is verified
- 5.12 Flow path is established from IRWST to IRWST via BAMP

14.2.12.1.13 Reactor Makeup Subsystem Test

1.0 OBJECTIVES

- 1.1 To verify RMWT pressure alarms, temperature alarms, level alarms and interlock setpoints
- 1.2 To set RMWP minimum and full recirculation flow
- 1.3 To verify RMWP performance including head versus flow curve
- 1.4 To verify RMWP operation alarm and interlock setpoints
- 1.5 To verify RMW filter differential pressure, alarm setpoint
- 1.6 To verify blending system in all modes of makeup operation
- 1.7 To verify valve operations, position indications, responses to failed condition and measure stroke times

2.0 PREREQUISITES

- 2.1 Construction activities on the RMW subsystem have been completed.
- 2.2 RMW subsystem instrumentation has been calibrated.
- 2.3 Plant makeup system is operational.
- 2.4 Support systems required for the operation of the RMW subsystem are complete and operational.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control positions and observe valve operation and position indication.
- 3.2 Fill the RMWT and observe level indications and alarms.
- 3.3 Simulate RMWT temperature and pressure, and observe indications and alarms.

- 3.4 Drain the RMWT using each RMWP. Observe tank level and pump discharge pressure, indications, alarms, and controls.
- 3.5 Simulate RMW filter differential pressure and observe indications and alarms.
- 3.6 Verify performance, including head and flow characteristics, for the RMWP.
- 3.7 Verify makeup to volume control tank and boric acid storage tank through the RMWP
- 3.8 Check power-operated valves fail to the position upon loss of motive power.

4.0 DATA REQUIRED

- 4.1 Valve position indication
- 4.2 Position response of valves to loss of motive power
- 4.3 RMWT level, pressure, and temperature
- 4.4 RMWP discharge pressure
- 4.5 RMW filter differential pressure
- 4.6 Setpoints of alarms and interlocks
- 4.7 Pump head vs. flow
- 4.8 VCT and BAST levels

- 5.1 The RMW subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.8.1.
- 5.2 RMWT subsystem valves can be opened and closed by their respective hand switches and status is indicated at the indication location(s) as specified

- 5.3 RMWT subsystem valve should meet the required stroke times (open and close)
- 5.4 RMWT subsystem valves fail to the required position on loss of air or power, and go to the position indicated upon restoration of power. Upon restoration of air, the valves go to the pre-failed position
- 5.5 RMWT subsystem valve interlocks and control are verified
- 5.6 RMWT level alarms, RMWP flow alarms, interlocks and temperature and pressure alarms are verified
- 5.7 Rated flow of RMWPs at rated head are within design range

14.2.12.1.14 Holdup Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify the holdup subsystems valve operation and position indication.
 - 1.2 To verify the holdup subsystems interlocks with valve operation.
 - 1.3 To verify the holdup tank temperature and level indications, alarms, and interlocks
 - 1.4 To verify the PHIX inlet temperature controller indications, alarms, and control function
 - 1.5 To demonstrate the operation of the holdup pumps, including the ability to drain the holdup tank and interlocks to the holdup pump operation
 - 1.6 To demonstrate that the RDT contents can be processed to the holdup tank through the RDPs, reactor drain filter, PHIX, and gas stripper.
 - 1.7 To demonstrate that the EDT contents can be processed to the holdup tank through the RDPs, reactor drain filter, PHIX, and gas stripper.
 - 1.8 To demonstrate that the holdup tank contents can be purified through the holdup pumps, reactor drain filter, and PHIX.

- 1.9 To demonstrate that the Holdup Tank contents can be processed to the BAST through the holdup pumps, reactor drain filter, and PHIX.
- 1.10 To demonstrate that the holdup tank contents can be processed to the BAST, LWMS.
- 1.11 To demonstrate that the holdup tank contents can be processed to the BAST and RMWT through the holdup pumps and boric acid concentrator.

2.0 PREREQUISITES

- 2.1 Construction activities on the holdup subsystem have been completed.
- 2.2 Holdup subsystem instrumentation has been calibrated.
- 2.3 Boric acid concentrator is ready to receive water from the holdup tank.
- 2.4 Support systems required for operation of the holdup subsystem are complete and operational.

3.0 TEST METHOD

- 3.1 Fill the holdup tank and observe level indications and alarms.
- 3.2 Simulate holdup tank temperature and observe indications and alarms.
- 3.3 Using each holdup pump, drain the holdup tank to the boric acid concentrator. Observe holdup tank level indications, alarms, interlocks, and holdup pump discharge pressure.
- 3.4 Refill and isolate the holdup tank. Open the holdup tank recirculation valves and start each holdup pump. Observe tank level. Line up the holdup pumps to the reactor drain filter and observe holdup tank level.
- 3.5 Verify performance, including head and flow characteristics, for the holdup pumps.

4.0 DATA REQUIRED

- 4.1 Holdup tank level and temperature
- 4.2 Holdup pump pressure
- 4.3 Setpoints of alarms and interlocks
- 4.4 Position response of valves to loss of motive power
- 4.5 Pump head vs. flow

- 5.1 The holdup subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.2
- 5.2 The holdup subsystem valves can be stroked to required position by their respective hand switches and status is indicated as specified
- 5.3 The holdup subsystem valve should meet required stroke time
- 5.4 The holdup subsystem valves fail to the required position on loss of air and power and go to the position indicated upon restoration of air and power
- 5.5 Holdup subsystem valve interlocks are verified
- 5.6 The holdup subsystem alarms are verified
- 5.7 Holdup pumps are capable of required developing head to process the holdup tank
- 5.8 Holdup pump interlocks are verified
- 5.9 The RDT and EDT contents can be processed to the Holdup Tank through the RDP, reactor drain filter and PHIX as required flow rate
- 5.10 The holdup tank contents can be purified through the holdup pumps, reactor drain filter, PHIX to the holdup tank as required flow rate

- 5.11 The holdup pump can deliver to the BAC and to the recirculation line as required flow rate
- 5.12 The holdup tank contents can be processed through the holdup pumps, reactor drain filter, PHIX to the BAST as required flow rate
- 5.13 The holdup tank contents can be processed to the RMWT through the holdup pumps and BACIX as required flow rate
- 5.14 The holdup tank contents can be processed to the BAST through the holdup pumps as required flow rate
- 5.15 The holdup tank contents can be processed to the LWMS through the holdup pumps as required flow rate.

14.2.12.1.15 Boric Acid Concentrator Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify the BAC subsystems valve operation and position indication
 - 1.2 To verify the BAC subsystems interlocks with valve operation
 - 1.3 To verify the BAC skid valve operation and position indication
 - 1.4 To verify the BAC flow, temperature, level, and pressure indications, alarms and interlocks
 - 1.5 To demonstrate the operation of the concentrate pumps, distillate Pumps and concentrate transfer pumps and interlocks to the pumps
 - 1.6 To verify the BAC performance and perform initial operation
 - 1.7 To verify the BAC skid valve interlocks

2.0 PREREQUISITES

2.1 Construction activities have been completed on the boric acid concentrator subsystem.

- 2.2 Support systems required for operation of the boric acid concentrator are complete and operational.
- 2.3 Boric acid concentrator subsystem instrumentation has been calibrated.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control positions and observe valve operation and position indication.
- 3.2 Simulate interlock signals from interfacing equipment and observe boric acid concentrator subsystem response observe alarms.
- 3.3 Line up the boric acid concentrator subsystem to interfacing systems and, using appropriate operating modes and indications, establish flow paths to these systems.

4.0 DATA REQUIRED

- 4.1 Valve position indication
- 4.2 Boric acid condensate subsystem response to simulated interlocks
- 4.3 Setpoints at which alarms interlock and automatic actuations occur
- 4.4 Flow indications

- 5.1 The boric acid concentrator subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.2.
- 5.2 The BAC skid valves can be open and closed by their respective controller and/or handswitch and status is indicated on BAC Control Panel as specified
- 5.3 The BAC skid valves fail to the required position on loss of air and power and go to the position indicated upon restoration of air and power
- 5.4 BAC skid valve interlocks are verified

- 5.5 BAC alarms are verified
- 5.6 Concentrate pumps are capable of developing sufficient head to recirculate the flash tank to support BAC operation as required flow rate
- 5.7 BAC concentrate pump interlocks are verified
- 5.8 Distillate pumps are capable of developing sufficient head to process the condenser to support BAC operation with required flow range
- 5.9 BAC distillate pump and concentrate transfer pump interlocks are verified
- 5.10 Concentrate transfer pumps are capable of developing sufficient head to process the heater to support BAC operation with required flow range
- 14.2.12.1.16 Gas Stripper Subsystem Test
 - 1.0 OBJECTIVES
 - 1.1 To verify the gas stripper subsystems valve operation and position indication
 - 1.2 To verify the gas stripper subsystems interlocks with valve operation
 - 1.3 To verify the gas stripper skid valve operation and position indication
 - 1.4 To verify the gas stripper flow, temperature, level, and pressure indications, alarms, and control function.
 - 1.5 To demonstrate the operation of the gas stripper discharge pumps and interlocks to the gas stripper discharge pump
 - 1.6 To verify the gas stripper performance and perform initial operation
 - 1.7 To verify the gas stripper skid valve interlocks
 - 2.0 PREREQUISITES
 - 2.1 Construction activities have been completed on the gas stripper subsystem.

- 2.2 Gas stripper subsystem instrumentation has been calibrated.
- 2.3 Support systems required for operation of the gas stripper subsystem are operational.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control positions and observe valve operation and position indications.
- 3.2 Simulate interlock signals from interfacing equipment and observe gas stripper subsystem response.
- 3.3 Line up the gas stripper subsystem to interfacing systems and, using appropriate operating modes and indications, establish flow paths to these systems.
- 3.4 Observe alarms.

4.0 DATA REQUIRED

- 4.1 Valve position indication
- 4.2 Position response of valves to loss of motive power
- 4.3 Setpoints at which alarms, automatic actuations, and interlocks occur
- 4.4 Flow indications

- 5.1 The gas stripper subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.2.
- 5.2 The gas stripper skid valves can be open and closed by their respective controller or handswitch and status is indicated on Gas Stripper Control Panel as specified

- 5.3 The gas stripper skid valves fail to the required position on loss of air and power and go to the position indicated upon restoration of air and power
- 5.4 Gas stripper skid valve interlocks are verified
- 5.5 Gas stripper alarms are verified
- 5.6 Gas stripper discharge pumps are capable of developing sufficient head to process the gas stripper column as required flow rate
- 5.7 Gas stripper discharge pump Interlocks are verified
- 5.8 The gas stripper is capable of reducing dissolved gas in the process stream by a required factor
- 14.2.12.1.17 Boronometer Subsystem Test
 - 1.0 OBJECTIVES
 - 1.1 To verify the proper operation of the boronometer subsystem.

2.0 PREREQUISITES

- 2.1 The boronometer has been calibrated and is operational.
- 2.2 Support systems required for boronometer subsystem operation are complete and operational.
- 2.3 System software is installed.

3.0 TEST METHOD

3.1 Using the built-in test features, observe boronometer indications, outputs to interface equipment, and alarm operation.

4.0 DATA REQUIRED

- 4.1 Pulse rates and boronometer output
- 4.2 Alarm setpoints and actuation levels

5.0 ACCEPTANCE CRITERIA

- 5.1 The boronometer subsystem performs as described in Subsections 9.3.4 and 7.7.1.1 f.
- 5.2 The actual outputs of boronometer display are within required range of the expected output.
- 5.3 The boronometer alarm and indication operate as described in the related design specification.

14.2.12.1.18 Process Radiation Monitor Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify the proper energization of the PRMS
 - 1.2 To verify the proper operation of the PRMS gross channel, including the gross gamma activity output to the BOP RMS
 - 1.3 To verify the proper operation of the PRMS spectrometer channel, including the specific isotope activity output to the BOP RMS
 - 1.4 To verify the proper operation of the PRMS range control, including proper range indication on the large display panel and the range select contact outputs to the BOP RMS.

2.0 PREREQUISITES

- 2.1 The process radiation monitor has been installed, all interconnections have been completed, and the sample chamber has been filled with reactor makeup water.
- 2.2 The process radiation monitor has been calibrated.
- 2.3 A check source is available.
- 2.4 Support systems required for operation of the process radiation monitor are complete and operational.
2.5 System software is installed.

3.0 TEST METHOD

- 3.1 Using the built-in test features, observe process monitor indications, outputs to interface equipment, and alarm operation.
- 3.2 Using the check source, verify calibration of the process monitor.

4.0 DATA REQUIRED

- 4.1 Check source data
- 4.2 Process monitor operating data
- 4.3 Process monitor response to the check source
- 4.4 Value of parameters required to actuate alarms

5.0 ACCEPTANCE CRITERIA

- 5.1 The process radiation monitor of the process sampling system performs as described in Subsections 9.3.2.3 and 9.3.4.5.5.2.
- 5.2 PRMS energization shall be as designed
- 5.3 PRMS gross channel alarms are verified
- 5.4 The error of PRMS between the true output and observed output shall be within required range
- 5.5 PRMS spectrometer channel alarms are verified
- 5.6 The error of PRMS spectrometer channel between the true output and observed output shall be within required range

14.2.12.1.19 Gas Stripper Effluent Radiation Monitor Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To verify the proper energization of the GSERMS

1.2 To verify the proper operation of the GSERMS Gross Channel, including the gross gamma activity output to the BOP RMS

2.0 PREREQUISITES

- 2.1 The gas stripper effluent radiation monitor has been installed, all interconnections have been completed, and the sample chamber has been filled with reactor makeup water.
- 2.2 The gas stripper radiation monitor has been calibrated.
- 2.3 Support systems required for operation of the gas stripper effluent radiation monitor subsystem are complete and operational.
- 2.4 A check source is available.
- 2.5 System software is installed.

3.0 TEST METHOD

- 3.1 Using the built-in test features, observe process radiation monitor indications, outputs to interface equipment, and alarm operation.
- 3.2 Using a check source, verify calibration of the process monitor.

4.0 DATA REQUIRED

- 4.1 Process monitor operating data
- 4.2 Process monitor response to the check source
- 4.3 Value of parameters required to actuate alarms

5.0 ACCEPTANCE CRITERIA

- 5.1 The GSERMS performs as described in Subsection 9.3.4.5.5.1.
- 5.2 The actual output of GSERMS is-within required range of the expected output.

5.3 The alarm and indication operate as described in the related design specification.

14.2.12.1.20 Shutdown Cooling System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate valve response to failed conditions and to measure valve stroke times
 - 1.2 To demonstrate proper operations of Shutdown Cooling System (SCS) suction isolation valve control interlocks and alarms for Low Temperature Over-pressurization Protection (LTOP)
 - 1.3 To verify the set-point of the LTOP relief valves
 - 1.4 To demonstrate SCP performance in conformance to manufacturer's head versus flow curve
 - 1.4 To adjust SCP bypass flow
 - 1.5 To adjust SDCHX flow
 - 1.6 To adjust SDCHX bypass flow
 - 1.7 To adjust the IRWST return line flow
 - 1.8 To demonstrate that SCP suction pressure is adequate
 - 1.9 To demonstrate the capability of SCP pump to transfer flow to the IRWST
 - 1.10 To demonstrate the capability of CSP pump to transfer flow at a satisfactory rate to RCS
 - 1.11 To demonstrate SCP response to SIAS and CSAS in the lineup of containment spray operation
 - 1.12 To demonstrate Pull-to-Lock verification

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Plant systems required to support testing are operable and temporary systems are installed and operable.
- 2.3 Permanently installed instrumentation is operable and calibrated.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 All lines in the shutdown cooling system have been filled and vented. After verifying that there is no evidence of air through the vent valve, the vent valve shall be closed.
- 2.6 It shall be checked that all vent valves are closed before starting the shutdown cooling pumps.
- 2.7 The LTOP valve relief capacity has been verified by bench testing.

3.0 TEST METHOD

- 3.1 Verify proper operation of each shutdown cooling pump with minimum flow established.
- 3.2 Verify pump performance including head and flow characteristics for all design flow paths, which include the normal decay heat removal flow path and:
 - a. Shutdown cooling system flow to the chemical and volume control system for purification
 - b. Shutdown cooling system transfer of refueling water to the IRWST
 - c. Shutdown cooling system to cool the IRWST
- 3.3 Perform a full flow test of the shutdown cooling system.

- 3.4 Verify proper operation, stroking speed, position indication, and response to interlock of control and isolation valves.
- 3.5 Verify the proper operation of the protective devices, controls, interlocks, indications, and alarms using actual or simulated signals.
- 3.6 Verify isolation valves can be opened against design differential pressure.
- 3.7 Verify setpoint of the LTOP relief valves.
- 3.8 Verify the interchangeability of the containment spray pumps with the SCS pumps.
- 3.9 Verify adequate net positive suction head is available to the pumps.
- 3.10 Verify adequate heat removal capability by the SCS heat exchangers.
- 3.11 Verify proper operation of flow-limiting device in the SCS lines to limit runout flow.
- 3.12 Verify that each SCS train is capable of being powered by the electrically independent and redundant emergency power supplies.
- 3.13 Verify power-operated valves fail to the position specified in Subsection5.4.7 upon loss of motive power.

4.0 DATA REQUIRED

- 4.1 Valve position indications
- 4.2 Pump head versus flow
- 4.3 Valve opening and closing times, where required
- 4.4 Setpoints of alarms and interlocks
- 4.5 Setpoints of the LTOP relief valves
- 4.6 Position response of valves to loss of motive power

5.0 ACCEPTANCE CRITERIA

- 5.1 The shutdown cooling system performs as described in Subsection 5.4.7.
- 5.2 Shutdown Cooling System valves is opened and closed by their respective hand switches
- 5.3 Shutdown Cooling System valve maximum opening and closing times are satisfied
- 5.4 SCS valves fail to the required position on loss of power and go to the position indicated upon restoration of power.
- 5.5 SCS suction Isolation valves shall not be opened when pressurizer pressure exceeds the set-points
- 5.6 LTOP Transient Alarm is alarmed in accordance with pressurizer pressure / SCS Loop Isolation Valve position combinations
- 5.7 SCS Relief Valve Alignment Alarm is alarmed in accordance with cold leg temperature/SCS Loop Isolation Valve position combinations.
- 5.8 SCS Suction Isolation valve alarm is alarmed in the MCR when NOT FULLY CLOSED.
- 5.9 SCS manual valves alarm is alarmed in the MCR when NOT FULLY CLOSED or NOT FULLY OPENED.
- 5.10 SCP Suction pressure as measured at the pump suction centerline
- 5.11 Refueling pool water transfer flow rate for either SCP satisfy design limit
- 5.12 With the local handswitch in "Pull to Lock" CLOSE, the following valves can be operated from their hand switches at MCR
- 5.13 With the local handswitch in "Pull to Lock" OPEN the following valves can be operated from their hand switches at MCR
- 5.14 SCP bypass flow is within design limit

- 5.15 The total flowrate of the pathway below shall be adjusted to satisfy maximum design limit
 - RCS-CSP-SDCHX-RCS
 - RCS-SCP-SDCHX-RCS
 - RCS-SCP-Bypass Line of SDCHX-RCS
 - IRWST-SCP-Bypass Line of SDCHX-IRWST

14.2.12.1.21 <u>Safety Injection System Test</u>

- 1.0 OBJECTIVES
 - 1.1 To functionally test the operation and performance of the components within the SIS, including valve and pump performance
 - 1.2 To verify proper SI response to a SIAS using normal, alternate, and emergency power sources
 - 1.3 To verify the flow paths through the DVI nozzles and the hot leg injection piping
 - 1.4 To demonstrate the capability to perform full flow test of the SIS
 - 1.5 To verify the SI sampling system functions as designed
 - 1.6 To verify the elevation of SIS containment isolation valves relative to the IRWST water level

2.0 PREREQUISITES

- 2.1 Construction activities have been completed on the SIS.
- 2.2 Support systems and instrumentation required for operation of the SIS are essentially complete and operational.
- 2.3 The IRWST is filled with sufficient primary makeup water to conduct testing on the SI subsystem.

- 2.4 The reactor vessel head and internals have been removed.
- 2.5 Test instrumentation to be used for pump performance has been installed and calibrated.
- 2.6 SIS instrumentation has been checked and calibrated.
- 2.7 All lines in the safety injection system have been filled and vented. After verifying that there is no evidence of air through the vent valve, the vent valve shall be closed.
- 2.8 It shall be checked that all vent valves are closed before starting the safety injection pumps.

3.0 TEST METHOD

- 3.1 Operate control valves from all appropriate control locations and observe valve operation and position indication. Where required, measure opening and closing times.
- 3.2 Verify power-operated valves fail to the position specified in Subsection6.3.2 upon loss of motive power.
- 3.3 Operate SI from alternate electrical power sources and determine pump and valve responses including response times, when required.
- 3.4 Start each SI pump using an SIAS signal and collect initial pump operating data. For this portion of the test, the SI pumps are aligned to discharge to the depressurized RCS with appropriate discharge valves throttled and calibrated instrumentation installed to compare SI pump flow and discharge pressure to the pump manufacturer's head-flow curve. In addition, the throttle capability of the discharge valve is verified over its full operating position. This test is performed using normal, alternate, and emergency power. Suction is taken from the IRWST under maximum flow conditions in the combined suction header. Measured suction head is compared to the manufacturer's NPSH requirements when corrected for IRWST fluid temperature.

Operate each SI pump available for HLI through the HLI line and collect pump operating data.

- 3.5 Run each SI pump to demonstrate the ability to perform full-flow test capability.
- 3.6 Collect fluid samples from each of the system sampling points.
- 3.7 Run each SI pump at minimum flow recirculation to the IRWST and determine flow rate. Measured flow rate is compared to the required minimum flow rate.
- 3.8 Open valves in the SI lines between the IRWST and RCS and observe static head of water in pump discharge lines relative to IRWST level.

4.0 DATA REQUIRED

- 4.1 Valve position indication
- 4.2 Valve opening and closing times, where required
- 4.3 Position response of valves to loss of motive power
- 4.4 SI pump initial operational data including pump head versus flow, pump suction pressure and pumped fluid temperature, chemistry, and debris content
- 4.5 Response of SIS to SIAS when powered by normally alternate and emergency power sources
- 4.6 SI flow rates
- 4.7 Selected water levels

5.0 ACCEPTANCE CRITERIA

5.1 The SIS performs as described in Section 6.3 to provide adequate flow (manufacturer's curves) under minimum actual suction head to maintain RCS inventory and/or cool the core for the RCS breaks and transients in the scope of the safety analysis (Chapters 6 and 15).

- 5.2 SIS response times are less than those specified in Section 6.3.
- 5.3 Water samples from the SIS can be obtained.
- 5.4 Full-flow testing of the SIS can be performed.
- 5.5 SI system valves can be open and closed by their respective hand switches and status is indicated as specified
- 5.6 SI system valves should meet required stroke time (open and close) without flow
- 5.7 SI system valves fail to the required position on loss of control and 3phase power and go to the position indicated upon restoration of control and 3-phase power
- 5.8 Specified valves go to the position indicated upon a receipt of a SIAS signal
- 5.9 Total developed head of SIPs are within required range in miniflow operation
- 5.10 Total developed head of SIPs are within required range at rated flow conditions including miniflow or the flow rates of SIPs are within required range including miniflow at rated head
- 5.11 Total developed head of SIPs are within required range at runout condition
- 5.12 The DVI line flow rate should meet required design value with SI line isolation valves fully open
- 5.13 The hot-leg injection flow rate should meet required design value with SIP orifice 2-bypass valve fully open
- 5.14 The SIPs shall re-establish full flow in less than required time after being shutdown then restarted in the injection mode
- 5.15 SIS can be realigned from the injection mode to simultaneous hot-leg nozzle injection mode without any interruption of flow the RCS

- 5.16 Specified valves have a stroke time should meet required time in the open direction while the SIS is operating in the injection mode
- 5.17 SI line injection valves open and close against rated pump head and provide shutoff flow
- 5.18 SI hot-leg injection valves open and close against rated pump head and flow and provide shutoff flow as required

14.2.12.1.22 Safety Injection Tank Subsystem Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate valve operation and position indication
 - 1.2 To demonstrate valve response to failed conditions
 - 1.3 To measure valve stroke times
 - 1.4 To demonstrate valve control interlocks
 - 1.5 To demonstrate valve response to SIAS
 - 1.6 To verify instruments alarm setpoints
 - 1.7 To demonstrate SIT vent valve venting capability
 - 1.8 To demonstrate SIT hydraulic performance
 - 1.9 To verify SIT outlet valve operability in response to maximum differential pressure between SITs and RCS
 - 1.10 To demonstrate "Pull to lock" verification
 - 1.11 To demonstrate valve response to power removed condition

2.0 PREREQUISITES

2.1 Construction activities on the SIT subsystem have been completed.

- 2.2 Support systems required for the operation of the SIT subsystem are complete and operational.
- 2.3 Adequate supply of makeup water from the IRWST is available.
- 2.4 The reactor vessel head and internals have been removed.
- 2.5 The reactor vessel is filled above the DVI nozzles.
- 2.6 SIT subsystem instrumentation has been checked and calibrated.
- 2.7 All lines in the safety injection system have been filled and vented
- 2.8 Temporal vibration instrumentation on the SIT subsystem has been installed and calibrated.

3.0 TEST METHOD

- 3.1 Operate power-operated valves from all appropriate control locations and observe valve operation and position indication. Where required, measure valve opening and closing times.
- 3.2 Verify power-operated valves fail to the position specified in Subsection 6.3.2 upon loss of motive power.
- 3.3 Simulate an SIAS signal and observe valve interlock and alarm operation.
- 3.4 Fill the SITs from the IRWST and observe level indication and alarm operation.
- 3.5 Pressurize the SITs and observe pressure indication, control, and alarm operation.
- 3.6 Simulate an SIAS to each SIT and measure the time required for the SITs to discharge their contents to the RCS and measure the flow rate and the flow turndown time by fluidic device.
- 3.7 Pressurize each SIT to its maximum operating pressure and verify each SIT discharge valve open.

4.0 DATA REQUIRED

- 4.1 Valve position indications
- 4.2 Valve opening and closing times, where required
- 4.3 Position response of valves to loss of motive power
- 4.4 System response to SIAS
- 4.5 Setpoints at which alarms and interlocks occur
- 4.6 Times required for SITs to discharge their contents to the RCS
- 4.7 Flow turndown times required for SITs
- 4.8 Flow rate required for SITs when discharging their contents to the RCS
- 4.9 SIT pressure when stroking valves
- 4.10 Vibration of SIT subsystem pipes

5.0 ACCEPTANCE CRITERIA

- 5.1 The SIT subsystem performs as described in Subsection 6.3.2.2.2.
- 5.2 SIT subsystem valves can be open and closed by their respective hand switches and status is indicated as specified
- 5.3 Valves stroke time (open and close) without flow should meet required time
- 5.4 SIT system valves fail to the required position on loss of air and power and go to the position indicated upon restoration of air and power
- 5.5 Specified valves in SIT subsystem responses to SIAS
- 5.6 Specified initially closed valves can be power removed from the valve and switches at the MCR and RSR. Also the following initially open valves can close and be power removed at the MCR and RSR

- 5.7 SIT Subsystem level instrument alarm setpoints are verified
- 5.8 SIT Subsystem pressure instrument alarm setpoints are verified
- 5.9 SIT control valve interlocks are verified
- 5.10 SIT venting capability is demonstrated by each vent valve depressurizing SIT in less than required time
- 5.11 SIT hydraulic performance is demonstrated by each of the four SITs discharging its contents to the RCS from an initial wide range level and pressure which is provided by vendor, and the resistance coefficients in high flow and low flow mode are within required design range
- 5.12 Valves response to specified differential pressure between SITs and RCS pressure
- 5.13 Piping vibration is within acceptable limits and meets the criteria of ASME OM S/G Part 3.

14.2.12.1.23 Engineered Safety Features – Component Control System Test

The internal functions of the ESF-CCS are confirmed through factory acceptance testing. The basis of this in-plant test is to confirm the correct installation of the ESF-CCS, including inter-cabinet cable interfaces, and interfaces to other I&C systems, plant instrumentation and the controlled plant components. This test includes samples that overlap the digital functions previously tested in the factory to confirm that the correct operation of those functions has not been adversely affected by plant installation activities.

- 1.0 OBJECTIVES
 - 1.1 To verify the operation of the manual controls for each ESF component from the MCR, including the correct ESF component response and status feedback.1.2 To verify bumpless transfer of control from the MCR to the RSR, and the operation of the RSR manual controls, including the correct ESF component response.

- 1.3 To verify the interface of the PPS ESF actuation signals with associated alarms, including the correct ESF component response, for actuation and reset.
- 1.4 To verify the operation of the ESF actuation signals generated internally within the ESF-CCS with associated alarms, including the correct ESF component response, for actuation and reset. This test does not confirm instrument calibration.
- 1.5 To verify the operation of the emergency diesel generator (EDG) Load Sequencer with associated alarms. This test does not confirm instrument calibration.
- 1.6 To verify the operation of all ESF system process interlocks and automatic control signals with associated alarms, including the correct ESF component response for actuation and reset. This test does not confirm instrument calibration.
- 1.7 To verify the interface of the diverse protection system (DPS) actuation signals with associated alarms, including the correct ESF component response, for actuation and reset.
- 1.8 To verify the interface of the diverse manual ESF actuation (DMA) switches, for each ESF component with a DMA interface, including the correct ESF component response.
- 1.9 To verify the operation of redundant ESF-CCS power supplies.

2.0 PREREQUISITES

- 2.1 Factory acceptance tests have been completed for the ESF-CCS.
- 2.2 Construction activities for the ESF-CCS have been completed and system software is installed. This includes:

Installation and power-up of ESF-CCS electronic components, including digital controllers and I/O modules.

Connection of digital data communication interfaces, both wired and fiber-optic, between ESF-CCS internal components (e.g., operator modules) and to/from other plant systems.

Connection of wired interfaces between ESF-CCS internal components (e.g., conventional switches and indicators), to/from other plant systems, and to/from plant sensors and controlled plant components. Instrument calibration is not a prerequisite.

- 2.3 There are no unexpected ESF-CCS self-diagnostic alarms. Selfdiagnostic alarms may exist for temporary test conditions; any selfdiagnostic alarms are justified.
- 2.4 Electrical and mechanical systems, which contain the plant components controlled by the ESF-CCS, are configured to allow short term component state changes during the ESF-CCS tests. These state changes confirm correct ESF control and correct component status feedback processing.

3.0 TEST METHOD

The ESF-CCS tests are conducted to confirm the correct ESF-CCS control of the ESF plant components, not to confirm the performance of the plant's mechanical and electrical systems. Each method, below, corresponds to the test objective with the corresponding 1.X/3.X number designation. To verify redundancy and electrical independence within the ESF-CCS, these tests are conducted separately for each safety division with observations within the division under test and concurrent observations of the other divisions.

3.1 Manually change the state of each ESF plant component using each unique MCR human systems interface. This includes manual control from an ESF-CCS soft control module (ESCM), and control from each minimum inventory (MI) control for ESF components that have MI control. Distribute the tests across all ESCMs; but any single component is controlled from only one ESCM. Observe component status feedback and alarms.

- 3.2 Manually transfer control between the MCR and RSR using the master transfer switches. Manually change the state of the ESF plant components credited for safe shutdown using the ESCMs in the RSR. Observe component status feedback and alarms. This test is conducted on a sample basis, at least one component in each plant electrical and mechanical system, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1.
- 3.3 Manually initiate each ESF actuation signal generated by the PPS using the MCR system-level MI switches, then manually reset the signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in each ESF actuation group, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1.
- 3.4 Manually initiate each ESF actuation signal generated directly by the ESF-CCS using the MCR MI switches, then manually reset the signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in each ESF actuation group, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1. In addition, stimulate the sensor inputs to the ESF-CCS to generate these same ESF actuation signals automatically.
- 3.5 Stimulate the loss of offsite power (LOOP) and EDG sensor inputs to the ESF-CCS to initiate load shed and group sequence signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in

each sequence group, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1.

- 3.6 Stimulate the sensor inputs to the ESF-CCS for process interlocks and automatic control signals, then manually reset the signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be monitored. This monitoring is conducted on a sample basis, at least one component actuated by each interlock/control signal, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1.
- 3.7 Stimulate the DPS to generate each diverse actuation signal. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in each DPS actuation group, since the ability to change the state of all ESF components was confirmed in 14.2.12.1.23, subsection 3.1.
- 3.8 Manually change the state of each ESF plant component with a DMA interface, using the DMA switches in the MCR. Observe component status feedback and alarms.
- 3.9 De-energize each set of ESF-CCS logic power supplies (one at a time for each pair). Repeat this test for I/O power supplies. Observe component status feedback or ESFCCS outputs. This monitoring is conducted on a sample basis, at least one component controlled from each I/O rack of the ESF-CCS or one ESF-CCS output from each I/O rack of the ESF-CCS.

4.0 DATA REQUIRED

- 4.1 Component status feedback and alarms
- 4.2 Component status feedback or ESF-CCS outputs

5.0 ACCEPTANCE CRITERIA

Each acceptance criteria, below, corresponds to the test objective in Section 14.2.12.1.23 subsection 1.0 and the test method in Section 14.2.12.1.23 subsection 3.0, with the corresponding 1.X/3.X/5.X number designation. Test acceptance is confirmed for each separate safety division under test, with confirmation of no unexpected interactions with other safety divisions.

- 5.1 Each ESF plant component responds correctly to the manual control command from a MCR ESCM. Each ESF plant component with a MI control responds correctly to the MCR manual control command from the MI control.
- 5.2 There are no component state changes when the master transfer switches are activated. Each sampled ESF plant component responds correctly to the manual control command from a RSR ESCM.
- 5.3 ESF actuation alarms are generated and each ESF plant component, or ESF-CCS sampled output, responds correctly to the ESF actuation signal from the PPS. When the signals are reset all components remain in their actuated position.
- 5.4 ESF actuation alarms are generated and each ESF plant component, or ESF-CCS sampled output, responds correctly to the ESF actuation signal from the internally generated ESF actuation signals from the SLS. When the signals are reset all components remain in their actuated position. These same ESF actuation signals are generated through sensor stimulation.
- 5.5 LOOP alarms are generated and each ESF plant component that is controlled by load shed or group sequence signals, or ESF-CCS sampled output, responds correctly to the LOOP load shed and group sequence signals. Load shed signals result in ESF plant components going to their de-energized state. Group sequence signals energize the ESF plant component directly or allow the component to be energized by other ESF actuation signals.

- 5.6 Interlock alarms are generated and each ESF plant component, or ESF-CCS sampled output, responds correctly to the interlock and control signals. When an interlock is reset all components remain in their interlock demanded position, unless there is a specific reset reposition command in the component's control logic.
- 5.7 Each ESF plant component, or ESF-CCS sampled output, responds correctly to the diverse actuation signal from the DPS.
- 5.8 Each ESF plant component with a DMA control responds correctly to the manual control command from a MCR DMA switch.
- 5.9 Power supply failure alarms are generated. There are no state changes for the controlled plant components or the ESF-CCS outputs.

14.2.12.1.24 Plant Protection System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the proper operation of the bistable logic and coincidence logic of the PPS
 - 1.2 To verify the RPS and the ESFAS response times
 - 1.3 To verify the operation of the manual reactor trip
 - 1.4 To verify the PPS related alarm functions
 - 1.5 To verify the process input/output inter-connection and the input accuracy of PPS
 - 1.6 To verify the operation of the PPS interface to the MTP and Interface and Test Processor (ITP)
 - 1.7 To verify the integrity of signal path using manual testing functions and verify the operation of the manual testing functions on the MTP
 - 1.8 To verify the operation of watchdog timer of PPS
 - 1.9 To verify the operation of the interlock functions of PPS

- 1.10 To verify the operation of the operating bypasses functions of PPS
- 1.11 To verify the operation of the PPS power supplies
- 1.12 To verify the operation of the reactor trip circuit breaker in the reactor trip switchgear system (RTSS)
- 1.13 To verify the safe failure of the system on loss of power

2.0 PREREQUISITES

- 2.1 Construction activities on the trip circuit breaker and plant protection system and ESF-CCS have been completed.
- 2.2 PPS and ESF-CCS software is installed.
- 2.3 PPS instrumentation has been calibrated.
- 2.4 External test instrumentation is available and calibrated.
- 2.5 The interface systems for PPS such as CPCS, RTSS and ESF-CCS are operational.
- 2.6 Manual reactor trip switches and ESFAS switches in the MCR and RSR are operational.

3.0 TEST METHOD

To verify redundancy and electrical independence within the PPS, these tests are conducted separately for each safety division with observations within the division under test and concurrent observations of the other divisions.

- 3.1 Energize power supplies and verify output voltage.
- 3.2 Using simulated reactor trip signals, trip each reactor trip circuit breaker located in the RTSS with the breaker in the TEST position. Observe the reactor trip circuit breaker operation.
- 3.3 Repeat Step 3.2 with the reactor trip circuit breakers in the CONNECT position.

- 3.4 Perform the bistable logic test using the MTP and observe the setpoints used in the bistable logic and operation of the appropriate bistable logic.
- 3.5 Perform the coincidence logic test using the MTP and observe the operation of the coincidence logic.
- 3.6 Check the operation of operating bypass logic and switches.
- 3.7 Test the manual RPS trips and ESFAS actuation.
- 3.8 Check that low pressurizer pressure and low steam generator pressure trip setpoints track the process variable with a fixed value and can be manually reset to the proper margin below the process variable.
- 3.9 Using the MTP initiation testing function, trip the reactor trip circuit breakers and initiate ESFAS for each division at a time, and then observe alarm, and interface operation.
- 3.10 Inject signals into appropriate sensors or sensor terminals and measure the elapsed time to achieve tripping of the reactor trip circuit breakers or initiation of the ESFAS. Trip or actuation paths can be tested by overlapped testing method.
- 3.11 Check each bistable trip parameter's trip channel bypass feature, which blocks the trip condition at the LCL logic so that the channel trip does not occur as long as the trip channel bypass is enabled.
- 3.12 Simulate the loss of power by disconnecting the power connected to the PPS cabinets in the division under test. Observe the alarms and status of that division and check if a proper safe failure occurs in that division.

4.0 DATA REQUIRED

- 4.1 Power supply voltages
- 4.2 Reactor trip circuit breaker and indicator operation
- 4.3 Bistable logic trip/pre-trip setpoints
- 4.4 Reset margin and rate of setpoint change of variable setpoints

- 4.5 Maximum and minimum values of variable setpoints
- 4.6 RPS and ESF trip and actuation path response times
- 4.7 LCL operation

5.0 ACCEPTANCE CRITERIA

- 5.1 The PPS performs the safety functions as described in Sections 7.2 and 7.3.
- 5.2 The total response time of each RPS and ESFAS trip or actuation path is verified to be conservative with respect to the times used in the safety analysis.
- 5.3 Power Supplies are properly operated as specified in Subsection 7.2.2.3.
- 5.4 Fiber optic interconnections are provided as specified in Subsection 7.2.1.2.
- 5.5 PPS/APC-S interconnection is provided as specified in Subsection 7.2.1.
- 5.6 Alarm operations are provided as specified in Subsections 7.2.1.3 and 7.2.1.4.
- 5.7 Manual trip operation from MCR and RSR is operated as specified in Subsection 7.2.1.3.
- 5.8 Bistable trip function operations are provided as specified in Subsection 7.2.1.
- 5.9 Interlock functions are provided as specified in Subsection 7.2.1.7.
- 5.10 Operating bypass operation is provided as specified in Subsection 7.2.1.6.
- 5.11 Trip channel bypass operation is provided as specified in Subsection 7.2.1.6.

5.12 The proper safe failure is provided upon the loss of power to the PPS cabinets in the division under test. The alarms and status of that division is provided as specified in Table 7.2-7 and Subsections 7.2.1.3 and 7.2.1.4

14.2.12.1.25 <u>Ex-Core Neutron Flux Monitoring System</u>

1.0 OBJECTIVES

- 1.1 To verify the proper functional performance of the ex-core neutron flux monitoring system
- 1.2 To verify the proper performance of audio and visual indicators
- 1.3 To verify electrical independence of safety and non-safety portions of the ex-core neutron flux monitoring system.

2.0 PREREQUISITES

- 2.1 Construction activities on the ex-core neutron flux monitoring system have been completed.
- 2.2 Ex-core neutron flux monitoring system instrumentation has been calibrated.
- 2.3 External test equipment has been calibrated and is operational.
- 2.4 Support systems required for operation of the ex-core neutron flux monitoring system are operational.
- 2.5 Factory acceptance testing has been completed.

3.0 TEST METHOD

- 3.1 Using appropriate test instrumentation, simulate and vary input signals to the startup, safety, and control channels of the ex-core neutron flux monitoring system.
- 3.2 Monitor and record all output signals as a function of variable inputs provided by test instrumentation.

- 3.3 Record the performance of audio and visual indicators in response to changing input signals.
- 3.4 Verify that electrical independence is achieved for each channel, at interfaces between redundant channels, and at interfaces between safety and non-safety systems.

4.0 DATA REQUIRED

- 4.1 Values of input and output signals for correlation purposes, as required
- 4.2 Values of all output signals triggering audio and visual alarms

5.0 ACCEPTANCE CRITERIA

- 5.1 The ex-core neutron flux monitoring system performs as described in Subsections 7.2.1.1.c and 7.7.1.1.h.
- 5.2 Non-safety portions of the ENFMS channels are electrically independent of safety-related portions.

14.2.12.1.26 Fixed In-Core Nuclear Signal Channel Test

1.0 OBJECTIVES

- 1.1 To verify that the FIDAS hardware is installed and operating properly by providing each test input to the FIDAS terminals, verifying proper calibration.
- 1.2 To verify the measured output is provided to the IPS through the data link server and DCS network.
- 1.3 Verify Cable Continuity.
- 1.4 Verify Cable Insulation Resistance.

2.0 PREREQUISITES

- 2.1 Construction activities on the in-core nuclear instrumentation system are complete and system software is installed (Detectors do not need to be installed).
- 2.2 Fixed in-core nuclear instrumentation signal channel has been calibrated.
- 2.3 External test equipment has been checked and calibrated.
- 2.4 Support systems required for operation of the in-core nuclear instrumentation system are operational.

3.0 TEST METHOD

- 3.1 Measure and record cabling insulation resistance.
- 3.2 Using external test instrumentation, simulate in-core detector signals into the signal conditioning circuits.
- 3.3 Using internal test circuits, test each amplifier for proper operation in accordance with manufacturer's instruction manual.
- 3.4 Vary the simulated inputs to the amplifier and record its values displayed by the information processing system.

4.0 DATA REQUIRED

- 4.1 Cabling insulation resistance readings
- 4.2 Status and performance of the internal test circuits
- 4.3 Values of simulated input and derived output signals for correlation purposes

5.0 ACCEPTANCE CRITERIA

5.1 The fixed in-core nuclear signal channel cables and instrumentation perform as described in Subsection 7.7.1.1 g.

- 5.2 For each test input signal, the measured output should be within design values.
- 5.3 Cable continuity and cable insulation should be within design values.

14.2.12.1.27 Digital Rod Control System

- 1.0 OBJECTIVES
 - 1.1 To demonstrate proper input signals and proper sequencing of input signals to CEDM coils
 - 1.2 To demonstrate proper operation of the DRCS in all modes
 - 1.3 To verify proper operation of the DRCS interlocks and alarms
 - 1.4 To verify operation of the power supplies of the DRCS
 - 1.5 To verify operation of the status indicators of DRCS
 - 1.6 To verify that CEA positions are properly displayed on the "CEA Position" display of the IPS
 - 1.7 To verify operation of the manual individual, manual group and manual sequential modes
 - 1.8 To verify operation of interlock signals during the manual individual mode of operation
 - 1.9 To verify that applicable signals are given to the IPS
 - 1.10 To verify that applicable signals are given to the qualified indication and alarm system information non-safety
 - 1.11 To verify that applicable signals are given to the "CEA Core Mimic Display" section of the PCS display of the IPS
 - 1.12 To verify that applicable signal is given to the LPMS for the LPMS alarm inhibit

- 1.13 To verify that the applicable signals are given to the FWCS and the SBCS
- 1.14 To verify operation of the continuous CEA motion alarm
- 1.15 To verify that applicable signals are given to the BOP process component control system for the bus under voltage condition
- 1.16 To verify that the applicable signals are interfaced with the RRS and the RPCS

2.0 PREREQUISITES

- 2.1 Construction activities on the DRCS have been completed and system software is installed.
- 2.2 Cable continuity tests have been completed.
- 2.3 Special test instrumentation has been calibrated and is operational.
- 2.4 Special test equipment is operational.
- 2.5 Support systems required for operation of the DRCS are operational.

3.0 TEST METHOD

- 3.1 Using special test instrumentation, observe the sequence in which withdraw and insert signals are passed to the appropriate CEDM coil. Observe operation of the digital CEA position indicators.
- 3.2 Operate the DRCS in all modes. Simulate input signals and observe operation of interlocks and alarms.

4.0 DATA REQUIRED

- 4.1 CEDM coil current traces
- 4.2 DRCS totalizer indications
- 4.3 DRCS operating data

4.4 Interlock and alarm actuation points

5.0 ACCEPTANCE CRITERIA

- 5.1 The DRCS performs as described in Subsection 7.7.1.1 a.
- 5.2 Instrument power supply voltages of the DRCS should be within a design value.
- 5.3 Indicators in the DRCS should operate as specified in the respective steps.
- 5.4 DRCS operates in the MI mode, MG mode and MS modes as specified in the related design specification.
- 5.5 Interlock signals should operate during MI mode of operation in the related design specification.
- 5.6 Each alarm signal should be provided to the IPS under conditions in the related design specification.
- 5.7 The applicable signals should be provided to the IPS under the conditions described in the related design specification.
- 5.8 The applicable signals should be provided to the "CEA Core Mimic Display" section of the PCS display.
- 5.9 LPMS alarm inhibit signals should be provided to the LPMS.
- 5.10 Bus undervoltage signals should be provided to the FWCS.
- 5.11 Bus undervoltage signals should be provided to the SBCS.
- 5.12 Bus undervoltage signals should be provided to the RRS/RPCS.
- 5.13 Bus undervoltage signals should be provided to the BOP process component control system for the TCS.

14.2.12.1.28 <u>Reactor Regulating System Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the proper operation of the reactor regulating system (RRS)
- 1.2 To verify operation of RRS power supplies.
- 1.3 To verify that operation of the MTP, the status indicators on the RRS/RPCS and IPS.
- 1.4 To verify input operation from the interfacing equipment or systems to the RRS.
- 1.5 To verify internal calculation and logic processing operations.
- 1.6 To verify output operation to the interfacing equipment or systems.

2.0 PREREQUISITES

- 2.1 Construction activities on the RRS have been completed.
- 2.2 RRS software is installed and instrumentation has been calibrated.
- 2.3 External test equipment has been calibrated and is operational.
- 2.4 Support systems required for operation of the RRS are operational.
- 2.5 Cabling has been completed between the RRS and interface equipment.

3.0 TEST METHOD

- 3.1 Using actual or simulated interface inputs to the RRS, observe receipt of these signals at the RRS.
- 3.2 Using installed and external test instrumentation, vary all input signals to the system and observe output responses at the RRS and at interfacing equipment.

4.0 DATA REQUIRED

- 4.1 Input signal values
- 4.2 Status of interfacing control board equipment
- 4.3 RRS output response
- 4.4 Status of outputs received at interfacing equipment

5.0 ACCEPTANCE CRITERIA

- 5.1 The RRS performs as described in Subsection 7.7.1.1 a.
- 5.2 TAVG loop 1 and 2 should be within design value.
- 5.3 TAVG should be within design value.
- 5.4 TLI should be within design value.
- 5.5 Reactor power should be within design value.
- 5.6 CEA motion demand should be within design value.

14.2.12.1.29 Steam Bypass Control System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the proper operation of the SBCS

2.0 PREREQUISITES

- 2.1 Construction activities on the SBCS and interfacing equipment have been completed.
- 2.2 SBCS software is installed and instrumentation has been calibrated.
- 2.3 External test equipment has been calibrated and is operational.
- 2.4 Support systems required for operation of the SBCS are operational.

3.0 TEST METHOD

- 3.1 Using actual or simulated interface inputs to the SBCS, observe receipt of these signals at the SBCS.
- 3.2 Using installed and external test equipment, vary system inputs, and observe output responses at the SBCS and at interfacing equipment.
- 3.3 Verify proper response of the turbine bypass valves and position indicators with three types of valve signals which are a modulation signal, a quick opening signal, and permissive signal.

Dynamic operation of the turbine bypass valves is demonstrated during hot functional testing, and capacity testing of the turbine bypass valves is demonstrated during power ascension testing.

4.0 DATA REQUIRED

- 4.1 Input signal values
- 4.2 Status of interfacing control board equipment
- 4.3 SBCS output response
- 4.4 Status of outputs received at interfacing equipment

5.0 ACCEPTANCE CRITERIA

- 5.1 The SBCS performs as described in Subsections 7.7.1.1 d and 10.4.4.
- 5.2 SG steam flow 1, flow 2 and total flow should be as specified in the related design specification.
- 5.3 SG steam flow signal validation should be as specified in the related design specification.
- 5.4 Steam header pressure 1 and 2 should be as specified in the related design specification.

- 5.5 Pressurizer pressure 1 and 2 should be as specified in the related design specification.
- 5.6 Pressurizer pressure deviation should be as specified in the related design specification.
- 5.7 TAVG should be as specified in the related design specification.
- 5.8 Reactor power should be as specified in the related design specification.
- 5.9 Turbine load index should be as specified in the related design specification.
- 5.10 Quick open block for main and permissive should be as specified in the related design specification.
- 5.11 Reactor power cutback and quick open of related valve should be as specified in the related design specification.
- 5.12 Emergency off and condenser interlock should be as specified in the related design specification.
- 5.13 Automatic motion inhibit should be as specified in the related design specification.
- 5.14 Turbine runback demand should be as specified in the related design specification.
- 5.15 Turbine bypass valve 1-8 digital and analog outputs should be as specified in the related design specification.
- 5.16 Main and permissive controller outputs should be as specified in the related design specification.
- 5.17 Dedicated controllers on safety console should be as specified in the related design specification.
- 5.18 SBCS valve stroke test should be as specified in the related design specification.

14.2.12.1.30 Feedwater Control System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the proper operation of the FWCS
- 1.2 To verify operation of the EWS and the IFPDs for FWCS

2.0 PREREQUISITES

- 2.1 Construction activities on the FWCS and interfacing equipment have been completed.
- 2.2 FWCS software is installed and instrumentation has been calibrated.
- 2.3 External test equipment has been calibrated and is operational.
- 2.4 Support systems required for the operation of the FWCS are operational.
- 2.5 Cabling has been completed between the FWCS and interfacing equipment.

3.0 TEST METHOD

- 3.1 Using actual or simulated interface inputs to the FWCS, observe receipt of these signals at the FWCS.
- 3.2 Using installed and external test instrumentation, vary all input signals to the system and observe output responses at the FWCS and at interfacing equipment.
- 3.3 Monitor the system during initial operation and verify proper operation.

4.0 DATA REQUIRED

- 4.1 Input signal values
- 4.2 Status of interfacing control board equipment
- 4.3 FWCS output response

4.4 Status of output received at interfacing equipment

5.0 ACCEPTANCE CRITERIA

- 5.1 The FWCS performs as described in Subsections 7.7.1.1 c and 10.4.7.
- 5.2 Feedwater Temperature should be as specified in the related design specification.
- 5.3 Main steam header pressure should be as specified in the related design specification.
- 5.4 Feedwater common header pressure should be as specified in the related design specification.
- 5.5 Total feedwater flow should be as specified in the related design specification.
- 5.6 SG level should be as specified in the related design specification.
- 5.7 Downcomer feedwater flow should be as specified in the related design specification.
- 5.8 Input signals from the interfacing systems should be as specified in the related design specification.
- 5.9 Reactor trip override should be as specified in the related design specification.
- 5.10 Feedwater pump speed and valve position demand programs should be as specified in the related design specification.
- 5.11 Feedwater pump and valve M/A controllers should be as specified in the related design specification.
- 5.12 Steam/feedwater flow error should be as specified in the related design specification.
- 5.13 SG level setpoint should be as specified in the related design specification.

- 5.14 Pressure setpoint signal should be as specified in the related design specification.
- 5.15 Feedwater pump speed setpoint Bias should be as specified in the related design specification.

14.2.12.1.31 Core Operating Limit Supervisory System Test

1.0 OBJECTIVES

- 1.1 To verify proper operation of the COLSS application program contained in the IPS
- 1.2 To confirm the COLSS algorithms and constants
- 1.3 To demonstrate that NAPS COLSS results correspond to expected results with acceptance tolerances including generation of bad values as expected.

2.0 PREREQUISITES

- 2.1 The IPS is functioning to support this testing.
- 2.2 The COLSS application program has been implemented in the IPS.
- 2.3 Test cases have been generated in an off-line computer and adapted to interface with the IPS COLSS test program.
- 2.4 Results of the test case runs performed on the COLSS program are available.

3.0 TEST METHOD

3.1 Using the COLSS test program contained in the IPS, simulate the COLSS inputs for each test case.
4.0 DATA REQUIRED

4.1 Record values of all simulated inputs, appropriate intermediate values, and outputs. (The online test program automatically performs this task.)

5.0 ACCEPTANCE CRITERIA

- 5.1 The COLSS performs as described in Subsection 7.7.1.4.
- 5.2 The test result of COLSS test program should meet the acceptance criteria for each test case which is specified in related design documents.

14.2.12.1.32 Reactor Power Cutback System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate proper operation of the RPCS
 - 1.2 To verify operation of the MTP and the IPS to the RPCS.
 - 1.3 To verify that the applicable RPCS output signals are received by the interfacing equipment or systems.

2.0 PREREQUISITES

- 2.1 Construction activities on the RPCS have been completed and RPCS software is installed.
- 2.2 RPCS instrumentation has been calibrated.
- 2.3 External test equipment has been checked and calibrated.
- 2.4 Support systems required for the operation of the RPCS are operational.
- 2.5 Wiring has been completed between the RPCS and interface equipment.

3.0 TEST METHOD

3.1 Using actual or simulated interface inputs to the RPCS, observe receipt of these signals at the RPCS.

3.2 Using installed and external instrumentation, vary all input signals to the system and observe output responses at the RPCS and at interfacing equipment.

4.0 DATA REQUIRED

- 4.1 Input signal values
- 4.2 Status of interfacing control board equipment
- 4.3 RPCS output response
- 4.4 Status of outputs received at interfacing equipment

5.0 ACCEPTANCE CRITERIA

5.1 The RPCS performs as described in Subsection 7.7.1.1 e.

14.2.12.1.33 Fuel Storage and Handling system Test

- 1.0 OBJECTIVES
 - 1.1 To verify the proper operation of the fuel handling equipment

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Permanently installed instrumentation is operable and calibrated.
- 2.3 Plant systems required to support testing are operable or temporary systems are installed and operable.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The reactor vessel head and upper guide structure are removed.
- 2.6 The core support barrel is installed and aligned.
- 2.7 Dummy fuel assembly, dummy control element assemblies (CEAs), and test weights are available.

3.0 TEST METHOD

- 3.1 Verify the proper operation of the new fuel elevator and the associated interlocks.
- 3.2 Verify the proper operation of the spent fuel handling machine, checking bridge, trolley, hoist speeds, load limits, interlocks, and limit switches.
- 3.3 Using the X-Y coordinates and the spent fuel handling machine, fit each of the usable spent fuel storage rack positions using the dummy fuel assembly.
- 3.4 Verify the fuel transfer system using both control consoles and upenders to prove proper operation.
- 3.5 Verify the proper operation of the refueling machine, checking bridge, trolley, hoist speeds, limit switches, interlocks, and load limits.
- 3.6 Index and record the reactor core positions using the refueling machine.
- 3.7 Using a dummy fuel assembly, fit the core locations and record coordinates.
- 3.8 Verify the proper operation of the CEA change platform and CEA elevator, including operating speeds, interlocks, load limits, and limit switches.
- 3.9 Verify the following:
 - 3.9.1 Using the full sequence of focusing, TV camera tilt mechanism, verify the proper operation of the underwater TV camera system.
 - 3.9.2 Using the complete fuel handling equipment, transfer a dummy fuel assembly from the new fuel elevator through a total fuel loading cycle in the reactor core and a total spent fuel cycle from the core to the spent fuel storage rack both in automatic and manual modes of operation.

- 3.9.3 Demonstrate the capabilities of the special fuel handling tools through proper operation with dummy fuel assembly and dummy control element assembly.
- 3.9.4 Perform a static load test at 125% rated load and a dynamic load test at 100% rated load for the refueling machine and spent fuel handling machine.

4.0 DATA REQUIRED

- 4.1 Applicable indexing coordinates
- 4.2 Monitoring instrumentation responses

5.0 ACCEPTANCE CRITERIA

- 5.1 Fuel Storage and Handling System performs as described in Section 9.1.
- 5.2 The refueling machine and spent fuel handling machine lift and hold 125% of rated load under static conditions and are capable of full operation at 100% of rated load.

14.2.12.1.34 <u>Auxiliary Feedwater System Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the manual operation of the motor and solenoid operated valves
- 1.2 To demonstrate the operability of the system indications, alarms and status lights
- 1.3 To verify endurance of the auxiliary feedwater pump for a 48 hour test
- 1.4 To demonstrate the fail positions of the solenoid valves
- 1.5 To demonstrate the manual operation of the auxiliary feedwater pumps
- 1.6 To record baseline vibration and temperature data of the auxiliary feedwater pumps while operating at recirculation flow and design flow

- 1.7 To verify the time to open and close valves
- 1.8 To demonstrate AFW pumps design performance
- 1.9 To demonstrate supply of the raw water tank and CST
- 1.10 To demonstrate proper valve response to auxiliary feedwater actuation signal (AFAS) and override signals
- 1.11 To demonstrate AFW Pump response to AFAS and override signals
- 1.12 To verify endurance of the AFW Pump for a 48-hour test

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Permanently installed instrumentation is operable and calibrated.
- 2.3 Test instrumentation is available and calibrated.
- 2.4 Plant systems required to support testing are operable, or temporary systems are installed and operable.

3.0 TEST METHOD

- 3.1 Verify all control logic.
- 3.2 Verify head and flow characteristics of motor-driven auxiliary feedwater pumps.
- 3.3 Verify the starting time and head and flow characteristics of the turbinedriven auxiliary feedwater pump at the full design range of steam pressures (hot functional test / power ascension test [HFT/PAT]).
- 3.4 During the startup program, demonstrate five consecutive cold quick starts for the turbine-driven auxiliary feedwater pump (HFT/PAT).
- 3.5 Verify all design flow paths and verify that flow downstream of venturi meets design requirement.

- 3.6 Verify proper operation in response to simulated AFAS from the plant protection system and the diverse protection system.
- 3.7 Verify proper operation in response to manual control actions
- 3.8 Verify, if appropriate, proper operation, stroking speed, and position indication of control valves.
- 3.9 Verify AFW discharge line isolation valves stroke properly with design basis differential pressure across them.
- 3.10 Verify proper operation of protective devices, controls, interlocks, instrumentation, and alarms using actual or simulated inputs.
- 3.11 Demonstrate proper pump performance during an endurance test.
- 3.12 Verify power-operated valves fail to the position specified in Subsection 10.4.9 upon loss of motive power.

4.0 DATA REQUIRED

- 4.1 Valve position indications
- 4.2 Valve opening and closing times, where required, including valve stroke time under design basis differential pressure
- 4.3 Pump head-versus-flow curves
- 4.4 Flow rates downstream of venturi
- 4.5 Response of AFW pumps and components to manual controls and automatic controls of AFAS
- 4.6 Pump start times
- 4.7 Position response of valves to loss of motive power

5.0 ACCEPTANCE CRITERIA

5.1 Auxiliary feedwater pumps suction/discharge pressure hi/low alarms are properly annunciated.

- 5.2 AFWP discharge temperature Hi alarms are properly annunciated.
- 5.3 48-hour endurance test is performed on all AFWS pumps. Following the 48-hour run, the pumps are shut down and cooled down and then restarted for one hour. It is confirmed that the pump remains within the design limits with respect to bearing/bearing oil temperatures and vibration, and that pump room ambient conditions (temperature and humidity) do not exceed environmental qualification limits for safety-related equipment in the room.
- 5.4 AFW pump provide design flowrate at total developed head greater than minimum design value.
- 5.5 AFW pumps and components properly respond to manual controls and automatic controls of AFAS.
- 5.6 48-hour endurance test is performed on all AFWS pumps. Following the 48-hour run, the pumps are shutdown and cooldown and then restarted for one hour. It is confirmed that the pump remains within the design limits with respect to bearing/bearing oil temperatures and vibration, and that pump room ambient conditions (temperature and humidity) do not exceed environmental qualification limits for safety-related equipment in the room.

14.2.12.1.35 Reactor Coolant System Hydrostatic Test

- 1.0 OBJECTIVES
 - 1.1 To verify the integrity of the reactor coolant system (RCS) pressure boundary and associated unisolable Safety Class 1&2 piping systems.

2.0 PREREQUISITES

- 2.1 The RCS is filled, vented, and at the required temperature.
- 2.2 The reactor coolant pumps are operable.
- 2.3 Test pump is available.

- 2.4 Pressurizer pilot-operated safety relief valves are removed and other temporary relief valve opening set pressures are changed.
- 2.5 Permanently installed instrumentation necessary for testing is operable and calibrated.
- 2.6 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Operate reactor coolant pumps to sweep gases from the steam generator tubes.
- 3.2 Vent the RCS and all control element drive mechanism housings.
- 3.3 Operate the reactor coolant pumps to increase the RCS temperature to that required for pressurization of RCS to test pressure.
- 3.4 Perform the test in accordance with the American Society of Mechanical Engineers (ASME) Code.

4.0 DATA REQUIRED

4.1 RCS temperature and pressure

5.0 ACCEPTANCE CRITERIA

- 5.1 The RCS hydrostatic test meets the requirements of ASME Code Section III
- 5.2 There is no leakage from all joints and welded connections within the hydrostatic test boundary

14.2.12.1.36 Control Element Drive Mechanism Cooling System Test

1.0 OBJECTIVES

- 1.1 To verify proper operation of the CEDM cooling fans
- 1.2 To verify all status lights and system alarms

- 1.3 To demonstrate the interlock and link operation of CEDM cooling fans
- 1.4 To demonstrate that the CEDM cooling fans installed on the IHA meet the required airflow rate
- 1.5 To verify continuity of the CEDM power and RSPT cable assemblies
- 1.6 To verify insulation resistance for the RSPT cable assemblies
- 1.7 To verify proper CEDM cooling performance of the IHA

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Permanently installed instrumentation is operable and calibrated.
- 2.3 Test instrumentation is available and calibrated.
- 2.4 Plant systems required to support testing are operable, or temporary systems are installed and operable.

3.0 TEST METHOD

- 3.1 Verify all control logic.
- 3.2 Operate the system in the normal mode and verify system airflow and balance.
- 3.3 Verify the proper operation of interlocks and alarms.
- 3.4 During hot functional testing, verify that the system maintains design temperature under actual heat load conditions.

4.0 DATA REQUIRED

- 4.1 Airflow rates
- 4.2 RCS temperatures and pressures
- 4.3 Setpoints at which interlocks and alarms occur

5.0 ACCEPTANCE CRITERIA

- 5.1 The CEDM cooling fans can be started and stopped using their respective hand switches.
- 5.2 The airflow rate of CEDM cooling fan shall be within design limit.
- 5.3 The insulation resistance shall be greater than or equal to design limit.
- 5.4 During normal operating condition of the RCS and the CEDM cooling system, all the CEDM coil temperatures in CEA HOLD mode shall be remained lower than design limit in any operating condition.

14.2.12.1.37 <u>Reactor Coolant Gas Vent System Test</u>⁽¹⁾

- 1.0 OBJECTIVES
 - 1.1 To verify proper operation of the reactor coolant gas vent system (RCGVS) valves.
 - 1.2 To verify the function to provide the Reactor Coolant System (RCS) depressurization.
 - 1.3 To verify proper operation of the instruments for temperature and pressure, and system alarms.
 - 1.4 To verify valve response to failed conditions.
 - 1.5 To verify valve stroke times.

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Plant systems required to support testing are operable and temporary systems are installed and operable.
- 2.3 Permanently installed instrumentation is operable and calibrated.

⁽¹⁾ It is also performed during Pre-core HFT

2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Verify proper operation of the valves and position indication.
- 3.2 Verify that the RCGVS (both the pressurizer vent and the reactor vessel closure head vent) perform the depressurization function of RCS.
- 3.3 Verify proper operation of the instruments and system alarms.
- 3.4 Verify power-operated valves fail to the position upon loss of motive power.
- 3.5 Verify valve opening and closing times.

4.0 DATA REQUIRED

- 4.1 Valve position indications
- 4.2 RCS temperature and pressures
- 4.3 Depressurization rates using the reactor coolant gas vent function
- 4.4 Reactor drain tank temperature, pressure, and level
- 4.5 IRWST temperature, pressure, and level
- 4.6 Setpoints of alarms
- 4.7 Position response of valves to loss of motive power
- 4.8 Valve opening and closing times

5.0 ACCEPTANCE CRITERIA

5.1 The RCGVS valves are opened and closed by their respective hand switches, and the position indicator for each valve indicates the status of valve (open or close) properly following the corresponding valve operation.

- 5.2 The RCGVS (both the pressurizer vent and the reactor vessel closure head vent) meets the depressurization rates.
- 5.3 Alarms for high temperature and high pressure are properly annunciated.
- 5.4 The RCGVS valves fail to the required position on loss of power and go to the position indicated upon restoration of power.
- 5.5 The RCGVS valves maximum opening and closing times are satisfied.

14.2.12.1.38 Containment Spray System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the containment spray ring headers and their nozzles are free of obstruction
 - 1.2 To demonstrate the operation of the CS system remote operated valves.
 - 1.3 To demonstrate the performance of the containment spray pumps.
 - 1.4 To demonstrate system responses to CSAS and SIAS signals.
 - 1.5 To demonstrate the system valves fail position.
 - 1.6 To demonstrate the operation of the system status lights and alarms
 - 1.7 To demonstrate the emergency containment spray backup system (ECSBS) spray ring header and its nozzles are free of obstruction.
 - 1.8 To verify proper operation of the ECSBS

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Plant systems required to support testing are operable and temporary systems are installed and operable.
- 2.3 Permanently installed instrumentation is operable and calibrated.

- 2.4 Test instrumentation is available and calibrated.
- 2.5 The ECSB pumping device is operable.
- 2.6 The ECSBS components are located in their designated storage area(s).
- 2.7 The ECSB water source is sufficient for testing.

3.0 TEST METHOD

- 3.1 Verify proper operation of each containment spray pump with minimum flow established.
- 3.2 Verify pump and system performance including head and flow characteristics for all design flow paths.
- 3.3 Verify, if applicable, proper operation, stroking speed, and position indication of control valves.
- 3.4 Verify by using service air that the containment spray header and nozzles are free of obstructions.
- 3.5 Verify the automatic operation of all components in response to a containment spray actuation signal.
- 3.6 Verify the interchangeability of the shutdown cooling pumps with the CSS pumps.
- 3.7 Verify adequate heat removal capability by the CSS heat exchangers.
- 3.8 Verify power-operated valves fail to the position specified in Subsections 6.5.2 and 6.3.2 upon loss of motive power.
- 3.9 Verify containment spray pump suction static head
- 3.10 Verify emergency containment spray backup pumping device connectability to the containment spray tee connection. Verify pumping device performance, including head and flow characteristics.
- 3.11 Verify CS Pump suction static head.

- 3.12 For ECSBS testing in division A:
 - a. Confirm that the containment spray header isolation valve (inside containment) is closed.
 - b. Connect the ECSB to the suction (water) source and to the IRWST fill / CSS header flange.
 - c. Establish a flow path to a suitable collection tank (e.g., IRWST).
 - d. Verify ECSB pump performance characteristics at rated flow conditions.

4.0 DATA REQUIRED

- 4.1 Valve position indications
- 4.2 Pump head-versus-flow characteristics
- 4.3 Valve opening and closing time, where required
- 4.4 Setpoints at which interlocks and alarms occur
- 4.5 Position response of valves to loss of motive power
- 4.6 For ECSBS testing in division A:
 - a. Time to connect ECSB and initiate flow
 - b. ECSB pump head at rated flow

5.0 ACCEPTANCE CRITERIA

- 5.1 The containment spray ring headers should be verified on air flow path through each of the nozzles.
- 5.2 Isolation valves should be automatically open upon CSAS.
- 5.3 Containment spray pump should start upon CSAS in accordance with diesel generator load sequences.

- 5.4 Containment spray pump should be stopped upon a load shed signal
- 5.5 The alarm should be initiated when the containment spray heat exchanger inlet valves are not fully open
- 5.6 The CS Pumps discharge pressure low signal alarm should be initiated when setpoint is reached
- 5.7 The CS Pumps motor air filter differential pressure low signal alarm should be initiated when setpoint is reached
- 5.8 Motor operated valves should meet the required stroke open/close time
- 5.9 The ECSBS spray ring headers should be verified on air flow path through each of the nozzles.
- 14.2.12.1.39 Integrated Engineered Safety Features / Loss of Power Test
 - 1.0 OBJECTIVES
 - 1.1 To verify the full operational sequence of the engineered safety features (ESF)
 - 1.2 To demonstrate electrical redundancy, independence, and load group assignment
 - 1.3 To demonstrate proper plant response to partial and full losses of offsite power

2.0 PREREQUISITES

- 2.1 Individual system preoperational tests are complete.
- 2.2 Containment spray isolation valves are tagged shut.
- 2.3 Permanently installed instrumentation is operable and calibrated.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 IRWST is filled to normal operating level.

3.0 TEST METHOD

- 3.1 Perform partial and full losses of offsite power. Verify the proper response of ESF systems, alternate power sources, uninterruptible power supplies, and instrumentation and control systems. To verify redundancy and electrical independence within the ESF-CCS and throughout the ESF systems, these tests are conducted separately for each safety division with observations within the division under test and concurrent observations of the other divisions.
- 3.2 Under loss-of-power conditions, verify operability of systems/components from energized buses and absence of voltage on de-energized buses. Include ESF systems, appropriate heating, ventilation and air conditioning (HVAC) systems, decay heat removal systems, and systems required under post-accident conditions. Observe the status of ESF plant components that are load shed by the ESF-CCS.
- 3.3 Demonstrate the proper diesel generator response to loss of power including bus energization, load sequencing, and load-carrying capability. Verify the response of the EDG and EDG breaker to ESF-CCS signals for EDG start and EDG connection to the ESF buses. Verify the response of the ESF plant components that are automatically connected to the ESF buses by the load sequencer; this verification confirms that components are reenergized within the correct load group and within the correct sequence time.
- 3.4 Verify that full load is within the emergency diesel generator design capability.
- 3.5 Demonstrate proper response to actual or simulated engineered safety features actuation signals (ESFAS). ESF actuation signals are generated before a LOOP is generated, during a load sequence, and after a load sequence has been completed.

4.0 DATA REQUIRED

4.1 Response to ESFAS signals

- 4.2 Diesel start times, load sequence times, frequency, voltage, and current
- 4.3 Valve stroke times

5.0 ACCEPTANCE CRITERIA

5.1 Correct response in accordance with Section 7.3 includes the following:

All components that must be load shed are disconnected from the ESF buses when the LOOP is detected. The EDG is started when the LOOP is detected. The EDG is connected to the ESF buses when the EDG has reached the correct load carrying rating. The ESF controlled plant components are connected to the ESF buses in the correct time sequence and with the correct load groups.

- 5.2 Electrical redundancy, independence, and load group assignments are as designed. Correct electrical redundancy and independence is confirmed by testing each division separately, separately confirming each division's response, including the response of the EDG, EDG breaker and ESF component load group sequencing, and confirming no unexpected interactions with other safety divisions.
- 5.3 Plant response to partial and full losses of offsite power is as designed.
- 5.4 The diesel generators reenergize loads as designed and full load is within design capability.

14.2.12.1.40 In-Containment Water Storage System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the proper operation of the in-containment refueling water storage tank (IRWST), holdup volume tank (HVT), and cavity flooding system (CFS)
 - 1.2 To demonstrate the operation of the IRWST remote operated valves
 - 1.3 To demonstrate system alarms and status lights
 - 1.4 To demonstrate system responses to CIAS signals

1.5 To demonstrate the failed position of valves

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Plant systems required to support testing are operable or temporary systems are installed and operable.
- 2.3 Permanently installed instrumentation is operable and calibrated.
- 2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Operate control valves from all appropriate control positions. Observe valve operation and position indication, and measure opening and closing times.
- 3.2 Fill the IRWST with reactor makeup water and record volume versus indicated level. Observe level alarms.
- 3.3 Simulate IRWST temperature and observe alarms.
- 3.4 Verify design flow path from IRWST to the HVT and reactor cavity.
- 3.5 Verify the level alarms and indication of the IRWST and HVT.
- 3.6 Verify the operability and adequacy of range of the control room IRWST pressure instrumentation.
- 3.7 Verify the operation and setpoints of the IRWST swing panel.

4.0 DATA REQUIRED

- 4.1 Valve position indications
- 4.2 Valve opening and closing time, where required
- 4.3 Setpoints at which alarms occur

4.4 Swing panel opening pressure

5.0 ACCEPTANCE CRITERIA

- 5.1 Valves should be operated at their status indicated.
- 5.2 IRWST temperature HI/LOW alarm should be annunciated.
- 5.3 IRWST Level HI/LOW alarm should be annunciated.
- 5.4 HVT Level HI alarm should be annunciated.
- 5.5 Swing Panel Open alarm should be annunciated.
- 5.6 Containment isolation valves should be closed within max closing time upon receipt of a CIAS signal.
- 5.7 SOVs should be closed on loss of control power and reopened when control power is restored.
- 14.2.12.1.41 Internals Vibration Monitoring System Test
 - 1.0 OBJECTIVES
 - 1.1 To verify the proper operation of the IVMS of the NIMS
 - 2.0 PREREQUISITES
 - 2.1 Construction activities on the NIMS applicable to the IVMS are completed.
 - 2.2 Sensors, cables, and signal conditioning electronics are installed and operable.
 - 2.3 Data analysis software programs are installed and operable.
 - 2.4 Power cabinets are operable to support testing requirements.
 - 2.5 Required test equipment is operable.

3.0 TEST METHOD

- 3.1 Verify the ability to detect and record reactor core internal motion by applying simulated signals to the core internal motion channels.
- 3.2 Verify all alarming functions, as applicable.
- 3.3 Verify that data analysis software programs receive appropriate data and perform specified analysis functions.

4.0 DATA REQUIRED

4.1 Data analysis results and evaluations

5.0 ACCEPTANCE CRITERIA

- 5.1 The IVMS performs as described in Subsection 7.7.1.
- 5.2 All 12 channels of excore signals are received at the IVMS system as described in the related design specification.
- 5.3 The automatic data acquisition and alarming function performs as described in the related design specification.
- 5.4 NIMS operating station, including the remote control, the remote channel status display, IPS alarming and alarm logging perform as described in the related design specification.
- 5.5 Boron concentration level properly affects the alarming algorithm as described in the related design specification.
- 5.6 "Min % Power for Data Acquisition" is operating properly as described in the related design specification.

14.2.12.1.42 Loose Parts Monitoring System Test

- 1.0 OBJECTIVES
 - 1.1 To verify the proper operation of the LPMS of the NIMS
 - 1.2 To adjust the loose parts alarm setpoints for power operation

2.0 PREREQUISITES

- 2.1 Construction activities on the NIMS applicable to the LPMS are completed.
- 2.2 Sensors, cables, and signal conditioning electronics are installed and operable.
- 2.3 Power cabinets, test circuits, and amplifiers are ready to support testing.
- 2.4 Required test equipment is operational.

3.0 TEST METHOD

- 3.1 Verify the calibration and alarm setpoint of the loose parts monitoring channels with a mechanical impulse type device.
- 3.2 Verify all alarm functions.
- 3.3 Establish the alarm level for loose parts channels in a cold, subcritical plant. This alarm level applies to the preoperational test phase, to startup, and to power operations.

4.0 DATA REQUIRED

- 4.1 Baseline vibration data
- 4.2 Alarm levels applicable to detectable loose parts

5.0 ACCEPTANCE CRITERIA

- 5.1 The LPMS performs as described in Subsection 7.7.1.
- 5.2 The loose parts alarm setpoints have been adjusted for power operation.
- 5.3 The preamplifier test signal and the system test signal are generated as described in the related design specification.
- 5.4 The alarms and indication operate as described in the related design specification.

- 5.5 The LPMS determine the source location of an unknown impact as described in the related design specification.
- 5.6 The audio from the LPMS can be heard as described in the related design specification.

14.2.12.1.43 Acoustic Leak Monitoring System Test

1.0 OBJECTIVES

- 1.1 To verify proper operation of the ALMS of the NIMS
- 1.2 To adjust the alarm setpoints under operational conditions

2.0 PREREQUISITES

- 2.1 Construction activities on the NIMS applicable to the ALMS are complete.
- 2.2 Sensors, cables, and signal conditioning electronics are installed and operable.
- 2.3 Power cabinets, test circuits, and amplifiers are ready to support testing.
- 2.4 Required test equipment is operable.

3.0 TEST METHOD

- 3.1 Verify the calibration and alarm setpoints using simulated signals to the acoustic monitoring channels.
- 3.2 Verify all alarm functions.
- 3.3 Establish the alarm level. This alarm level applies to the preoperational test phase, to startup, and to power operations.

4.0 DATA REQUIRED

- 4.1 Baseline acoustic data
- 4.2 Alarm levels applicable to detection of coolant leaks

5.0 ACCEPTANCE CRITERIA

- 5.1 The ALMS performs as described in Subsection 7.7.1.
- 5.2 The alarm setpoints have been established as described in the related design specification.
- 5.3 The alarms and indication operate as described in the related design specification.

14.2.12.1.44 Information Processing System and Qualified Information and Alarm System Test

1.0 OBJECTIVES

- 1.1 To verify that the IPS, as incorporated in the human-system interface system, is installed properly, responds correctly to external inputs, and provides proper outputs to the distributed display, control, and recording equipment
- 1.2 To verify proper operation of the QIAS

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Applicable operating manuals are available.
- 2.3 Required software is installed and operable.
- 2.4 External test equipment and instrumentation is available and calibrated.
- 2.5 Plant systems required to support testing are operable to the extent necessary to perform the testing or suitable simulation of these system are used.

3.0 TEST METHOD

3.1 Verify power sources to all related equipment.

- 3.2 Validate that external inputs are received and processed correctly by the appropriate system devices.
- 3.3 Verify that alarms and indication displays respond correctly to actual or simulated inputs.
- 3.4 Verify the operability of required software application programs.
- 3.5 Verify the correct operation of data output devices and displays at applicable workstations and terminals.
- 3.6 Evaluate processing system loading under actual or simulated operating conditions.

4.0 DATA REQUIRED

4.1 Computer-generated summaries of external input data, data processing, analysis functions, displayed information, and data records

5.0 ACCEPTANCE CRITERIA

5.1 The IPS and QIAS associated with the human-system interface system perform as described in Subsections 7.7.1.4 and 7.5.1.1.

14.2.12.1.45 <u>Turbine Generator Building Open Cooling Water System Test</u>

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the ability of TGBOCWS to supply cooling water under normal plant operations.

2.0 PREREQUISITES

- 2.1 Construction activities on the TGBOCWS have been completed.
- 2.2 The TGBOCWS instrumentation has been calibrated.
- 2.3 Support system required for operation of the TGBOCWS has been completed and operational.
- 2.4 Test instruments are available and calibrated.

2.5 The CWS discharge header is available to receive flow.

3.0 TEST METHOD

- 3.1 Verify system flow from the CWS meets design.
- 3.2 Verify indications and alarms

4.0 DATA REQUIRED

- 4.1 System flow data.
- 4.2 Setpoints at which alarms and interlocks occur.

5.0 ACCEPTANCE CRITERIA

- 5.1 The TGBOCWS operates as described in Subsection 9.2.9.
- 5.2 The alarm setpoints have been established as described in the related design specification.
- 5.3 The alarms and indication operate as described in the related design specification.

14.2.12.1.46 <u>Pre-Core Hot Functional Test Controlling Document</u>

1.0 OBJECTIVES

To demonstrate the proper integrated operation of plant systems when in simulated or actual operating configurations. This includes a demonstration that reactor coolant temperature and pressure can be lowered to permit operation of the shutdown cooling system and the shutdown cooling system can be used to achieve cold shutdown at a cooldown rate not exceeding Technical Specification limits, and a demonstration of the operation of the steam bypass valves.

2.0 PREREQUISITES

2.1 All construction activities on the systems to be tested have been completed.

- 2.2 All permanently installed instrumentation on systems to be tested has been properly calibrated and is operational.
- 2.3 All necessary test instrumentation is available and properly calibrated.
- 2.4 Hydrostatic testing has been completed.
- 2.5 Steam generators are in wet layup in accordance with the NSSS chemistry manual.
- 2.6 Reactor internals, as appropriate for pre-core hot functional testing, have been installed.

3.0 TEST METHOD

3.1 Specify plant conditions and coordinate the execution of the related precore hot functional test listed in Table 14.2-1.

4.0 DATA REQUIRED

4.1 As specified by the individual pre-core hot functional test appendices.

5.0 ACCEPTANCE CRITERIA

- 5.1 The operations of the RCS, secondary systems, and related auxiliary systems are integrated in accordance with design criteria.
- 5.2 RCS temperature and pressure can be lowered to permit operation of the shutdown cooling system.
- 5.3 The shutdown cooling system is used to achieve cold shutdown at a cooldown rate not in excess of Technical Specification limits.
- 5.4 The turbine bypass valves can be operated to control RCS temperature.
- 5.5 Criteria as specified by the individual pre-core hot functional test procedures are met.

14.2.12.1.47 <u>Pre-Core Instrument Correlation</u>

1.0 OBJECTIVES

- 1.1 To demonstrate that the inputs and appropriate outputs between the PPS, process instrumentation, QIAS, and IPS are in agreement
- 1.2 To verify narrow-range temperature and pressure instrumentation accuracy and operation by comparing similar channels of instrumentation

2.0 PREREQUISITES

2.1 Instrumentation has been calibrated and is operational.

3.0 TEST METHOD

3.1 Record PPS, QIAS and IPS readings as directed by the pre-core hot functional test.

4.0 DATA REQUIRED

- 4.1 PPS operating modules reading
- 4.2 QIAS and IPS readings

5.0 ACCEPTANCE CRITERIA

5.1 All instrument readings agree within the accuracy of the instrumentation as described in Subsections 7.7.1.4 and 7.5.1.1.

14.2.12.1.48 <u>Remote Shutdown Console Test</u>

1.0 OBJECTIVES

- 1.1 To verify proper operation of the remote shutdown instrumentation
- 1.2 To determine transfer of control occurs and that the plant can be cooled down from the remote shutdown console

2.0 PREREQUISITES

- 2.1 All construction activities on the remote shutdown console have been completed and system software is installed.
- 2.2 All remote shutdown console instrumentation has been calibrated.
- 2.3 The communication systems between the MCR and remote shutdown console location have been demonstrated to be operational.

3.0 TEST METHOD

- 3.1 Using simulated signals, verify proper operation of remote shutdown console instrumentation.
- 3.2 During preoperational post-core hot functional tests, perform a full transfer of control from the MCR and perform a controlled cooldown from the remote shutdown console.

4.0 DATA REQUIRED

4.1 RCS temperatures and pressures

5.0 ACCEPTANCE CRITERIA

- 5.1 The plant can be cooled down and stabilized in the cold shutdown condition within the design limits from outside the main control room.
- 5.2 The remote shutdown console performs as described in the related design specification.

14.2.12.1.49 Diverse Protection System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the proper operation of the diverse protection system (DPS)
- 1.2 To verify the operation of DPS alarms and indications

- 1.3 To verify for each DPS channel, the channel bypass logic will block its trip outputs while the DPS is in "Bypass"
- 1.4 To verify the operation of coincidence logic for steam generator 1 low level, steam generator 2 low level, high pressurizer pressure, low pressurizer pressure, high containment pressure, reactor trip on turbine trip, and DPS manual reactor trip signals
- 1.5 To verify that the DPS trip and pretrip setpoints have been installed properly, and are within the acceptable tolerances
- 1.6 To verify the initiation of reactor trip, turbine trip, auxiliary feedwater actuation, and safety injection actuation signals
- 1.7 To verify the DPS response time

2.0 PREREQUISITES

- 2.1 Construction activities on the RTSS and the DPS have been completed, and DPS software is installed.
- 2.2 DPS instrumentation has been calibrated.
- 2.3 External test instrumentation is available and calibrated.
- 2.4 Support systems required for operation of the RTSS and DPS are operational.

3.0 TEST METHODS

- 3.1 Energize power supplies and verify output voltage.
- 3.2 Using simulated input signals into the DPS, trip each reactor trip circuit breaker with the breaker in the test position. Observe the RTSS trip circuit breaker operation.
- 3.3 Using simulated input signals into the DPS, observe the initiation of auxiliary feedwater actuation signal, and safety injection actuation signal.

3.4 Observe the turbine trip signal which is automatically generated with a 3-second time delay after the initiation of DPS reactor trip signal.

4.0 DATA REQUIRED

- 4.1 Power supply voltages
- 4.2 Resistance for ground fault detector operation
- 4.3 Trip setpoints

5.0 ACCEPTANCE CRITERIA

- 5.1 Initiation and bypass logics for steam generator 1 auxiliary feedwater actuation signal caused by low steam generator level perform as specified in the related design specification.
- 5.2 Initiation and bypass logics for steam generator 2 auxiliary feedwater actuation signal caused by low steam generator level perform as specified in the related design specification.
- 5.3 Initiation and bypass logics for the reactor trip signal caused by high pressurizer pressure perform as specified in the related design specification.
- 5.4 Initiation and bypass logics for the safety injection actuation signal caused by low pressurizer pressure trip perform as specified in the related design specification.
- 5.5 Initiation and bypass logics for the reactor trip signal caused by high containment pressure perform as specified in the related design specification.
- 5.6 Initiation and bypass logics for the reactor trip on turbine trip perform as specified in the related design specification.
- 5.7 Initiation and bypass logics for the manual reactor trip perform as specified in the related design specification.

- 5.8 Indication and alarms for the DPS should operate as specified in the related design specification.
- 5.9 System response time should be within design limit as specified in the related design specification.
- 5.10 Initiation and bypass logics for the turbine trip signal perform as specified in the related design specification.

14.2.12.1.50 <u>Pre-Core Test Data Record</u>

- 1.0 OBJECTIVES
 - 1.1 To monitor instrumentation during integrated plant operation
 - 1.2 To verify, by cross-checking channels, the satisfactory tracking of process instrumentation
 - 1.3 To provide a permanent record of plant pre-core loading parameter indication

2.0 PREREQUISITES

2.1 Instrumentation has been calibrated and is operational.

3.0 TEST METHOD

3.1 Record control room instrumentation steady-state readings as directed by the pre-core hot functional test controlling document.

4.0 DATA REQUIRED

- 4.1 Plant conditions at time when instrument readings are recorded
- 4.2 Instrument readings

5.0 ACCEPTANCE CRITERIA

5.1 All like instrumentation readings agree within the accuracy limits of the instrumentation.

14.2.12.1.51 Pre-Core Reactor Coolant System Expansion Measurements

1.0 OBJECTIVES

- 1.1 To demonstrate that the reactor coolant system (RCS) components are free to expand thermally as designed during initial plant heatup and return to their baseline cold position after the initial cooldown to ambient temperatures
- 1.2 To demonstrate that surge line movements due to stratification are within design limits

2.0 PREREQUISITES

- 2.1 All construction activities have been completed on the RCS components.
- 2.2 Initial ambient dimensions have been set on the steam generator and reactor coolant pump (RCP) hydraulic snubbers, upper and lower steam generator and reactor vessel keys, pressurizer keys, RCP columns and surge line supports.
- 2.3 Initial ambient dimensions for the steam generator, reactor vessel, pressurizer, RCP and surge line supports have been recorded.
- 2.4 The instruments for the real-time measurements of the surge line pipe displacements at several major locations are installed.
- 2.5 The potential component support shimming is required to achieve proper gaps.

3.0 TEST METHOD

- 3.1 Check clearances at hydraulic snubber joints, keys, and column clevises during heatup and record at 37.8 °C (100 °F) increments during heatup.
- 3.2 At stabilized conditions, record all steam generator, reactor vessel, pressurizer and RCP clearances.
- 3.3 Record the real-time surge line displacements and the plant data such as hot leg and pressurizer temperatures, pressurizer pressure and level,

charging and letdown flows as well as the status RCPs, pressurizer heaters and spray valves.

4.0 DATA REQUIRED

- 4.1 Plant conditions
- 4.2 Clearances at the steam generator sliding base keys, hydraulic snubber joints, upper keys, and piston setting for hydraulic snubbers
- 4.3 Clearances between the reactor vessel upper and lower supports and expansion plates
- 4.4 Reactor vessel support temperature
- 4.5 Clearances at pressurizer keys
- 4.6 Clearances at the RCP snubbers, column joints, and piston setting for the hydraulic snubbers
- 4.7 Clearances at all test points after cooldown
- 4.8 Surge line displacement time-history
- 4.9 Time-history plant data such as hot leg and pressurizer temperatures, pressurizer pressure and level, charging and letdown flows as well as the status of RCPs, pressurizer heaters, and spray valves

5.0 ACCEPTANCE CRITERIA

- 5.1 Unrestricted expansion for selected points on components as described in Subsection 3.9.2
- 5.2 Verification that components return to their baseline ambient position as described in Subsection 3.9.2
- 5.3 Verification that proper gaps exist for selected points on components as described in DCD Subsections 3.9.2 and 5.4.15
- 5.4 Verification that surge line moves within design limits

14.2.12.1.52 Pre-Core Reactor Coolant and Secondary Water Chemistry Data

1.0 OBJECTIVES

1.1 To demonstrate that proper water chemistry for the RCS and secondary system can be maintained

2.0 PREREQUISITES

- 2.1 The primary and secondary sampling systems are operable.
- 2.2 Chemicals and test equipment to support hot functional testing are available.
- 2.3 The primary and secondary chemical addition systems are operable.
- 2.4 Purification ion exchangers are charged with resin.

3.0 TEST METHOD

- 3.1 The sampling frequency is modified as required to provide reasonable assurance of the proper RCS and secondary system water chemistry.
- 3.2 Perform RCS and secondary system sampling and chemistry analysis after every significant change in plant conditions (i.e., heatup, cooldown, chemical additions).

4.0 DATA REQUIRED

- 4.1 Plant conditions
- 4.2 Secondary system chemistry analysis
- 4.3 RCS chemistry analysis

5.0 ACCEPTANCE CRITERIA

5.1 RCS and secondary system water chemistry can be maintained within the specifications.

14.2.12.1.53 <u>Pre-Core Pressurizer Performance Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate that the pressurizer pressure and level control systems function properly
- 1.2 To demonstrate proper operation of the auxiliary spray valves and pressurizer heaters
- 1.3 To demonstrate proper operation of the charging control valves and the letdown orifice isolation valves

2.0 PREREQUISITES

- 2.1 Pressurizer pressure and level control system instrumentation has been calibrated.
- 2.2 Support systems required for the operation of the pressurizer pressure and level control systems are operational.
- 2.3 Test equipment is available and calibrated.

3.0 TEST METHOD

- 3.1 Decrease pressurizer pressure and observe heater response and alarm and interlock setpoints.
- 3.2 Increase pressurizer pressure and observe heater and spray valve response and alarm and interlock setpoints.
- 3.3 Make a low level error in the pressurizer and observe letdown orifice isolation valve response alarm and interlock setpoints.
- 3.4 Make a high level error in the pressurizer and observe letdown orifice isolation valve response alarm and interlock setpoints.
- 3.5 Make a low pressurizer level and observe operation of the charging control valves.

3.6 Make pressurizer level below the low level interlock setpoint and observe heater response and alarm and interlock setpoints.

4.0 DATA REQUIRED

- 4.1 Response of pressurizer heaters to actual pressure and level signals
- 4.2 Response of spray valves to actual pressurizer pressure
- 4.3 Response of charging control valves to actual pressurizer level
- 4.4 Response of letdown orifice isolation valves to actual low pressurizer level error
- 4.5 Values of parameters at which alarms and interlocks occur.

5.0 ACCEPTANCE CRITERIA

5.1 The pressurizer performs as described in Subsections 7.7.1 and 5.4.10.

14.2.12.1.54 <u>Pre-Core Control Element Drive Mechanism Performance Test</u>

- 1.0 OBJECTIVES
 - 1.1 To determine the effectiveness of the control element drive mechanism (CEDM) cooling system by measurement of coil resistance at several temperature plateaus during RCS heatup
 - 1.2 To determine the operating temperature of the upper gripper coils
 - 1.3 To verify proper operation and sequencing of the CEDM

2.0 PREREQUISITES

- 2.1 CEDM coil stacks are assembled and associated cabling is connected.
- 2.2 Cabling between the reactor bulkhead and the CEDM cooling system is disconnected.
- 2.3 CEDM "cold" coil resistance has been measured and recorded.
- 2.4 Individual CEDM cable resistance has been measured and recorded.
- 2.5 CEDM cooling system is operational.
- 2.6 Test equipment is available and calibrated.
- 2.7 Support systems required for operation of the CEDM are operational.

3.0 TEST METHOD

- 3.1 At the specified RCS temperature and pressure, measure and record the loop resistance for each of the CEDM coils.
- 3.2 Balance CEDM cooling system as required to maintain the coil temperatures within the specified limits.
- 3.3 Connect cabling between the reactor bulkhead and the DRCS cabinets and energize the CEDM. Measure and record the dc voltage across the upper gripper coil and across the shunt on the DRCS power switch assembly panel.
- 3.4 Operate the CEDM and observe count totalizer operation.

- 4.1 CEDM "cold" coil resistance
- 4.2 CEDM cable resistance
- 4.3 RCS temperature and pressure
- 4.4 CEDM coil loop resistance at specified RCS temperature and pressure
- 4.5 DC voltage across the upper gripper coil at the specified RCS temperature and pressure
- 4.6 DC voltage across the shunt, which indicates the CEDM coil power trace
- 4.7 CEDM count totalizer readings

5.0 ACCEPTANCE CRITERIA

- 5.1 The DRCS performs as described in Subsection 7.7.1.1 a.
- 5.2 The CEDM coil temperatures (calculated from the measured coil resistances) are less than the maximum allowable temperature of 177 °C (350 °F).
- 5.3 The appropriate withdrawal and insertion coil traces occur in proper sequence.

14.2.12.1.55 Pre-Core Reactor Coolant System Flow Measurements

- 1.0 OBJECTIVES
 - 1.1 To determine the pre-core reactor coolant system (RCS) flow rate
 - 1.2 To establish baseline RCS pressure drops

2.0 PREREQUISITES

- 2.1 All permanently installed instrumentation has been properly calibrated and is operational.
- 2.2 All test instrumentation has been checked and calibrated.
- 2.3 RCS is operating at nominal hot zero-power (HZP) conditions.
- 2.4 Desired reactor coolant pumps (RCPs) are operating.
- 2.5 The core operating limit supervisory system (COLSS), core protection calculators (CPCs), and information processing system (IPS) are in operation.

3.0 TEST METHOD

3.1 RCS flow, pressure drops, and the data necessary to calculate RCS flows for four reactor coolant pump (RCP) operations are obtained.

4.0 DATA REQUIRED

- 4.1 IPS data
- 4.2 RCP differential pressure
- 4.3 RCS temperature and pressure
- 4.4 RCP speed
- 4.5 Reactor vessel differential pressure
- 4.6 Pump configurations

5.0 ACCEPTANCE CRITERIA

- 5.1 Pre-core RCS pressure drops have been recorded.
- 5.2 The measured four-pump RCS volumetric flow rate should be within the allowable range
- 5.3 The RCS flow exceeds the value necessary to provide reasonable assurance that post-core flow is in excess of that used for analysis in Chapter 15 but less than the design maximum flow rate as described in Subsections 4.4.1.3

14.2.12.1.56 Pre-Core Reactor Coolant System Heat Loss Measurement

- 1.0 OBJECTIVES
 - 1.1 To measure reactor coolant system (RCS) heat loss under HZP conditions
 - 1.2 To measure pressurizer heat loss under HZP conditions

- 2.1 Test instrumentation is available and calibrated.
- 2.2 Construction activities on the RCS and associated systems are completed.

2.3 All permanently installed instrumentation on the system to be tested is available and calibrated.

3.0 TEST METHOD

- 3.1 Determine the RCS heat loss using the steam-down method:
 - 3.1.1 Stabilize the steam generator levels with the RCS at HZP conditions.
 - 3.1.2 Secure steam generator feedwater and blowdown.
 - 3.1.3 Measure both the pressurizer heater power required to maintain RCS temperature and pressure and RCP power.
 - 3.1.4 Perform a heat balance calculation to determine heat loss.
- 3.2 Determine the pressurizer heat loss, with ⁽²⁾ and without continuous spray flow, by measuring the pressurizer heater power required to maintain the RCS at HZP conditions, and then performing a heat balance calculation.

- 4.1 RCS temperatures
- 4.2 Pressurizer pressure and level
- 4.3 Steam generator pressures and levels
- 4.4 Pressurizer heater power
- 4.5 RCP power

⁽²⁾ Pressurizer heat loss with continuous spray flow to be determined during post-core hot functional test after spray valve adjustments have been performed per Subsection 14.2.12.2.7.

5.0 ACCEPTANCE CRITERIA

5.0 ACCEPTANCE CRITERIA

- 5.1 The measured heat loss is less than the design limit
- 5.2 The pressurizer heat loss is less than the design limits.

14.2.12.1.57 Pre-Core Reactor Coolant System Leak Rate Measurement

1.0 OBJECTIVES

1.1 To measure the reactor coolant leakage at hot zero-power (HZP) conditions

2.0 PREREQUISITES

- 2.1 Hydrostatic testing of the reactor coolant system (RCS) and associated systems has been completed.
- 2.2 The RCS and the chemical and volume control system (CVCS) are operating as a closed system.
- 2.3 The RCS is at HZP conditions.

3.0 TEST METHOD

3.1 Measure and record the changes in water inventory of the RCS and CVCS for a specified interval of time.

- 4.1 Pressurizer pressure, level, and temperature
- 4.2 Volume control tank level, temperature, and pressure
- 4.3 Reactor drain tank level, temperature, and pressure
- 4.4 Equipment drain tank level, temperature, and pressure
- 4.5 RCS temperature and pressure

4.6 Safety injection tank level and pressure

5.0 ACCEPTANCE CRITERIA

- 5.1 There is no visible pressure boundary leakage
- 5.2 The identified leakage from the RCS shall not exceed design limit as described in Subsection 5.2.5
- 5.3 The unidentified leakage from the RCS shall not exceed design limit as described in Subsection 5.2.5

14.2.12.1.58 Pre-Core Chemical and Volume Control System Integrated Test

1.0 OBJECTIVES

1.1 To verify proper operation of the CVCS under normal operating conditions including plant heatup and cooldown

2.0 PREREQUISITES

- 2.1 The chemical and volume control system (CVCS) is in operation.
- 2.2 Selected ion exchanger has been filled with an appropriate resin.
- 2.3 Ion exchangers not to be used have been bypassed.
- 2.4 Associated instrumentation has been checked and calibrated.

3.0 TEST METHOD

- 3.1 Taking manual control of the letdown orifice isolation valve, position the letdown orifice isolation valve to obtain various letdown flow rates set by orifice capacity.
- 3.2 Taking manual control, position the charging control valve to obtain various charging flow rates.
- 3.3 Observe the operation parameters of the RCP seal injection and controlled bleedoff.

- 3.4 Measure and record the pressure drops across the ion exchanger, filter, and strainer.
- 3.5 During the plant heatup and cooldown, observe the various operation parameters of the letdown and charging subsystems.

4.0 DATA REQUIRED

- 4.1 Letdown control valve controller settings
- 4.2 Letdown temperature, pressure, and flow rates
- 4.3 Charging temperature and flow rates
- 4.4 Ion exchanger, filter, and strainer differential pressure
- 4.5 Volume control tank pressure and level
- 4.6 Pressurizer level
- 4.7 RCS temperature and pressure

5.0 ACCEPTANCE CRITERIA

- 5.1 Letdown temperature at the outlet of the RHX is less than design limit.
- 5.2 Letdown pressure and temperature at the outlet of the LHX is within design range.
- 5.3 Differential pressure across each purification filter, letdown strainer, and seal injection filter are less than the maximum allowable design limit.
- 5.4 RCP seal injection flow, RCP controlled bleed off flow and header pressure is within design range.
- 5.5 Charging flow, temperature, and pressure is within design range.
- 5.6 Letdown flow is maintained within design range.

- 5.7 Letdown flow is sufficient to maintain a constant RCS inventory with one charging pump in operation under shutdown purification operating conditions.
- 5.8 During heatup and cooldown tests, letdown and charging flow is within the design range and, the pressurizer level is within the acceptable range.

14.2.12.1.59 <u>Pre-Core Safety Injection Check Valve Test</u>

1.0 OBJECTIVES

- 1.1 To verify that the safety injection tank (SIT) discharge check valve passes flow with the RCS at hot zero-power (HZP) conditions
- 1.2 To verify that the safety injection (SI) loop check valves passes flow with the RCS at HZP conditions
- 1.3 To verify that leakage through the check valves at normal operating pressure and temperature is less than design requirements

2.0 PREREQUISITES

- 2.1 The RCS is at HZP conditions.
- 2.2 SITs are filled and pressurized to their normal operating conditions.
- 2.3 All lines in the safety injection system have been filled and vented.

3.0 TEST METHOD

- 3.1 Verify flow through the SI loop check valves. Reduce RCS pressure to below shut-off head for the SI pumps. Start each SI pump, open loop isolation valves, and observe flow to the RCS on installed flow indicators.
- 3.2 Verify flow through each SIT discharge check valve by flowing back to the in-containment refueling water storage tank (IRWST).

3.3 Verify the leakage rate at SI line check valves, hot leg injection line check valves and SIT outlet check valves at normal operating pressure and temperature.

4.0 DATA REQUIRED

- 4.1 SIT level and pressure
- 4.2 SI discharge pressure
- 4.3 SI flow
- 4.4 Leakage rate through check valve

5.0 ACCEPTANCE CRITERIA

- 5.1 Verify that the check valve listed below will pass flow with the Reactor Coolant System (RCS) at hot zero power condition.
 - Safety injection line check valves
 - SI hot leg injection line check valves
 - Safety injection tank outlet check valves
- 5.2 Verify that leakage through the check valve listed is within design limit at normal operating pressure and temperature.
 - Safety injection line check valves
 - SI hot leg injection line check valves
 - Safety injection tank outlet check valves

14.2.12.1.60 Pre-Core Boration / Dilution Measurements

1.0 OBJECTIVES

- 1.1 To demonstrate the ability of the chemical and volume control system (CVCS) to control the boron concentration of the reactor coolant system (RCS) by the feed-and-bleed method
- 1.2 To demonstrate the ability of the CVCS to supply concentrated boric acid to the RCS

2.0 PREREQUISITES

- 2.1 The boric acid storage tank (BAST) and reactor makeup water tank (RMWT) are filled with borated water and demineralized water, respectively.
- 2.2 The CVCS makeup system is operational.
- 2.3 The boronometer is operational.
- 2.4 RCS and CVCS boron concentration is approximately zero (0) ppm.
- 2.5 Makeup control subsystem is operational.

3.0 TEST METHOD

- 3.1 Perform a boration and dilution operation of the RCS by operating the CVCS makeup system in its various modes of operation.
- 3.2 Sample the RCS during boration and dilution operations and observe operation of the boronometer.

- 4.1 RCS temperature and pressure
- 4.2 Makeup controller flow readings and setpoints
- 4.3 Chemical analysis of boron concentration

- 4.4 Volume control tank (VCT) level
- 4.5 Boronometer readings
- 4.6 Charging flow rates
- 4.7 Letdown flow rate

5.0 ACCEPTANCE CRITERIA

- 5.1 Boronometer indication agrees with the RCS sample result.
- 5.2 The RCS boron concentration can be increased and decreased with the actual injected borated water and reactor makeup water, respectively.
- 5.3 The flowrate on each controller for blended makeup to the RCS will result in a blended feed boron concentration in automatic and manual modes.

14.2.12.1.61 Downcomer Feedwater System Water Hammer Test

1.0 OBJECTIVES

1.1 The SG feeding and associated piping are designed to minimize the possibility of damage due to water-hammer when auxiliary feedwater flow is actuated and introduced into the drained feeding.

- 2.1 Construction activities on the AFWS and those sections of the FWS that are affected have been completed.
- 2.2 FWCS instrumentation and other appropriate permanently installed instrumentation has been calibrated.
- 2.3 The main steam system is available.
- 2.4 Appropriate ac and dc power sources are available.

2.5 The RCS is operating at nominal hot zero-power conditions (hot standby).

3.0 TEST METHOD

- 3.1 Lower the steam generator water level below the feedwater sparger but within the narrow-range level indication band for a period of 30 minutes (no feedwater is introduced into the generator through the sparger during this period).
- 3.2 Station personnel as appropriate ⁽³⁾ to monitor for noise or vibration.
- 3.3 Initiate AFW flow to restore steam generator level in a manner that simulates automatic AFW actuation.

4.0 DATA REQUIRED

4.1 Visual inspection

5.0 ACCEPTANCE CRITERIA

- 5.1 Visual inspection indicates that the integrity of feedwater piping, supports, and sparger ⁽⁴⁾ have not been violated.
- 5.2 Post test visual inspection of the feedwater piping reveals no damage to pipe, hangers, snubbers, supports, insulation, or other structures.
- 5.3 Post test visual inspection of the downcomer feedwater feeding shows no damage due to water hammer.

14.2.12.1.62 <u>Main Turbine Systems Test</u>

1.0 OBJECTIVES

- 1.1 Protection.
 - 1.1.1 Demonstrate the ability to trip the turbine manually.

⁽³⁾ Personnel safety limits proximity to the feedwater system.

⁽⁴⁾ Visually inspect during the next regular SG inspection following testing.

- 1.1.2 Demonstrate that the trip inputs to turbine control system will trip the turbine.
- 1.1.3 Demonstrate proper operation of the MLV to allow testing of the MTV without tripping the ETS.
- 1.1.4 Demonstrate proper operation of the electrical lockout solenoid valve to allow testing of the electrical trip valve without tripping the electrical lockout solenoid valve.
- 1.1.5 Demonstrate the ability of each individual electrical overspeed module (VPRO module) by using simulated speed inputs.
- 1.1.6 EOS trip set point using simulated speed signals.
- 1.1.7 Demonstrate the power load unbalance function of primary controller to give a command to close IVs and CVs.
- 1.2 Turbine Control
 - 1.2.1 Calibration of all servo control valves and non-control valves.
 - 1.2.2 Function of PLU to close fast all CV's and IV's by using software simulation.
 - 1.2.3 Verify that the EHC System is free of oscillations caused by frequency noise using software simulation.
 - 1.2.4 Demonstrate the correct operation of control valves and the control logic by using software simulation:
 - 1.2.5 The function of steam valves test by using software simulation.

- 2.1 Construction activities on the main turbine system are complete.
- 2.2 Main turbine system instrumentation has been calibrated.
- 2.3 Appropriate test equipment is available and has been calibrated.

- 2.4 Proper fluid levels throughout the system have been verified.
- 2.5 Appropriate ac and dc power sources are available and operable.
- 2.6 Support systems required for the main turbine system are complete and operational.
- 2.7 The main steam system is available.
- 2.8 The main condenser is available.
- 3.0 TEST METHODS
 - 3.1 Demonstrate the electro-hydraulic control system performs the following:
 - 3.1.1 Automatic control of turbine speed and acceleration through the entire speed range
 - 3.1.2 Automatic control of load and loading rate from station auxiliary load to full load, with continuous load adjustment and discrete loading rates
 - 3.1.3 Standby manual control of speed and load when it becomes necessary to take the primary automatic control out of service
 - 3.1.4 Limiting of load in response to preset limits on operating parameters
 - 3.1.5 Detection of dangerous or undesirable operating conditions, annunciation of detected conditions, and initiation of proper control response to such conditions
 - 3.1.6 Monitoring the status of the control systems, including the power supplies and redundant control circuits
 - 3.1.7 Testing of valves and controls, including response to a simulated reactor trip signal and simulated loss of condenser vacuum signal

- 3.1.8 Prewarming of valve chest and turbine rotor
- 3.2 Perform main turbine performance test per ASME PTC-6-2004.
- 3.3 Operate control valves from all appropriate control positions. Observe valve operation and position indication and, where required, measure opening and closing times.
- 3.4 Demonstrate the turbine lube oil system operation.
- 3.5 Demonstrate the stator cooling water system operation.
- 3.6 Demonstrate the main turbine steam seal system operation.
- 3.7 Demonstrate the moisture separators, reheaters, and extraction steam systems operation.
- 3.8 Demonstrate hydrogen and carbon dioxide gas control system operation.
- 3.9 Demonstrate generator shaft seal oil system operation.

- 4.1 Setpoint at which alarms and interlocks occur
- 4.2 Setpoints of automatic trips
- 4.3 Conditions under which manual trips operate
- 4.4 Verification of all control logic combinations
- 4.5 Valve logic verification of EHC system
- 4.6 Valve opening and closing times, where required
- 4.7 Valve position indication
- 4.8 Position response of valves to loss of motive power
- 4.9 Operating data and function verification of associated turbine support systems

5.0 ACCEPTANCE CRITERIA

- 5.1 The main turbine system and support systems performance are as described in Section 10.2.
- 5.2 Main turbine performance is as required by vendor ratings.
- 5.3 Main turbine generator trip is generated in response to a simulated reactor trip signal as described in Subsection 10.2.2.3.
- 5.4 Main turbine generator trip is generated in response to a simulated loss of condenser vacuum signal as described in Subsection 10.4.2.
- 5.5 Turbine is tripped manually by actuating the master trip push-buttons from the control room and all hydraulic operated valves closed.
- 5.6 Turbine is tripped by mechanical trip handle at front standard and all hydraulic operated valves closed.
- 5.7 Alarm should be actuated by injecting the signal and turbine should be tripped by injecting the signal at each vibration detectors.
- 5.8 The main stop valves, control valves and combined intermediate valves should be tested fully closed using the Functional Tests.
- 5.9 The load runback function should be tested to reduce load setpoint from 100% to minimum load at specified rate.
- 5.10 The Load Setback function should be tested to reduce load setpoint from 100% to 50% at specified rate.

14.2.12.1.63 <u>Main Steam Safety Valve Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the operation of MSSV at set-pressure.
- 1.2 To demonstrate the operation of MSSV status light and alarms.
- 1.3 To demonstrate the valve seat tightness by leakage verification.

2.0 PREREQUISITES

- 2.1 Construction activities on the MSSVs have been completed.
- 2.2 Main steam system instrumentation has been calibrated.
- 2.3 Support systems including instrument air required for operation of the MSSVs are complete and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The MSS is at the valve vendor recommended temperature and pressure for valve testing.
- 2.6 The lifting device with associated support equipment and calibration data is available.

3.0 TEST METHOD

- 3.1 Using the lifting device, increase the lifting force on the safety valve until the safety valve starts to simmer.
- 3.2 Determine popping set pressure.
- 3.3 Adjust valve popping set pressure if necessary and retest.
- 3.4 Repeat until three consecutive pops within the required range are obtained.
- 3.5 Alternative method is to perform the setpoint verification at a certified testing facility.
- 3.6 Verify all safety valves have no seat leakage.

- 4.1 MSS pressure and temperature
- 4.2 Pressure applied to the lifting device to lift the safety valve off its seat
- 4.3 Popping pressure of each MSSV

5.0 ACCEPTANCE CRITERIA

- 5.1 The MSSVs perform as described in Subsection 10.3.2.2.3 and Table 10.3.2-1.
- 5.2 The MSSVs open at set-pressures (IAD) with ± 1 % tolerance and the pressure difference between IAD and pop-open is not more than 10 psi (0.7 kg/cm²).
- 5.3 MSSV status light indicates Valve "OPEN/CLOSE" status and When MSSV is open, "MSSV open" alarm annunciates
- 5.4 There is no visible or audible leakage from MSSV at main steam system design pressure.

14.2.12.1.64 Main Steam Isolation Valves and MSIV Bypass Valves Test

1.0 OBJECTIVES

- 1.1 Demonstrate the OPEN/CLOSE operation of the main steam isolation Valves.
- 1.2 Demonstrate the OPEN/CLOSE operation of the main steam isolation Valve Bypass Valves.
- 1.3 Demonstrate the OPEN/CLOSE operation of the main steam drip leg isolation valves.
- 1.4 Verify the correctness of the "failed" position of the MSIVs and MSIVBVs.

- 2.1 Construction activities on the MSIVs have been completed.
- 2.2 Main steam system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the MSIVs are complete and operational.

- 2.4 Test equipment is available and test instrumentation has been calibrated.
- 2.5 MSIV accumulators are charged and associated hydraulic systems are operational.

3.0 TEST METHOD

- 3.1 Operate the MSIVs and MSIVBVs from all appropriate control positions. Observe valve operation and position indication and, where required, measure opening and closing times at ambient and HFT conditions.
- 3.2 Verify the MSIVs and MSIVBVs fail to the position indicated in Figure 10.3.2-1 on loss of motive power.
- 3.3 Verify MSIV and MSIVBV controls, alarms, and interlocks.
- 3.4 Verify MSIV and MSIVBV response to main steam isolation signal.
- 3.5 Verify MSIV and MSIVBV seat leakage.
- 3.6 Perform MSIV drift test.

- 4.1 MSIV and MSIVBV opening and closing times at ambient and HFT conditions
- 4.2 Valve position indication
- 4.3 Position response of valves to a loss of motive power
- 4.4 Setpoints at which alarms and interlocks occur
- 4.5 MSIV and MSIVBV seat leakage
- 4.6 MSIV and MSIVBV response to MSIS
- 4.7 MSIV drift data

5.0 ACCEPTANCE CRITERIA

- 5.1 The MSIVs and MSIVBVs operate as described in Subsections 10.3.2.2.2.
- 5.2 The MSIVs and MSIVBVs meet the test acceptance criteria described in Subsection 10.3.4.
- 5.3 MSIVs should be opened and closed using hand switches and the status is indicated.
- 5.4 MSIVs are closed within the specified time.
- 5.5 MSIVBVs should be opened and closed using hand switches and the status is indicated.
- 5.6 MSIVs and MSIVBVs fail to the closed position upon a loss of control power.
- 5.7 Seat leakage of the MSIVs is less than the specified condensed steam.

14.2.12.1.65 <u>Main Steam System Test</u>

1.0 OBJECTIVES

- 1.1 To verify automatic operation of main steam drain valves
- 1.2 To verify automatic operation of drain valves in main steam supply line to feedwater pump turbine.

- 2.1 Construction activities on the MSS have been completed.
- 2.2 MSS instrumentation has been calibrated.
- 2.3 Support systems required for operation of the MSS are complete and operational.
- 2.4 Test equipment is available and test instrumentation has been calibrated.

2.5 The main condenser is available to receive steam during HFT condition.

3.0 TEST METHOD

- 3.1 Demonstrate automatic drain valve operation.
- 3.2 Demonstrate availability of all flow paths.
- 3.3 Verify opening of the turbine bypass valves in response to a signal simulating turbine bypass.
- 3.4 Verify the operability of the main steam atmospheric dump valves at no-load steam pressure (HFT).
- 3.5 Verify the operability of the turbine bypass valves at no-load steam pressure (HFT).
- 3.6 Operate control valves from all appropriate control positions. Observe valve operation and position indication and, where required, measure opening and closing times.
- 3.7 Verify proper operation of designated components such as protective devices, controls, interlocks, instrumentation, and alarms using actual or simulated inputs.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power
- 4.4 Setpoints at which alarms and interlocks occur
- 4.5 Flow path availability data

5.0 ACCEPTANCE CRITERIA

5.1 The MSS performance is as described in Section 10.3.

- 5.2 Turbine bypass valves open in response to a signal simulating turbine bypass, as described in Subsection 10.4.4.
- 5.3 Main steam drain valves shall be opened and closed upon a level signal by respective level switches.
- 5.4 Drain valves in the main steam supply line to a feedwater pump turbine shall be opened and closed upon a level signal from their respective level switches.

14.2.12.1.66 Steam Generator Blowdown System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the operation of the SGBS remote operated valves
- 1.2 To demonstrate the operation of the SGBS pressure, level, and temperature control valves
- 1.3 To demonstrate the operation of the SGBS pressure, level, radiation level and temperature valve interlocks
- 1.4 To demonstrate system alarms and status lights
- 1.5 To demonstrate system responses to ESFAS and DPS signals
- 1.6 To demonstrate the failed position of system
- 1.7 To demonstrate that the SGBS accepts water from each SG blowdown line, processes the blowdown as required, and delivers the processed water to the condensate system.

- 2.1 Construction activities on the SGBS have been completed.
- 2.2 SGBS instrumentation has been calibrated.
- 2.3 Support systems required for operation of the SGBS are complete and operational.

2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Verify the availability of flow paths for generator blowdown and subsequent condensate recycle (HFT).
- 3.2 Verify blowdown flow path flow rates during HFT.
- 3.3 Operate control valves from all appropriate control positions. Observe valve operation and position indication and, where required, measure opening and closing times.
- 3.4 Verify power-operated valves fail to the position specified in Subsection 10.4.8 upon loss of motive power.
- 3.5 Verify the proper operation of pump, motors, and heat exchanger in all operation modes and flow paths.
- 3.6 Verify the proper operation of all protective devices, controls, interlocks, and alarms, using actual or simulated inputs.
- 3.7 Verify the proper system response to CIAS, MSIS, and AFAS.
- 3.8 Verify steam generator wet layup system operation.

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power
- 4.4 Setpoints at which alarms and interlocks occur
- 4.5 Wet layup pump running data
- 4.6 Response to MSIS, CIAS, and AFAS
- 4.7 SG blowdown flow path flow rates

5.0 ACCEPTANCE CRITERIA

- 5.1 The SGBS should receive water from each SG blowdown line, processes the blowdown as required, and delivers the processed water to the condensate system.
- 5.2 Valves should be operated upon related signals and their status indicated at the MCR.
- 5.3 The Valves in parallel paths should be operated in accordance with interlock provisions.
- 5.4 The status of blow down flash tank should be annunciated at the MCR.
- 5.5 The SOVs should be closed on loss of control power and re-opened when control power is restored.
- 5.6 The blowdown valves should be closed in less than specified time upon receipt of a CIAS, MSIS, AFAS and DPS-AFAS signal.

14.2.12.1.67 <u>Main Condenser and Condenser Vacuum Systems Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the automatic and manual operation of condenser vacuum pumps and their associated recirculation pumps.
- 1.2 To demonstrate the operation of air vent valve to atmosphere, containment isolation valve, and booster fan by high radiation signal.
- 1.3 To demonstrate the operation of vacuum pump inlet valves and containment isolation valve.
- 1.4 To demonstrate the correct fail position of MOVs.
- 1.5 To demonstrate the status lights and system alarms.
- 1.6 To demonstrate the automatic and manual operation of booster fan.
- 1.7 To demonstrate valve and fan operation.

2.0 PREREQUISITES

- 2.1 Construction activities on the main condenser and condenser vacuum systems have been completed.
- 2.2 Main condenser and condenser vacuum systems instrumentation has been calibrated.
- 2.3 Support systems required for operation of the main condenser and condenser vacuum systems are complete and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Steam seals and lagging are available.
- 2.6 All electrical testing is complete on the vacuum pumps and condenser valves.

3.0 TEST METHOD

- 3.1 Verify the vacuum integrity of the condenser by performing both a water hydrostatic test and a vacuum test.
- 3.2 Operate control valves from all appropriate control positions. Observe valve operation and position indication and, where required, measure opening and closing times.
- 3.3 Demonstrate the proper operation of the vacuum pumps with design operating modes and flow paths.
- 3.4 Verify the proper operation of protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.
- 3.5 Demonstrate the operation of the condenser makeup and reject to the condensate storage tank controls.
- 3.6 Demonstrate the operation of the automatic condenser tube cleaning system.

3.7 Demonstrate the proper operation of the air vent valve to atmosphere, containment isolation valve, and booster fan on a high radiation signal.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power
- 4.4 Setpoints at which alarms and interlocks occur
- 4.5 Vacuum pump running data

5.0 ACCEPTANCE CRITERIA

- 5.1 The main condenser and condenser vacuum systems perform as described in Subsections 10.4.1 and 10.4.2.
- 5.2 The condenser vacuum pumps are manually started and stopped using their respective hand switches.
- 5.3 When the condenser vacuum pumps start and stop, their associated recirculation pumps start and stop, respectively and their statuses are indicated.
- 5.4 The vacuum pump inlet valves are opened and closed when their associated condenser vacuum pumps are running and stop, respectively.
- 5.5 The air vent valve to atmosphere is closed on a high radiation signal from the radiation monitoring system.
- 5.6 The containment isolation value is opened on a high radiation signal from the radiation monitoring system and closed on a containment isolation value closed signal.
- 5.7 The booster fan is automatically started upon high radiation signal from radiation monitoring system and automatically stopped upon containment isolation valve closed signal.

14.2.12.1.68 <u>Feedwater System Test</u>

1.0 OBJECTIVES

- 1.1 To verify the operation of start-up feedwater pump and related auxiliary lube. oil pump
- 1.2 To verify the operation of feedwater pump turbine and associated lube oil pumps
- 1.3 To verify the operation of feedwater booster and associated lube oil pumps
- 1.4 To verify the operation of feedwater pump turbine HPSV and LPSV
- 1.5 To verify the operation of all system valves
- 1.6 To verify the close times of main feedwater isolation valves
- 1.7 To verify the operation of system alarms and status lights

- 2.1 Construction activities on the feedwater system have been completed.
- 2.2 Feedwater system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the feedwater system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 A suitable steam supply is available for operation.
- 2.6 The condensate system is operable.
- 2.7 The main condenser is operable.
- 2.8 The main turbine is available for turning gear operation.
- 2.9 Appropriate ac and dc power is available.

3.0 TEST METHOD

- 3.1 Demonstrate all design flow paths including economizer, downcomer, and cleanup recirculation (HFT or PAT).
- 3.2 Demonstrate proper startup feedwater valve alignments and flow paths.
- 3.3 Verify the starting, head, and flow characteristics of the motor-driven startup feedwater pumps.
- 3.4 Demonstrate minimum flow recirculation protection using simulated inputs.
- 3.5 Verify proper operation of protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.
- 3.6 Verify the starting, head, and flow characteristics of the turbine-driven feedwater pump.
- 3.7 Operate MFIVs from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.8 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.9 Verify the MFIVs fail to the position indicated in Figure 10.4.7-3 upon loss of motive power.
- 3.10 Verify the MFIVs close in response to a MSIS.

- 4.1 Motor-driven startup feedwater pump head-versus-flow data
- 4.2 Turbine-driven feedwater pump head-versus-flow data
- 4.3 Valve opening and closing times, where required

- 4.4 Valve position indication
- 4.5 Position response of valves to loss of motive power
- 4.6 Setpoints at which alarms and interlocks occur
- 4.7 MFIV data

5.0 ACCEPTANCE CRITERIA

- 5.1 The main feedwater system (including startup feedwater) operates as described in Subsection 10.4.7.
- 5.2 The MFIVs meet the test acceptance criteria as described in Subsection 10.4.7.2.2.
- 5.3 The feedwater control valves can be opened and closed manually and their statuses are indicated correctly.
- 5.4 The MFIVs and S/G chemical injection valves can be closed within the specified time.
- 5.5 Startup feedwater pump can be started and stopped by corresponding signals.
- 5.6 Feedwater pump turbine shall be started and stopped by the signal specified in the design specification
- 5.7 The feedwater booster pump shall be started and stopped by corresponding signals and their statuses are correctly indicated.

14.2.12.1.69 <u>Condensate System Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the manual and automatic operation of condensate pumps
- 1.2 To demonstrate the correct fail position, and manual and automatic operation of system valves

- 1.3 To demonstrate the operation of all status lights and system alarms.
- 1.4 To demonstrate the operation of condenser overboard pump.

2.0 PREREQUISITES

- 2.1 Construction activities on the condensate system have been completed.
- 2.2 Condensate system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the condensate system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Plant conditions are such as to provide a flow path for the condensate and feedwater booster pumps.

3.0 TEST METHOD

- 3.1 Verify all control logic.
- 3.2 Verify head-versus-flow characteristics for the condensate and feedwater booster pumps.
- 3.3 Demonstrate proper operation of the de-areator.
- 3.4 Demonstrate proper operation of design flow paths including system cleanup operation.
- 3.5 Demonstrate proper operation of minimum flow recirculation protections.
- 3.6 Demonstrate proper operation of the hotwell level control system.
- 3.7 Verify proper operation of designated components, such as protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.

- 3.8 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.9 Verify power-operated valves fail to the position specified in Subsection 10.4.7 upon loss of motive power.

4.0 DATA REQUIRED

- 4.1 Head-versus-flow performance and pump operating data
- 4.2 Valve opening and closing times, where required
- 4.3 Valve position indication
- 4.4 Position response of valves to loss of motive power
- 4.5 Setpoints at which alarms and interlocks occur
- 4.6 Setpoints of the hotwell level controls
- 4.7 Setpoints of the pumps minimum flow recirculation protection

5.0 ACCEPTANCE CRITERIA

- 5.1 The condensate system operates as described in Subsection 10.4.7.
- 5.2 The following valves shall be opened and closed manually and status is correctly indicated.
 - Condensate pump discharge valves
 - Condenser hotwell makeup valves
 - Condensate over flow control valve
 - Condenser recirculation valves etc.
- 5.3 The condensate pumps shall be started and sopped as required.
- 5.4 The alarms and indicators operate per design.

14.2.12.1.70 <u>Turbine Steam Seal System Test</u>

1.0 OBJECTIVES

1.1 To verify that the steam seal system provides adequate sealing to the turbine shaft and the main feedwater pump turbine shafts against leakage of air to the turbine casings and escape of steam to the turbine building

2.0 PREREQUISITES

- 2.1 Construction activities on the turbine steam seal system have been completed.
- 2.2 Turbine steam seal system instrumentation has been calibrated.
- 2.3 Test instrumentation is available and calibrated.
- 2.4 Plant systems required to support the test including auxiliary steam, the condenser, and Turbine Generator Building CCW system are operable.
- 2.5 Plant conditions for the main turbine, main feedwater pump turbines, and the turbine stop/control valves allow operation of the steam seal system.

3.0 TEST METHOD

- 3.1 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.2 At turbine startup, place the steam seal system in operation using auxiliary steam and verify proper operation of the system after the turbine load has increased and the system has been sealed off.
- 3.3 Verify the proper performance of the steam packing exhauster blowers and the steam packing exhauster.

- 3.4 Verify the proper operation of the high-pressure turbine gland spillover valve for dumping excess gland seal leakage.
- 3.5 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms.

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indication
- 4.3 Position response of valves to loss of motive power
- 4.4 Setpoints at which alarms and interlocks occur

5.0 ACCEPTANCE CRITERIA

- 5.1 The turbine steam seal system operates as described in Subsection 10.4.3.
- 5.2 The turbine steam seal system data obtained are within the design specification.

14.2.12.1.71 Circulating Water System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the ability of the CWS to provide a continuous supply of cooling water to the main condensers and the TGBCCW heat exchanger and reject the waste heat from main condensers to the circulating water

- 2.1 Construction activities on the CWS have been completed.
- 2.2 CWS instrumentation has been calibrated.

- 2.3 Support systems required for operation of the CWS are complete and operational.
- 2.4 The intake structure is at the required level and water quality is within limits.
- 2.5 Temporary test instruments are installed and calibrated.

3.0 TEST METHOD

- 3.1 Verify head-versus-flow and operational characteristics for the CW pumps.
- 3.2 Verify required alarms and verify the corresponding actions.
- 3.3 Verify automatic and manual systems controls function properly.
- 3.4 Perform a flow balance of the CWS to the TGBCCW system.

4.0 DATA REQUIRED

- 4.1 Verification of trips and alarms
- 4.2 Pump head-versus-flow and operating data
- 4.3 Flow data to the CWS and the TGBCCW system

5.0 ACCEPTANCE CRITERIA

- 5.1 The CWS operates as described in Subsection 10.4.5.
- 5.2 The circulating water pumps cannot be started if the discharge valve is not closed or the pump's lube water flow is low or their respective discharge valves do not open to greater than the specified degree.
- 5.3 Stand-by (non-lead) pump will start after the lead pump fails to start,

14.2.12.1.72 <u>Steam Generator Hydrostatic Test</u>

1.0 OBJECTIVES

- 1.1 To perform hydrostatic testing of the secondary side of the S/G including the unisolable portions of the main steam, main feed water, S/G blowdown, S/G recirculation and auxiliary feed water lines.
- 1.2. To verify integrity of the S/G tube to tube sheet connections by performing a secondary to primary leak check.

2.0 PREREQUISITES

- 2.1 Construction activities on the SG secondary side are complete.
- 2.2 The RCS is available to be pressurized and the RCPs are operable.
- 2.3 The main steam safety valves are removed and blind flanges are installed.
- 2.4 Temporary hydro pump and relief valves are installed.
- 2.5 Temporary instrumentation is calibrated and installed.
- 2.6 Systems required to support the operation the RCS and RCPs are available.
- 2.7 Any plant instrumentation not able to withstand hydro test pressure is removed from service.

3.0 TEST METHOD

- 3.1 Fill and vent the steam generators and chemically treat as required.
- 3.2 Operate the RCS and associated systems as needed to operate the RCPs. Heat the RCS and SGs to the required temperature.
- 3.3 Pressurize the primary side as required to maintain less than maximum secondary to primary differential pressure.

- 3.4 Pressurize the steam generator to the pressure required by the technical manual.
- 3.5 Perform an inspection of all designated items and record any discrepancies.

4.0 DATA REQUIRED

- 4.1 Record SG pressure and temperatures during performance of the test.
- 4.2 Record the location of any leaks.

5.0 ACCEPTANCE CRITERIA

- 5.1 The SG hydrostatic test meets the requirements as stated in the technical manual vendor provides and the ASME Code Section III (Reference 7).
- 5.2 A hydrostatic pressure meets the requirements as stated in the technical manual vendor provides and the ASME Code Section III
- 5.3 During the leakage inspection at a pressure equal to or greater than the design pressure must be maintained. No leakage is allowed from all joints, flanges, welded connections and regions of high stress within the hydrostatic boundaries identified. Leaks which are permitted in ASME Code Section III may be allowed.
- 5.4 There are no leaking S/G tubes on tube to tube sheet joints at an inspection pressure of design specification provided by vendor.

14.2.12.1.73 <u>Heater Drains System Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the feedwater heater and drain system alarms and controls operate as designed
- 1.2 To demonstrate that the feedwater heaters and drains system is capable of heating the feedwater system to the design temperature for normal plant operation (power ascension test [PAT])
2.0 PREREQUISITES

- 2.1 Construction activities on the feedwater heater and drains system have been completed.
- 2.2 Feedwater heater and drains system instrumentation has been calibrated.
- 2.3 Individual component testing is complete.
- 2.4 The power conversions systems are operating as required to support the test.

3.0 TEST METHOD

- 3.1 Verify the setpoints of alarms and interlock.
- 3.2 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.3 Verify feedwater temperature to the steam generators at 100 percent flow is per Subsection 10.4.7 (PAT).
- 3.4 Demonstrate that high-pressure feedwater heater level controls maintain proper level and drain to the deareator (PAT).
- 3.5 Demonstrate that the low-pressure feedwater heater level controls maintain proper level and drain to the main condenser (PAT).

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times, where required
- 4.2 Valve position indication
- 4.3 Setpoints at which alarms and interlocks occur
- 4.4 Feedwater temperature at 100 percent flow for each heater group
- 4.5 Setpoints of level controllers

5.0 ACCEPTANCE CRITERIA

- 5.1 The feedwater heater and heater drains system performs as described in Subsection 10.4.7.
- 5.2 The valves shall be opened and closed by appropriate manual or automatic signals.
- 5.3 The alarms and indicators operate per design.

14.2.12.1.74 Chilled Water System Test

1.0 OBJECTIVES

1.1 To demonstrate proper operation of the essential chilled water and plant chilled water systems

2.0 PREREQUISITES

- 2.1 Construction activities on the chilled water system have been completed.
- 2.2 Chilled water system instrumentation has been calibrated.
- 2.3 Test instrumentation is available and properly calibrated.
- 2.4 Component cooling water, demineralized water, nitrogen, and instrument air systems are available.
- 2.5 Appropriate ac and dc power sources are available.

- 3.1 Demonstrate that each essential chilled water system division can be operated from its local and remote manual control stations.
- 3.2 Demonstrate that plant chilled water system can be operated from its local and remote control stations.
- 3.3 Demonstrate that each essential chilled water system division starts automatically in response to the appropriate signal.

- 3.4 Verify that the chillers supply chilled water at the rated flow and design conditions.
- 3.5 Verify chilled water flow to supplied components.
- 3.6 Verify alarms, interlocks, indicating instruments, and status lights are functional.
- 3.7 Verify head-versus-flow characteristics for the chilled water system pumps.
- 3.8 Verify system baseline performance during HFT.
- 3.9 Simulate CIAS and observe isolation valve response in the plant chilled water system.

4.0 DATA REQUIRED

- 4.1 Flows as required to components and throttle valve positions
- 4.2 Alarm, interlock, and control setpoints
- 4.3 Chiller normal operating parameters
- 4.4 Pump head-versus-flow and operating data
- 4.5 System operating parameters during HFT

- 5.1 The chilled water system operates as described in Subsection 9.2.7.
- 5.2 The automatic operation of chilled water compression tank nitrogen regulating valves is verified.
- 5.3 The automatic operation and the fail position of the chilled water makeup valves is verified.
- 5.4 The operation of chilled water pumps is verified.
- 5.5 The chilled water cooling coil flow rates is verified.

- 5.6 The operation of chillers is verified.
- 5.7 The operation of cooling coil flow regulating valves is verified.
- 5.8 The operation of RCFC cooling coil isolation valves is verified.
- 5.9 All system alarms and indication operate per design.

14.2.12.1.75 Essential Service Water System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the operation of essential service water pumps and CCW heat exchanger ESW side.
 - 1.2 To demonstrate the operation of motor operated valves.
 - 1.3 To demonstrate all status lights and system alarms.
 - 1.4 To demonstrate that the required flow rates are provided by the ESW pumps.
 - 1.5 To demonstrate "BISI (Bypass Inoperable Status Indicating)" functions of pump and valves.
 - 1.6 To demonstrate the heat exchanger performance at rated flow rate.
 - 1.7 To demonstrate the operation of ESW debris filters in Manual/Auto mode.

2.0 PREREQUISITES

- 2.1 Construction activities on the ESWS have been completed.
- 2.2 ESWS instrumentation has been calibrated.
- 2.3 Support systems required for the operation of the ESWS are complete and operational.
- 2.4 Test instruments are available and calibrated.

3.0 TEST METHOD

- 3.1 Verify head-versus-flow characteristics for the essential service water pumps.
- 3.2 Verify adequate flow of essential service water to each supplied component.
- 3.3 Verify alarms, indicating instruments, and status lights are functional.
- 3.4 Verify system response on a loss of offsite power.
- 3.5 Verify a low essential service water pump discharge pressure starts the standby pump in each division.
- 3.6 Verify proper operation of the control valves, pump discharge check valves, and debris filter backwash valves.
- 3.7 Verify pump control from the control room.
- 3.8 Verify safety signals are initiated and response of system pumps.

4.0 DATA REQUIRED

- 4.1 Pump head-versus-flow and operating data
- 4.2 Flow to component cooling water (CCW) heat exchangers using various pump combinations
- 4.3 Setpoints of alarms, interlocks, and controls
- 4.4 Valve position indication

- 5.1 The ESWS operates as described in Subsection 9.2.1.
- 5.2 ESW system discharge valves shall be manually opened and closed with their respective hand switches.

- 5.3 ESW pumps shall be manually started and stopped with their respective hand switches.
- 5.4 Alternate pumps shall be automatically started upon a discharge pressure low signal from the starting pump discharge header and the alarms shall be annunciated.
- 5.5 The running pumps shall be stopped upon a load shedding signal and the pumps shall be restarted upon a load sequencer signal.
- 5.6 The ESW debris should be actuated at manual/auto mode.
- 5.7 Measured differential pressure between CCW HX inlet and outlet should be lower than specified value in design specification at rated flowrate.
- 5.8 BISI verification test should be performed.

14.2.12.1.76 Component Cooling Water System Test

1.0 OBJECTIVES

- 1.1 To verify pump performance at mini. flow & other modes flow
- 1.2 To set system flow balance per subsection 9.2.2
- 1.3 To verify automatic control signals, alarms, and indicators
- 1.4 To verify proper valve sequencing and operability of remotely operated valves
- 1.5 To verify response to ESFAS signals for the CCW System.
- 1.6 To verify system operating conditions characteristics in normal, startup, shutdown and post-LOCA modes of operation

2.0 PREREQUISITES

2.1 Construction activities on the CCWS have been completed.

- 2.2 CCWS instrumentation has been calibrated.
- 2.3 Test instrumentation is available and calibrated.
- 2.4 Plant systems required to support testing are operable, or temporary systems are installed and operable.
- 2.5 The essential service water system is available to supply cooling water to the CCW heat exchanger.

- 3.1 Demonstrate proper operation of the surge tanks and their controls.
- 3.2 Demonstrate proper system and component flow paths, flow rates, and pressure drops including head-versus-flow verification for the CCW pumps.
- 3.3 Verify the nonessential portions of the system are isolated on a SIAS.
- 3.4 Verify the containment spray heat exchanger isolation valves open on a CSAS.
- 3.5 Verify all non-safety-related portions of the corresponding division are isolated on a surge tank low-low level signal.
- 3.6 Verify a low CCW pump discharge pressure signal starts the standby pump in corresponding division.
- 3.7 Operate control valves from all appropriate control positions. Observe valve operation and position indication. Measure valve opening and closing times, where required.
- 3.8 Verify power-operated valves fail to the position upon loss of motive power.
- 3.9 Verify alarms, interlocks, indicating instruments, and status lights are functional.
- 3.10 Verify pump control from the control room.

3.11 Demonstrate the ability of the CCWS in conjunction with the shutdown cooling system and essential service water system to perform a plant cooldown (HFT).

4.0 DATA REQUIRED

- 4.1 Pump head-versus-flow and operating data for each pump
- 4.2 Flow balancing data including flow to each component and throttle valve positions
- 4.3 Setpoints of alarms, interlocks, and controls
- 4.4 Valve opening and closing times, where required
- 4.5 Valve position indication
- 4.6 Position response of valves to loss of motive power
- 4.7 Temperature data during cooldown
- 4.8 Response of valves to SIAS, CSAS, low-low surge tank level signal, and CCW pump high differential pressure signal

- 5.1 The CCWS operates as described in Subsection 9.2.2.
- 5.2 Motor operated valves open and close manually by the respective hand switch and status is properly indicated.
- 5.3 Component cooling water make-up pumps performance is greater than specified value provided by vendor.
- 5.4 Component cooling water pumps performance is greater than specified value provided by vendor at rated flowrate.
- 5.5 Measured flow to each heat load served by CCW is within 10% of the design flow for all operating modes.
- 5.6 Surge tank level instruments shall perform correctly.

- 5.7 Component cooling water pumps manually start and stop from their respective control switches and their respective statuses are indicated.
- 5.8 Component cooling water pumps start automatically on a low pressure signal.
- 5.9 Component cooling water pumps respond to ESFAS signals.
- 5.10 SIAS, CIAS, and CSAS will operate the related valves correctly.
- 5.11 Alarms and indicators operate per design.

14.2.12.1.77 Spent Fuel Pool Cooling and Cleanup System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the operation of the system status lights and alarms
- 1.2 To demonstrate the operation and performance of the SFP Cooling Pump
- 1.3 To demonstrate the operation of the SFP Cleanup Pump

2.0 PREREQUISITES

- 2.1 Construction activities on the SFPCCS have been completed.
- 2.2 SFPCCS instrumentation has been calibrated.
- 2.3 Test instrumentation is available and properly calibrated.
- 2.4 Component cooling water is available.
- 2.5 Spent fuel pool and refueling pool construction leak tests completed.
- 2.6 Support systems required for the operation of the SFPCCS are complete and operable.
- 2.7 The spent fuel pool is filled to the normal level.

3.0 TEST METHOD

- 3.1 Verify head-versus-flow for the pumps.
- 3.2 Verify control logic.
- 3.3 Verify the proper operation of controls, interlocks instrumentation, and alarms using actual or simulated inputs.
- 3.4 Verify the operability of the fuel pool gates and verify leakage within acceptable limits.
- 3.5 Verify the vacuum breaker holes are free of obstructions.
- 3.6 Verify no leakage of the spent fuel pool by checking the leak detection system.
- 3.7 Verify that the SFPCCS meets the design flow rate.
- 3.8 Test control valves from all positions and observe operation and position indication.

4.0 DATA REQUIRED

- 4.1 Pump head-versus-flow and operating data for each pump
- 4.2 Setpoints of alarms, interlocks, and controls
- 4.3 Flow data through various system flow paths
- 4.4 Fuel pool gate leakage data
- 4.5 Control valve operation and position

- 5.1 The SFPCCS operates as described in Subsection 9.1.3.
- 5.2 The SFP cooling pumps and SFP cleanup pumps should be manually started and stopped from their respective and status is indicated.

- 5.3 SFP heat exchanger return flow low signal should initiate alarm when SFP cooling pump is running. Setpoint is provided by vendor and status is indicated.
- 5.4 Discharge flow low signal should stop SFP cleanup pump and initiate alarm after the specified time by starting the pump. Setpoint is provided by vendor and status is indicated.
- 5.5 Discharge flow high signal should stop SFP cleanup pump and initiate alarm. Setpoint is provided by vendor and status is indicated.
- 5.6 Discharge pressure low signal of SFP cooling pump should initiate alarm after the specified time by starting the pump. Setpoint is provided by vendor and status is indicated.
- 5.7 Suction pressure low signal of SFP cleanup pump should initiate alarm after the specified time by starting the pump. Setpoint is provided by vendor and status is indicated.
- 5.8 Spent fuel pool water level should initiate alarm at set level
- 5.9 SFP, refueling pool and SFP return temperature high should initiate an alarm, Setpoint is provided by vendor and status is indicated
- 5.10 Refueling pool water level should initiate alarm at set Level.
- 5.11 The design points should be demonstrated satisfactorily for SFP cooling and cleanup pumps.
- 5.12 The availability of the cooling and cleanup flow paths should be demonstrated satisfactorily.

14.2.12.1.78 <u>Turbine Generator Building Closed Cooling Water System Test</u>

- 1.0 OBJECTIVES
 - 1.1 To verify proper operation of TGBCCW system

- 1.2 To demonstrate the operating parameters of the turbine generator building closed cooling water pumps
- 1.3 To demonstrate that the associated controls and instrumentation are functioning properly

2.0 PREREQUISITES

- 2.1 Construction activities on the TGBCCW system have been completed.
- 2.2 Support systems required for the operation of the TGBCCW system are complete and operational.
- 2.3 Test instrumentation is available and calibrated.
- 2.4 TGBCCW system instrumentation has been calibrated.

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation of TGBCCW pumps, including head and flow characteristics.
- 3.3 Demonstrate flow paths and verify heat exchanger temperature rise, inlet and outlet water temperatures, and equipment temperature. Monitor performance and make appropriate flow rate adjustments to satisfy performance parameters.
- 3.4 Demonstrate that the heat exchangers operate at design flow rate without exceeding heat exchanger design pressure drop.
- 3.5 Verify the proper operation of the surge tank level control and upper and lower level alarms.
- 3.6 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms.

3.7 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.

4.0 DATA REQUIRED

- 4.1 Operating data for the TGBCCW pumps
- 4.2 Throttle valve positions and flows to each component
- 4.3 Valve opening and closing times, where required
- 4.4 Valve position indication
- 4.5 Position response of valves to loss of motive power
- 4.6 Setpoints at which alarms and interlocks occur

- 5.1 The TGBCCW system performs as described in Subsection 9.2.8.
- 5.2 The manual and automatic operation of the turbine generator building closed cooling water pumps are verified.
- 5.3 The automatic operation of the turbine generator building closed cooling water surge tank make-up inlet valve is verified.
- 5.4 The manual operation of all system motor operated valves is verified.
- 5.5 The flow of turbine generator building closed cooling water provided meets the design capacity.
- 5.6 The system alarms and indicators operate per design.

14.2.12.1.79 <u>Condensate Storage System Test</u>

1.0 OBJECTIVES

1.1 To demonstrate that the condensate storage system provides a reliable source of water for the designated systems

2.0 PREREQUISITE

- 2.1 Construction activities on the condensate storage system have been completed.
- 2.2 Condensate storage system instrumentation has been calibrated.
- 2.3 Test instrumentation is available and calibrated.
- 2.4 Support systems required for the operation of the condensate storage system are complete and operable.

- 3.1 Verify all control logic.
- 3.2 Verify the operating parameters of the pumps.
- 3.3 Demonstrate the operability of all design flow paths.
- 3.4 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.5 Verify operation of protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.
- 3.6 Verify that the condensate storage tank is maintained at an acceptable water oxygen concentration.
- 3.7 Verify the availability of all flow paths.

4.0 DATA REQUIRED

- 4.1 Pump operating data
- 4.2 Valve opening and closing times, where required
- 4.3 Valve position indication
- 4.4 Setpoints at which alarms and interlocks occur
- 4.5 Applicable chemistry results

5.0 ACCEPTANCE CRITERIA

- 5.1 The condensate storage system operates as described in Subsection 9.2.6.
- 5.2 The condensate storage tank makeup valves can be opened and closed manually by their respective hand switches and the status is indicated.
- 5.3 The condensate storage tank makeup valves can be opened and closed automatically by their respective condensate storage tank level. Also, level alarms are operated by their respective tank level. Status is indicated.
- 5.4 System alarms operate per design.

14.2.12.1.80 Normal Lighting System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate that the normal lighting system provides adequate illumination for plant operations

2.0 PREREQUISITES

- 2.1 Construction activities on the normal lighting system are completed.
- 2.2 Test instruments are properly calibrated and available.

- 2.3 The normal lighting distribution panels are energized and required circuit breakers closed.
- 2.4 The emergency dc lighting fixtures are not turned on.

3.0 TEST METHOD

- 3.1 Place the plant lighting in service and check that illumination levels are adequate.
- 3.2 Demonstrate that a single circuit failure does not cause the loss of all lighting in a room that requires normal access.

4.0 DATA REQUIRED

- 4.1 Illumination levels in designated areas
- 5.0 ACCEPTANCE CRITERIA
 - 5.1 The normal lighting system provides its adequate illumination level for plant operations.

14.2.12.1.81 Emergency Lighting System Test

1.0 OBJECTIVES

1.1 To demonstrate that the emergency lighting system provides adequate illumination to operate equipment during emergency operations

2.0 PREREQUISITES

- 2.1 Construction activities on the emergency lighting system are completed.
- 2.2 Test instruments are properly calibrated and available.
- 2.3 The emergency lighting distribution panels are energized and required circuit breakers closed.

3.0 TEST METHODS

- 3.1 Demonstrate that the emergency lighting system provides adequate illumination as required in designated control areas.
- 3.2 Demonstrate that the emergency lighting system provides adequate illumination in other areas of the plant.
- 3.3 Demonstrate that the emergency dc lighting system comes on upon loss of normal lighting.
- 3.4 Demonstrate that the battery-operated emergency lights provide adequate illumination at designated locations.
- 3.5 Demonstrate that the battery-operated emergency lights are capable of providing lighting for the designated amount of time.

4.0 DATA REQUIRED

- 4.1 Illumination levels in designated areas
- 4.2 Battery-powered lighting data

5.0 ACCEPTANCE CRITERIA

5.1 The emergency lighting system provides its adequate illumination level for plant operations.

14.2.12.1.82 Compressed Air and Gas Systems Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the manual and automatic operation of the air compressors and auxiliaries
 - 1.2 To demonstrate the interlocks and safety features of the instrument air system
 - 1.3 To demonstrate that the quality of instrument air provided meets design requirements

- 1.4 To demonstrate the operation and failed position of all system valves
- 1.5 To demonstrate the alarms and status indications of the instrument air system
- 1.6 To demonstrate the automatic operation of the instrument air dryers

2.0 PREREQUISITES

- 2.1 Construction activities on the compressed air and gas system have been completed.
- 2.2 Compressed air and gas systems instrumentation has been calibrated.
- 2.3 Support systems required for operation of the compressed air and gas systems are complete and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Sufficient permanent loads are connected to the compressed air systems and are operable to verify air compressor loading.

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation and capacity of the instrument air compressors. Verify proper operation of compressor unloaders, auto and manual start and stop circuits.
- 3.3 Demonstrate the operability of the air compressor dryers and filters, aftercoolers, moisture separators, air receivers, and pressure-reducing stations.
- 3.4 Verify the proper operation of all protective devices, controls, interlocks, instruments, computer inputs, alarms and resets, pressure switches, safety and relief valves, and bypass valves, using actual or simulated inputs.

- 3.5 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.6 Verify power-operated valves fail to the position specified in Subsection9.3.1 upon loss of motive power.
- 3.7 Verify proper operation of all moisture drains.
- 3.8 Verify relief valve settings.
- 3.9 Verify appropriate differential pressures (e.g., delta-P across pre-filters and after-filters).
- 3.10 While at system normal steady-state conditions, if practicable, simultaneously operate those plant components requiring large quantities of instrument air, to verify pressure transients in the distribution system do not exceed acceptable values.
- 3.11 Functionally test instrument air systems to provide reasonable assurance that credible failures resulting in an increase in supply system pressure do not cause loss of operability.
- 3.12 Verify that the total air demand at normal steady-state conditions, including leakage from the systems, is in accordance with design.

4.0 DATA REQUIRED

- 4.1 Capacity data on compressors
- 4.2 Cycle times and regeneration temperatures of air dryers
- 4.3 Air dryer dew point temperatures
- 4.4 Air quality measurements (dewpoint, hydrocarbons, and particulates)
- 4.5 Valve opening and closing times, where required
- 4.6 Valve position indication

- 4.7 Position response of valves to loss of motive power
- 4.8 Setpoints at which alarms and interlocks occur
- 4.9 Pressure, temperature, and flow rate readings at remote and control board indicators
- 4.10 Cycle times for automatic moisture drain valves
- 4.11 System response to the simultaneous operation of plant components requiring large quantities of instrument air
- 4.12 System response to an increase in supply pressure

- 5.1 Alarm and fault lamps annunciated at local panel for air compressor upon the each appropriate signal
- 5.2 Oil heater for air compressor on and off automatically upon oil temperature condition when its hand-switch is auto mode
- 5.3 Each compressor can manually start and stop by using its respective hand-switch on the control panel.
- 5.4 Lube oil pump and cooling fan start/stop in accordance with an air compressor start/stop.
- 5.5 Closed loop circulating pump starts/stops manually by hand-switch.
- 5.6 Cooling Tower spray pump starts/stops manually by hand-switch.
- 5.7 Cooling Tower Fan starts/stops manually by hand-switch.
- 5.8 The lead operating compressor maintains the system pressure within design range.
- 5.9 The service air-supply isolation valve and cross-tied line air supply valve open/close manually by using its appropriate hand-switch.

- 5.10 The service air-supply isolation valve and cross-tied line air supply valve close when the instrument air supply header pressure drops below design value.
- 5.11 The instrument air-containment isolation valve can be open and closed by hand-switch.
- 5.12 The instrument-air containment isolation valve can be close within specified times.
- 5.13 Containment isolation valve closes automatically upon receipt of a Containment Isolation Actuation Signal (CSAS).
- 5.14 Local and control room alarms annunciate upon the following; air afterfilter discharge header pressure low, air supply header pressure low, and air dryer system differential pressure high.
- 5.15 The instrument air dryers operate automatically in regular sequence.

14.2.12.1.83 Process and Primary Sampling System Test

- 1.0 OBJECTIVES
 - 1.1 To verify the ability of the process sampling system to collect and deliver representative samples of liquids and gases in various process systems to sample stations for chemical and radiological analysis during operation, cooldown, and post-accident modes.
 - 1.2 To demonstrate the operation of the containment isolation valve
 - 1.3 To demonstrate containment isolation valves closure times
 - 1.4 To demonstrate containment isolation valves responses to CIAS signals
 - 1.5 To demonstrate the fail position of the primary sampling system valves
 - 1.6 To demonstrate the operation of the post-accident primary sample isolation & drain valves, normal primary sample system valves, post-accident sample valves and the nitrogen flush valves

- 1.7 To demonstrate the operation of the sample mixing pump, the containment sample pump and the drain pump in the Post-accident Primary Sample Sink (PPSS)
- 1.8 To demonstrate the operation of the primary off-gas sample pump
- 1.9 To demonstrate the sample system heat tracing operates correctly
- 1.10 To demonstrate all status light and system alarms
- 1.11 To verify the ability of the process sampling system to collect and deliver representative samples of liquids and gases in various process systems to sample stations for chemical and radiological analysis during operation, cooldown, and post-accident modes

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are completed and system software is installed.
- 2.2 Systems being sampled are at or near normal operating pressure and temperature.
- 2.3 Calibrating gases and solutions are available.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Process sampling system instrumentation is calibrated.

- 3.1 Withdraw fluid at each sample point, verifying adequate flow.
- 3.2 Verify the proper operation of all alarms and interlocks.
- 3.3 Verify the proper operation of all pumps and heat exchangers in specified operating modes and flow paths.
- 3.4 Verify the analytical instrumentation provides proper indication and response.

- 3.5 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure closing times.
- 3.6 Verify the proper operation of all continuous monitors and verify adequate flow.

4.0 DATA REQUIRED

- 4.1 Setpoints at which alarms and interlocks occur
- 4.2 Sampling flow rate from each sample point
- 4.3 Analytical instrument data
- 4.4 Valve closing times, where required
- 4.5 Valve position indication

- 5.1 The process sampling system performs as described in Subsection 9.3.2.
- 5.2 The containment isolation valves should be open and closed by using their respective hand-switches.
- 5.3 The containment isolation valves close in less than required close time.
- 5.4 The sample isolation valves should be open and closed by using their respective hand-switches.
- 5.5 The sample isolation valves should be in the closed position upon loss of electrical control power.
- 5.6 The isolation valves should be in the closed position upon loss of electrical power.
- 5.7 The MOVs fail as is upon loss of 480VAC and control power.
- 5.8 The containment isolation valves close upon receipt of a CIAS signals.

- 5.9 PPSS shutoff valve can be opened by placing the hand-switch to the "open" position with PPSS drain tank level not high-high and with PPSS temperature not high, and with PPSS sample pressure not high.
- 5.10 Gas sample sequencer performs satisfactorily in auto mode.
- 5.11 Containment air heat trace can be operated on and off by its respective hand-switch when normal H/T panel or back-up H/T panel control is ON.
- 5.12 The heat trace can be operated on/off by their respective hand-switch.
- 5.13 The pumps can be manually started and stopped by using their handswitch.
- 5.14 The PPSS drain tank pump starts in response to PPSS drain tank level when the hand-switch is in "auto" position, and stops when PPSS drain tank low level and the hand-switch is in "auto".
- 5.15 The alarm conditions are annunciated at the control panels.

14.2.12.1.84 <u>Heat Tracing System Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the ability of the heat tracing system to automatically control the associated heat tracing circuits.
- 1.2 To verify proper annunciation of alarm conditions.

2.0 PREREQUISITES

- 2.1 Construction activities on the heat tracing system are completed.
- 2.2 Heat tracing system instrumentation is calibrated.
- 2.3 Support systems required for operation of the heat tracing system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.

2.5 Electrical power supply available.

3.0 TEST METHOD

- 3.1 Produce simulated variations of temperature signals and verify the automatic on-off switching of heaters within the system.
- 3.2 Demonstrate the operation of controls and alarms.

4.0 DATA REQUIRED

- 4.1 Temperature data for the heat traced components
- 4.2 Setpoints of alarms and control points

5.0 ACCEPTANCE CRITERIA

- 5.1 The heat tracing system automatically controls its associated heat tracing circuits to maintain temperatures within a specified range.
- 5.2 Alarm conditions are properly annunciated

14.2.12.1.85Fire Protection System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the operation of the seismic category I fire pumps
 - 1.2 To demonstrate the pump performance characteristics
 - 1.3 To demonstrate the operation of containment isolation valve
 - 1.4 To demonstrate the operation of all status lights and system alarms
 - 1.5 To demonstrate the operation of fire protection system
 - 1.6 To demonstrate the proper operation of the fire detection system
 - 1.7 To demonstrate the head and flow characteristics of the fire water pumps, and the operation of all auxiliaries
 - 1.8 To verify control logic

- 1.9 To verify flow rates in the various flow paths of the fire protection water distribution system
- 1.10 To verify sprinkler and deluge spray patterns where possible
- 1.11 To verify alarms, indicating instruments, and status lights are functional
- 1.12 To verify proper operation of smoke control and fire dampers under the design air flow condition

2.0 PREREQUISITES

- 2.1 Construction activities on the FPS are completed.
- 2.2 FPS instrumentation has been calibrated.
- 2.3 Support systems required for operation of the FPS are complete and operational.
- 2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Demonstrate that the initial fire protection system testing is in accordance with the criteria in the codes and standards referenced in Subsection 9.5.1, "Fire Protection Program."

4.0 DATA REQUIRED

- 4.1 Setpoints under which alarms and interlocks occur
- 4.2 Sprinkler and deluge spray patterns
- 4.3 Fire alarm operability
- 4.4 Operability of temperature, flame, and smoke sensors
- 4.5 Pump head-versus-flow and operating data
- 4.6 Smoke control and fire damper operability

5.0 ACCEPTANCE CRITERIA

- 5.1 The FPS operates as described in Subsection 9.5.1.
- 5.2 The seismic Category I fire pumps shall be started and stopped manually by the respective hand-switch.
- 5.3 The seismic Category I fire pumps shall be started by emergency mechanical start handle mounted on local control panel.
- 5.4 The seismic Category I fire pumps shall perform according to the design specifications.
- 5.5 The seismic Category I fire pumps shall supply two hose reels according to the design specifications.
- 5.6 Containment isolation valve shall be closed within the required design time upon receipt of an ESFAS-CIAS signal.
- 5.7 Containment isolation valve shall be fail close position on loss of electrical power and air.
- 5.8 The related alarms shall be activated.

14.2.12.1.86 Emergency Diesel Generator Mechanical System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate performance characteristics of the emergency diesel generators (EDGs) and associated auxiliaries, and verify that each diesel reaches rated speed within the required time.
 - 1.2 To verify the operational capability of control circuits associated with the EDG and diesel auxiliaries, including the control circuit response to safety signals.
 - 1.3 To demonstrate the reliability of each diesel generator by means of 25 consecutive valid start and load-run tests.

- 1.4 To demonstrate the capability of each air storage tank to provide five diesel cranking cycles without being recharged.
- 1.5 To demonstrate the continuous operation of each diesel generator for 24 hours of full power, 2 hours at load equivalent to the short time rating, and 22 hours at load equivalent to the continuous rating.
- 1.6 To demonstrate the fuel oil consumption of the EDG while operating at the continuous load rating.

2.0 PREREQUISITES

- 2.1 Construction activities on the diesel generator system have been completed.
- 2.2 Required electrical power supplies and control circuits are operational.
- 2.3 EDG system instrumentation has been calibrated.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The component cooling water system is available to supply cooling water to the diesel engine heat exchanger.
- 2.6 The fuel oil system, cooling water system, starting air system, lubrication system, and combustion air intake and exhaust system are available.

- 3.1 Start the EDGs and record the time required to reach rated speed.
- 3.2 Evaluate performance characteristics of the EDGs and associated auxiliaries.
- 3.3 Evaluate the operational capability of all control circuits associated with the EDG including the control circuit response to safety signals.
- 3.4 Evaluate the ability of each diesel generator by means of 25 consecutive valid start and load-run tests.

- 3.5 Evaluate the ability of each air storage tank to provide five diesel cranking cycles without being recharged.
- 3.6 Evaluate the fuel oil consumption is monitored with EDG operating at the continuous load rating.
- 3.7 Evaluate the continuous operation of each diesel generator for 24 hours of full power, 2 hours at load equivalent to the short time rating, and 22 hours at load equivalent to the continuous rating.

4.0 DATA REQUIRED

- 4.1 EDG and associated auxiliaries operating parameters
- 4.2 EDG engine consecutive starts data
- 4.3 Set points of EDG trips
- 4.4 EDG governor operating data
- 4.5 Set points at which alarms and interlocks occur
- 4.6 EDG starting air volume parameters after consecutive starts

- 5.1 The required time for each EDG to reach rated speed is in accordance with Subsection 8.3.1.1.2.4.
- 5.2 Performance characteristics of the EDGs and associated auxiliaries are within design requirements.
- 5.3 Each EDG starts automatically on receipt of a safety injection actuation signal, containment spray actuation signal, auxiliary feedwater actuation signal, or 4.16 kV bus under-voltage signal.
- 5.4 Each EDG trips automatically on receipt of signals for automatic trip conditions described in Subsection 8.3.1.1.3.

- 5.5 The alarm, interlocks, controls, and operation of the EDG and associated auxiliaries are as described in Subsection 8.3.1.1.3, 9.5.5, 9.5.6, 9.5.7, and 9.5.8.
- 5.6 Each diesel generator completes 25 consecutive valid start and load-run tests.
- 5.7 Each air storage tank is capable of providing five diesel cranking cycles without being recharged.
- 5.8 The EDG engine cooling water system operates as described in Subsection 9.5.5.
- 5.9 The EDG engine starting air system operates as described in Subsection 9.5.6.
- 5.10 The EDG engine lubrication system operates as described in Subsection 9.5.7.
- 5.11 The EDG engine combustion air and exhaust system operates as described in Subsection 9.5.8.

14.2.12.1.87 Emergency Diesel Generator Electrical System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the ability of each EDG to carry the continuous rated load, the short-time rated load, and design rate load.
- 1.2 To demonstrate the ability of each EDG to attain and stabilize frequency and voltage within the rated limits and time.
- 1.3 To demonstrate that each EDG starts automatically on an engineered safety feature actuation signal (ESFAS) and/or 4.16 kV bus loss of voltage, and that the associated EDG feeder breaker closes when, on an under-voltage signal received form the respective 4.16 kV bus, the EDG rated voltage and frequency has been attained.

- 1.4 To demonstrate the capability of each EDG to withstand a maximum rate load rejection without exceeding speeds or voltages that cause tripping or damage.
- 1.5 To demonstrate the operability of each diesel generator feeder breaker and associated interlocks.

2.0 PREREQUISITES

- 2.1 Construction activities on the diesel generator system have been completed.
- 2.2 EDG mechanical system test is completed.
- 2.3 EDG system instrumentation has been calibrated.
- 2.4 The component cooling water system is available to supply cooling water to the diesel engine heat exchanger.
- 2.5 The fuel oil system, cooling water system, starting air system, lubrication system, and combustion air intake and exhaust system are available.
- 2.6 Electrical testing is complete as needed to allow the buses to be energized.
- 2.7 EDG electrical voltage tests are complete.
- 2.8 Engineered safety features loads are available to be loaded onto the bus.

- 3.1 Demonstrate the continuous rated load, short-time rated load and design rate load test.
- 3.2 Evaluate the ability of each EDG to attain and stabilize frequency and voltage within the rated time.
- 3.3 Evaluate the ability of each EDG to start automatically on an ESFAS and/or 4.16 kV bus loss of voltage. Evaluate the ability of the

associated breaker to close on an under-voltage signal received from the respective 4.16 kV bus when the EDG rated voltage and frequency has been attained.

- 3.4 Evaluate the ability of each EDG to withstand a maximum rated load rejection without exceeding speeds or voltages.
- 3.5 Evaluate the operability of each EDG feeder breaker and associated interlocks.

4.0 DATA REQUIRED

- 4.1 Starting and loading sequence timing
- 4.2 Test data traces for starting, stopping, and load shedding
- 4.3 Running data for the parameters monitored during each of the required testing sequences
- 4.4 Verification of field performance data versus shop data
- 5.0 Acceptance criteria
 - 5.1 The continuous rated load, short-time rated load, and design rated load tests are in accordance with Subsection 8.3.1.1.2.4.
 - 5.2 Each EDG can attain and stabilize frequency and voltage within specifications.
 - 5.3 Each EDG starts automatically on an ESFAS and/or 4.16 kV bus loss of voltage and the feeder breaker and the associated breakers close on receipt of an undervoltage signal from the respective 4.16 kV bus when the EDG has attained its rated voltage and frequency.
 - 5.4 Each EDG is capable of withstanding the maximum rated load rejection without exceeding frequency or voltage design limits.
 - 5.5 The controls and interlocks associated with the EDG feeder breakers operate in accordance with system design.

14.2.12.1.88 Emergency Diesel Engine Fuel Oil System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the operability of the diesel fuel oil transfer pumps and verify all system control functions
- 1.2 To demonstrate that the emergency diesel generator (EDG) fuel oil system provides a reliable and adequate supply to each EDG

2.0 PREREQUISITES

- 2.1 Construction activities on the emergency diesel engine fuel oil system have been completed.
- 2.2 Required electrical power supplies and control circuits are operational.
- 2.3 Adequate volume of diesel fuel oil is available to support this test.

- 3.1 Demonstrate the operation of the diesel fuel oil transfer pumps.
- 3.2 Initiate all automatic system function signals and verify required responses.
- 3.3 Demonstrate that the day tank can be filled manually.
- 3.4 Demonstrate the operation of the fuel oil recirculation system.
- 3.5 Demonstrate, by performing a loaded run of the EDG with its day tank filled to its low-level alarm point, that the day tank provides sufficient fuel for at least 60 minutes of EDG operation with the EDG supplying the power requirements of the most limiting design basis accident.
- 3.6 Demonstrate, by performing a loaded run of the EDG and analysis of EDG fuel storage capacity, that each EDG has sufficient fuel storage capacity to operate for a period of no less than 7 days with the EDG supplying the power requirements of the most limiting design basis accident.

4.0 DATA REQUIRED

- 4.1 EDG fuel oil consumption rate
- 4.2 Set points of alarms, interlocks, and controls
- 4.3 Operating data for pumps

5.0 ACCEPTANCE CRITERIA

- 5.1 Diesel fuel oil transfer pumps operate per system design specifications.
- 5.2 Control functions are operable per system design requirements.
- 5.3 The EDG engine fuel oil system operates as described in Subsection 9.5.4.

14.2.12.1.89 <u>Alternate AC Source System Test (Mechanical)</u>

- 1.0 OBJECTIVES
 - 1.1 To demonstrate that the Alternate AC Source (Gas Turbine Generator GTG) set operates reliably.
 - 1.2 To demonstrate the operation of the GTG supporting systems, namely, fuel oil storage & transfer system, starting system, lubrication system, combustion intake air and exhaust system, and ventilation system for GTG enclosure.
 - 1.3 To demonstrate the capability of the starting system to provide five (5) GTG cycles (for starting), without being charged.
 - 1.4 To determine that the fuel oil consumption of GTG while operating at continued load rating condition.

2.0 PRE-REQUESITES

2.1 The required construction activities is completed for the Gas Turbine Generator and its supporting systems

- 2.2 The GTG supporting systems, namely, fuel oil storage & transfer system, starting system, lubrication system, combustion intake air and exhaust system, and ventilation system for GTG enclosure are available and operational
- 2.3 GTG and its supporting system instrumentation is available, functional and calibrated for its operation / tests
- 2.4 Test instrumentation is available and calibrated

- 3.1 Demonstrate that the GTG and its supporting systems can be started in automatic and manual modes using Main Control Room (MCR), Remote Shutdown Room (RSR), and local control station.
- 3.2 Demonstrate that the following mechanical trips are functional:
 - 3.2.1 Engine over speed
 - 3.2.2 Low lube oil pressure
 - 3.2.3 Low lube oil level in lube oil tank or sump
 - 3.2.4 High pressure in crank case
 - 3.2.5 High-high lube oil temperature
 - 3.2.6 Low fuel oil pressure
- 3.3 Demonstrate that the following parameters are monitored in the MCR, RSR, and local control panel:
 - 3.3.1 Lube oil temperature and pressure
 - 3.3.2 Engine bearing temperatures
 - 3.3.3 Engine speed
 - 3.3.4 Air pressure (if air is used for starting)

- 3.4 Demonstrate the operation of following status indication:
 - 3.4.1 Engine Over speed
 - 3.4.2 Low oil pressures
 - 3.4.3 Low air pressure (if air is used for starting)
- 3.5 Evaluate the ability of the starting system to allow cranking a cold GTG five (5) times, without re-charging the receiver / motor.
- 3.6 Verify that the system alarms, instrumentation, interlocks and controls
- 3.7 Fuel oil is transferred from the fuel oil storage tank to the fuel oil day tanks by means of transfer pumps; record the appropriate flow parameter.
- 3.8 Verify the operability of the GTG supporting systems (namely, fuel oil storage & transfer system, starting system, lubrication system, combustion intake air and exhaust system, and ventilation system for GTG enclosure).
- 3.9 Fuel oil consumption is monitored at continuous load rating condition.

4.0 DATA REQUIRED

- 4.1 Setpoints at which alarms and interlocks occur
- 4.2 AAC source system and supporting system operating parameters at designated loads
- 4.3 GTG consecutive start data
- 4.4 GTG starting air volume parameters after consecutive starts (if air is used)
- 4.5 Battery capacity after consecutive starts (if motor is used)
5.0 ACCEPTANCE CRITERIA

- 5.1 Performance requirements of GTG and associated mechanical system (starting system, lubrication system, combustion intake air & exhaust system, and ventilation system for GTG enclosure) are within the design requirements.
- 5.2 Starting system is capable of providing five (5) starts, without being recharged.
- 5.3 The required time for GTG to reach rated speed per DCD Chapter 8.4
- 5.4 The alarms, interlocks, controls and trips of the GTG system and supporting systems is in accordance with Subsection 8.4.1.
- 5.5 The fuel oil consumption by the GTG while operating at continuous load rating does not exceed the design requirements including fuel oil storage capacity as described in Subsection 9.5.9.

14.2.12.1.90 <u>Alternate AC Source System Test (Electrical)</u>

- 1.0 OBJECTIVES
 - 1.1 To demonstrate that the Alternate AC Source (Gas Turbine Generator GTG) can reliably supply power at continuous rated load, the short-time rated load, and design rated load.
 - 1.2 To demonstrate that the GTG starts and verify that the required voltage and frequency are attained within the required time limits
 - 1.3 To demonstrate the ability of the GTG starting automatically on the event of LOOP and to synchronize with the offsite power system
 - 1.4 To demonstrate the capability of GTG breaker and associated interlocks
 - 1.5 To demonstrate GTG proper operation including a test of loss of the largest single load and complete loss of load

2.0 PRE-REQUESITES

- 2.1 The required construction activities are completed for the GTG and its supporting systems
- 2.2 The GTG mechanical system test is completed (See Subsection 14.2.12.1.89)
- 2.3 GTG system instrumentation is available, functional and calibrated for its operation / tests
- 2.4 Test instrumentation is available and calibrated
- 2.5 GTG Enclosure ventilation system test is completed (See Subsection 14.2.12.1.89)
- 2.6 Required electrical power supplies and control circuits are available.
- 2.7 Electrical testing is complete as needed to allow the required buses to be energized.

- 3.1 Demonstrate that the GTG starts from standby conditions and reaches required voltage and frequency within acceptable limits and time requirements using Main Control Room (MCR) and Remote Shutdown Room (RSR).
- 3.2 Demonstrate that the largest single load and complete load are shed with no tripping on over speed is verified using MCR and RSR.
- 3.3 Demonstrate by simulating a SBO event that: (a) non-essential loads are shed from the bus; (b) the GTG starts on auto-start signal from its standby conditions; (c) attains the required voltage and frequency within acceptable limits and time; (d) energizes the respective buses; and (e) can be manually connected with the respective buses within ten minutes using MCR and RSR.

- 3.4 Demonstrate the ability to synchronize the GTG with offsite power while loaded upon a simulated restoration of offsite power: (a) Parallel the SBO bus with offsite power, (b) transfer SBO GTG and open SBO GTG output circuit breaker; (c) Restore the SBO GTG to standby status using MCR and RSR.
- 3.5 Evaluate the operability of GTG breaker and associated interlocks using MCR and RSR.
- 3.6 Demonstrate that the following electrical trips are functional using Local Control Panel (LCP):
 - 3.2.1 Generator differential protection
 - 3.2.2 Generator electrical protection
 - 3.3.3 Electronic governor failure
- 3.7 Demonstrate the operation of following status indication using LCP:
 - 3.4.1 GTG output breaker position
 - 3.4.2 Loss of control power
 - 3.4.3 Generator fault

4.0 DATA REQUIRED

- 4.1 Test data for GTG output voltage, frequency and output circuit breaker closing data during start sequence
- 4.2 Running data for the parameters monitored during each of the required testing sequence
- 4.3 Verification of field data versus shop data
- 4.4 Periodic area temperature

5.0 ACCEPTANCE CRITERIA

- 5.1 SBO GTG electrical system meets the design requirements as described in Section 8.4
- 5.2 The controls, alarms, interlocks, and operation of the GTG breaker and support system are as described in Section 8.4.
- 5.3 GTG attains the required voltage and frequency within the required time limits
- 5.4 GTG starts automatically on receipt of an under-voltage signal from the 4.16 kV.
- 5.5 GTG is capable of being synchronized with offsite power and supplies the maximum expected load carrying capability.
- 5.6 Upon the loss of the largest single load and complete loss of load, GTG continues to operate without exceeding the over speed limit.

14.2.12.1.91 Containment Polar Crane Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the functional performance of the containment polar crane.

2.0 PREREQUISITES

- 2.1 Electric power is available.
- 2.2 Containment polar crane instrumentation has been calibrated.
- 2.3 Construction activities on the crane and associated equipment have been completed.
- 2.4 Test equipment and materials are available.
- 2.5 Handling adaptors and accessories are available.

3.0 TEST METHOD

- 3.1 Verify operability of trolley, bridge, and hoist.
- 3.2 Check hoist and trolley speeds.
- 3.3 Check capability of crane to position over all required containment building equipment.
- 3.4 Perform 150 percent static load capacity test.
- 3.5 Perform an operational test of the polar crane at 100 percent of rated load.
- 3.6 Verify the operation of protective and safety devices.

4.0 DATA REQUIRED

- 4.1 Hoist and trolley speeds
- 4.2 Verification of proper operation of interlocks
- 4.3 Load capacity data

5.0 ACCEPTANCE CRITERIA

5.1 The containment polar crane performs its functions as described in Subsection 9.1.5.2.2.

14.2.12.1.92 <u>Fuel Handling Area Cranes Test</u>

1.0 OBJECTIVES

1.1 To demonstrate the functional performance of the cask handling and fuel handling cranes

2.0 PREREQUISITES

- 2.1 Electric power is available.
- 2.2 Fuel building cranes instrumentation has been calibrated.

- 2.3 Construction activities on the crane and associated equipment have been completed.
- 2.4 Test equipment and materials are available.
- 2.5 Handling adaptors and accessories are available.

3.0 TEST METHOD

- 3.1 Verify operability of trolley, bridge, and hoist for each crane.
- 3.2 Check hoist and trolley speeds.
- 3.3 Check capability of cask handling and fuel handling crane to position over all required fuel building equipment.
- 3.4 Perform 150 percent static load capacity test of the cask handling crane and the fuel handling crane.
- 3.5 Perform an operational test of the cranes at 100 percent of rated load.
- 3.6 Verify the operation of protective and safety devices.

4.0 DATA REQUIRED

- 4.1 Hoist and trolley speeds
- 4.2 Verification of proper operation of interlocks
- 4.3 Load capacity data

5.0 ACCEPTANCE CRITERIA

5.1 The cask handling and fuel handling cranes performs as described in Subsection 9.1.5.2.1.

14.2.12.1.93 Reactor Containment Building HVAC System Test

1.0 OBJECTIVES

1.1 To demonstrate the capability of the containment building heating, ventilation and air conditioning (HVAC) system to maintain acceptable temperature limits in the containment building during normal operations.

2.0 PREREQUISITES

- 2.1 Construction activities inside the reactor containment building have been completed.
- 2.2 Construction activities on the reactor containment building HVAC system have been completed.
- 2.3 Reactor containment building HVAC system instrumentation has been calibrated.
- 2.4 Support systems required for operation of the reactor containment building HVAC system are complete and operational.
- 2.5 Test instrumentation is available and calibrated.
- 2.6 The reactor coolant system (RCS) is at normal operating temperature and pressure (HFT).

3.0 TEST METHOD

- 3.1 Verify the operation of the reactor containment fan coolers and fans.
- 3.2 Verify the operation of the reactor cavity air handling unit.
- 3.3 Verify the system is at rated airflow and is air balanced.
- 3.4 Verify alarms, indicating instruments, and status lights are functional.

4.0 DATA REQUIRED

4.1 Operation of all interlocks at proper setpoints

- 4.2 Air balancing verification
- 4.3 Fan operating data
- 4.4 Containment building temperature data
- 4.5 Temperature of chilled water supply and return from cooling coils

5.0 ACCEPTANCE CRITERIA

5.1 The reactor containment building HVAC system performs as described in Subsection 9.4.6.

14.2.12.1.94 <u>Reactor Containment Purge System Test</u>

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the capability of the containment purge system to clean up the containment atmosphere during normal operation and to maintain suitable environmental conditions during refueling condition

2.0 PREREQUISITES

- 2.1 Construction activities in the containment have been completed and acceptable levels of cleanliness established.
- 2.2 Construction activities on the reactor containment purge system have been completed.
- 2.3 Reactor containment purge system instrumentation has been calibrated.
- 2.4 Support systems required for operation of the reactor containment purge system are complete and operational.
- 2.5 Test instrumentation is available and calibrated.
- 2.6 High-efficiency particulate air (HEPA) filters, prefilters, and material of carbon adsorber used during construction are completely replaced.

3.0 TEST METHOD

- 3.1 Demonstrate manual and automatic system controls.
- 3.2 Verify alarms, indicating instruments and status lights are functional.
- 3.3 Verify the system is at rated airflow and is air balanced.
- 3.4 Perform filter and carbon adsorber efficiency tests.
- 3.5 Demonstrate system responses to a high-radiation signal.
- 3.6 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.7 Verify power-operated valves fail to the position specified in Subsection9.4.6 upon loss of motive power.
- 3.8 Simulate containment isolation actuation signal (CIAS), containment purge isolation actuation signal (CPIAS) and observe isolation valve response.
- 3.9 Verify the proper operation of containment purge system radiation monitors.
- 3.10 Testing of air cleaning units (ACUs) is performed in accordance with RG 1.140 (Reference 10) and ASME N511 (In-Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems).
- 3.11 Testing of the leakage from ductwork and ACU housing is performed in accordance with TA-4300 of ASME AG-1-2009 with Addenda (Code on Nuclear Air and Gas Treatment).

4.0 DATA REQUIRED

- 4.1 Air balancing verification
- 4.2 Fan operating data for low-volume purge and high-volume purge fans

- 4.3 Filter and carbon adsorber data for exhaust filter trains
- 4.4 Valve opening and closing times, where required
- 4.5 Valve position indication
- 4.6 Position response of valves to loss of motive power
- 4.7 Setpoints at which alarms and interlocks occur
- 4.8 Temperatures of air supply (outside) to high-volume purge supply and discharge into containment
- 4.9 Valve responses to simulated CIAS and CPIAS signals
- 4.10 Reactor containment purge system radiation monitors performance data

- 5.1 Reactor containment purge system performs its functions as described in Subsection 9.4.6.
- 5.2 The manual and automatic operation of all system valves and dampers should be checked.
- 5.3 The operation of all system fans should be checked.
- 5.4 The automatic operation of heating coil should be checked.
- 5.5 The operation of system status lights and alarms should be checked.
- 5.6 The valves respond to CIAS and CPIAS
- 5.7 Reactor containment purge system radiation monitors perform as described in Table 11.5-1.
- 5.8 Reactor containment purge system meets ductwork and ACU housing leakage requirements.

14.2.12.1.95 Control Room HVAC System Test

1.0 OBJECTIVES

- 1.1 To verify the functional operation of the control room HVAC system and to provide reasonable assurance of a proper environment for personnel and equipment under all modes of operation.
- 1.2 To perform a control room envelope integrity test

Note: The preoperational tests on the balance of the control room HVAC system are described in Subsection 14.2.12.1.100.

2.0 PREREQUISITES

- 2.1 Construction activities in the control room have been completed and all penetrations sealed.
- 2.2 Construction activities on the control room HVAC system have been completed.
- 2.3 Control room HVAC system instrumentation has been calibrated.
- 2.4 Support systems required for operation of the control room HVAC system are complete and operational.
- 2.5 Test instrumentation is available and calibrated.
- 2.6 HEPA filters, prefilters, and carbon adsorber material used during construction are completely replaced.

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation, stroking speed, and position indication of all dampers.
- 3.3 Verify proper operation of the units and system.

- 3.4 Demonstrate the automatic transfer to emergency operations as a result of control room emergency ventilation signal (CREVAS) and safety injection actuation signal (SIAS).
- 3.5 Demonstrate the recirculation operation.
- 3.6 Verify the filter particle removal efficiency, carbon adsorber efficiency, and filter bank airflow capacity.
- 3.7 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.
- 3.8 Verify that the system maintains the control room envelope (CRE) at positive pressure relative to the surrounding areas during system operation in the pressurized mode as required by the Technical Specifications.
- 3.9 Verify the proper operation of control room HVAC system radiation monitors and system response to a high-radiation signal.
- 3.10 Verify that the ACUs perform in accordance with RG 1.52 (Reference 11) and ASME N511 (In-Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems).
- 3.11 Verify the air inleakage to the CRE in accordance with ASTM E741-200 and RG 1.197.

4.0 DATA REQUIRED

- 4.1 Air balancing verification
- 4.2 Fan and damper operating data
- 4.3 Temperature and humidity data in the control room envelope
- 4.4 Response to radioactivity and products of combustion
- 4.5 Setpoints of alarms, interlocks, and controls
- 4.6 Pressurization data for the control room envelope

- 4.7 Filter and carbon adsorber data
- 4.8 Control room HVAC system radiation monitor performance data

5.0 ACCEPTANCE CRITERIA

- 5.1 The control room HVAC system operates its functions as described in Subsections 6.4.2 and 9.4.1.
- 5.2 The control room HVAC system radiation monitors perform as described in Table 11.5-1.
- 5.3 The control room HVAC system maintains CRE integrity.
- 5.4 The ASTM E741-00 tests confirm that total unfiltered inleakage rate to the CRE is less than 510 cmh (300 cfm) in the emergency mode.

14.2.12.1.96 <u>Turbine Generator Building HVAC System Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the manual and automatic operation of units
- 1.2 To demonstrate status of lights and alarms
- 1.3 To demonstrate the Fans are operating at design capacities

2.0 PREREQUISITES

- 2.1 Construction activities on the turbine building HVAC system have been completed.
- 2.2 Turbine building HVAC system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the turbine building HVAC system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation of the AHU, fans, and cubicle coolers.
- 3.3 Verify the proper operation of protective devices, controls, interlocks, instrumentation, and alarms.

4.0 DATA REQUIRED

- 4.1 Fan and damper operating data
- 4.2 Setpoints at which alarms and interlocks occur

- 5.1 The turbine building HVAC system operates as described in Subsection 9.4.4.
- 5.2 Cubicle cooler and AHU respond correctly to manually or automatically initiated start and stop signals.
- 5.3 Electric unit heaters respond to manually and automatically initiated on and off signals.
- 5.4 The exhaust fans and supply fans respond correctly to manually initiated start and stop signals.
- 5.5 System alarms are responded correctly to process instrumentation signals.
- 5.6 The battery room exhaust fan limits the hydrogen accumulation to 1 percent of the total volume of the battery room.

14.2.12.1.97 Emergency Diesel Generator Area HVAC System Test

1.0 OBJECTIVES

1.1 To demonstrate proper operation of the emergency diesel generator area HVAC system

2.0 PREREQUISITES

- 2.1 Construction activities on the emergency diesel generator area HVAC system have been completed.
- 2.2 Emergency diesel generator area HVAC system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the emergency diesel generator area HVAC system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation of the AHUs, fans, and cubicle coolers.
- 3.3 Verify the system is at rated airflow and is air balanced.
- 3.4 Verify design temperature can be maintained in each emergency diesel generator area.
- 3.5 Verify alarms, indicating instruments, and status lights are functional.

4.0 DATA REQUIRED

- 4.1 Fan and damper operating data
- 4.2 Airflow verification
- 4.3 Setpoints at which alarms, interlocks, and controls occur

4.4 Temperature data of each emergency diesel generator area

5.0 ACCEPTANCE CRITERIA

- 5.1 The emergency diesel generator area HVAC system operates as described in Subsection 9.4.5.
- 5.2 The manual and automatic operation of all units operates properly.
- 5.3 The proper operation of all system status lights and alarms is performed.

14.2.12.1.98 <u>Fuel Handling Area HVAC System Test</u>

1.0 OBJECTIVES

1.1 To demonstrate the proper operation of the fuel handling area HVAC system to maintain design conditions

2.0 PREREQUISITES

- 2.1 Construction activities on the fuel handling area HVAC system have been completed.
- 2.2 Fuel handling area HVAC system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the fuel handling area HVAC system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 HEPA filters, prefilters, and carbon adsorber material used during construction are completely replaced.

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation, stroking speed, and position indication of all dampers.

- 3.3 Verify the system maintains the fuel handling area at a negative pressure.
- 3.4 Verify the proper operation of the fuel handling area supply air handling unit (AHU) and cubicle coolers.
- 3.5 Verify the proper operation of the fuel handling area exhaust air cleaning units (ACUs).
- 3.6 Verify filter efficiency, carbon adsorber efficiency, and airflow capacity.
- 3.7 Verify the system is at rated airflow and is air balanced.
- 3.8 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.
- 3.9 Verify the proper operation of the fuel handling area HVAC system radiation monitor.
- 3.10 Verify that the ACUs perform in accordance with RG 1.140 (Reference 10), RG 1.52 (Reference 11) and ASME N511 (In-Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems).
- 3.11 Verify isolation of safety-related dampers installed upstream of supply AHU and downstream of normal exhaust ACU on a simulated fuel handling area emergency ventilation action signal (FHEVAS) and high radiation signal.
- 3.12 Demonstrate the automatic transfer to emergency operation as a result of FHEVAS and high radiation signal.
- 3.13 Testing of the leakage from ductwork and ACU housing is performed in accordance with TA-4300 of ASME AG-1-2009 with Addenda (Code on Nuclear Air and Gas Treatment).

4.0 DATA REQUIRED

- 4.1 Air balancing verification
- 4.2 Fan and damper operating data

- 4.3 Temperature data in the fuel handling area
- 4.4 Setpoints at which alarms, interlocks, and controls occur
- 4.5 Fuel handling area negative pressurization data during normal and postulated emergency conditions
- 4.6 Filter and carbon adsorber data
- 4.7 Fuel handling area HVAC system radiation monitor performance data

5.0 ACCEPTANCE CRITERIA

- 5.1 The fuel handling area HVAC system operates as described in Subsection 9.4.2.
- 5.2 The manual and automatic operation of all units operates properly.
- 5.3 The operation of all isolation dampers operates properly.
- 5.4 The fuel handling area HVAC system automatically transfers to emergency operation upon receipt of ESFAS-FHEVAS and a high radiation signal.
- 5.5 All status, lights and system alarms are verified.
- 5.6 The fuel handling area HVAC system radiation monitor performs as described in Table 11.5-1.
- 5.7 The fuel handling area HVAC system meets ductwork and ACU housing leakage requirements.

14.2.12.1.99 Compound Building HVAC System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the proper operation of the compound building HVAC system to maintain design condition
- 1.2 To demonstrate that airborne concentrations are capable of being maintained below Derived Air Concentration (DAC) limits.

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2.0 PREREQUISITES

- 2.1 Construction activities on the compound building HVAC system have been completed.
- 2.2 Compound building HVAC system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the compound building HVAC system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 HEPA filters, prefilters, and carbon adsorber material used during construction are completely replaced.

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation, stroking speed, and position indication of all dampers.
- 3.3 Verify the capacity of the HVAC system to maintain the area temperature.
- 3.4 Verify the system maintains the radwaste controlled area at a negative pressure.
- 3.5 Verify the proper operation of the general supply air handling units (AHUs), fans, and cubicle coolers.
- 3.6 Verify the proper operation of the general exhaust air cleaning units (ACUs) and fans.
- 3.7 Verify filter efficiency and airflow capacity.
- 3.8 Verify the system is at rated airflow and is air balanced.
- 3.9 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.

- 3.10 Verify the proper operation of the compound building HVAC system radiation monitor.
- 3.11 Verify that the ACUs perform in accordance with RG 1.140 (Reference 10) and ASME N511 (In-Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems).
- 3.12 Testing of the leakage from ductwork and ACU housing is performed in accordance with TA-4300 of ASME AG-1-2009 with Addenda (Code on Nuclear Air and Gas Treatment).
- 3.13 Demonstrate the automatic transfer to the carbon adsorber exhaust ACUs from the HEPA filter exhaust ACUs as a result of a high radiation signal.
- 3.14 Verify exhaust airflow rates from radiologically controlled rooms.

4.0 DATA REQUIRED

- 4.1 Air balancing verification
- 4.2 Fan and damper operating data
- 4.3 Temperature data
- 4.4 Setpoints of alarms interlocks and controls
- 4.5 Compound building negative pressurization
- 4.6 Compound building HVAC system radiation monitor performance data

- 5.1 The compound building HVAC system operates as described in Subsection 9.4.7.
- 5.2 The carbon adsorber exhaust ACUs start and HEPA filter exhaust ACUs stop automatically upon receipt of a high radiation signal.

- 5.3 The compound building HVAC system radiation monitor performs as described in Table 11.5-1.
- 5.4 The compound building HVAC system meets ductwork and ACU housing leakage requirements.
- 5.5 The compound building HVAC system maintains exhaust airflow rates from the radiologically controlled rooms located in the compound building at a minimum of the HVAC flows in Table 12.2-26.

14.2.12.1.100 Balance of Control Room HVAC System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate that the control room HVAC system airflow is balanced for normal mode

2.0 PREREQUISITES

- 2.1 Construction activities in the control room are complete with all penetrations sealed in place.
- 2.2 Construction activities on the control room HVAC system have been completed.
- 2.3 Control room HVAC system instrumentation has been calibrated.
- 2.4 Support systems required for operation of the control room HVAC system are complete and operational.
- 2.5 Test instrumentation is available and calibrated.

- 3.1 Verify control logic.
- 3.2 Verify the operation of control room supply AHUs.
- 3.3 Verify operation of the kitchen and toilet exhaust fan and smoke removal fan.

- 3.4 Verify alarms, indicating lights, and status lights are functional.
- 3.5 Verify the system is at rated airflow and is air balanced.
- 3.6 Verify the proper operation of dampers.
- 3.7 Verify the proper operation of the control room emergency makeup ACUs.

4.0 DATA REQUIRED

- 4.1 Fan operating data for each of the air handling units, air cleaning units, and kitchen and toilet exhaust fan, and smoke removal fan.
- 4.2 Damper operating data
- 4.3 Airflow and balancing verification
- 4.4 Setpoints at which alarms, interlocks, and controls occur
- 4.5 Temperature data for each of control room HVAC subsystems

5.0 ACCEPTANCE CRITERIA

5.1 The airflow balance of control room HVAC system operates as described in Subsection 9.4.1.

14.2.12.1.101 Hydrogen Mitigation System Test

1.0 OBJECTIVES

1.1 To demonstrate the proper operation of HMS

2.0 PREREQUISITES

- 2.1 Construction activities on the HMS have been completed.
- 2.2 Hydrogen instrumentation has been calibrated.
- 2.3 Electrical power systems required for the HMS are available.

- 2.4 Test instrumentation is available and calibrated.
- 2.5 Hydrogen monitoring system software is installed.

3.0 TEST METHOD

- 3.1 Verify HMS igniter control logic and indication.
- 3.2 Demonstrate each igniter reaches proper operating temperature.

4.0 DATA REQUIRED

4.1 Igniter temperatures

5.0 ACCEPTANCE CRITERIA

5.1 The HMS operates as described in Subsection 6.2.5.

14.2.12.1.102 Containment Hydrogen Recombiner System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the hydrogen recombiners are properly installed and operable.

2.0 PREREQUISITES

- 2.1 Construction activities on the CHRS have been completed.
- 2.2 Support systems required for operation of the CHRS are completed and operational.
- 2.3 Test instrumentation is available and calibrated.
- 2.4 Manufacturer hydrogen recombiner tests are completed and approved.

3.0 TEST METHOD

3.1 Verify the proper operation of the hydrogen sensors, instrumentation, controls, and alarms.

- 3.2 A portion of the installed recombiner plates are tested outside of containment to verify the ability of the passive autocatalytic recombiners to achieve their specified plate temperature when exposed to a specified atmosphere containing hydrogen. The testing may include certified manufacturing tests of the plates performed in accordance with the recombiner qualification requirements.
- 3.3 A sample of the passive autocatalytic recombiner cartridges or plates is selected and removed from each passive autocatalytic recombiner and surveillance bench tests are performed on the removed specimens to confirm continued satisfactory performance. The specimen is placed in a performance test apparatus and exposed to a known air/hydrogen sample. The test instrumentation is used to measure degradation in catalytic action.

4.0 DATA REQUIRED

- 4.1 Plant temperature
- 4.2 Depletion rate

5.0 ACCEPTANCE CRITERIA

5.1 The passive autocatalytic recombiners are verified to provide a hydrogen depletion rate of greater than or equal to the minimum depletion rate identified in Subsection 6.2.5. It is also verified that the required number of recombiners are installed at the locations defined in Subsection 6.2.5.

14.2.12.1.103 Liquid Waste Management System Test

1.0 OBJECTIVES

1.1 To demonstrate the manual/auto operation of liquid waste management system equipment and components including pumps, tanks, heater and valves

- 1.2 To demonstrate the operation of isolation function for liquid discharge line
- 1.3 To demonstrate the operation of status lights and system alarms and instruments
- 1.4 To demonstrate the performance characteristics of R/O package

2.0 PREREQUISITES

- 2.1 Construction activities on the LWMS have been completed.
- 2.2 LWMS instrumentation has been calibrated.
- 2.3 Support systems required for operation of the LWMS are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Proper types and amounts of filtration, membranes, and resins are loaded in the R/O package.

- 3.1 Operate control valves from all appropriate control positions. Observe valve operation and position indication. Measure opening and closing times, where required.
- 3.2 Verify the proper operation of the tank level alarms and interlocks.
- 3.3 Verify the proper operation of system pumps and valves.
- 3.4 Verify the proper operation of the tank mixers.
- 3.5 Simulate a high-radiation signal to the LWMS discharge radiation monitor and verify that the discharge isolation valves close to isolate the liquid waste effluent. Discharge radiation monitors are tested as described in Subsection 14.2.12.1.106.

- 3.6 Verify alarms, instruments, and status lights are functional.
- 3.7 Verify the process flow rate, filtration efficiency, and operability of R/O package.

4.0 DATA REQUIRED

- 4.1 Waste pump operating data
- 4.2 Valve opening and closing times, where required
- 4.3 Valve position indication
- 4.4 Setpoints at which alarms and interlocks occur
- 4.5 Filtration unit operating data

- 5.1 The LWMS operates as described in Section 11.2.
- 5.2 The liquid waste management system pumps should be manually started and stopped by their respective control switches, and their status should be indicated on Radwaste Control Console.
- 5.3 When the following tanks are "Lo" level, their respective pumps and cross-tied pumps should be stopped automatically, and their status should be indicated on radwaste control console.
- 5.4 The Caustic Storage Tank Heater should be manually operated by control switch on local panel and automatically started or stopped by Tank temperature "Lo" or "Hi" in AUTO mode.
- 5.5 Specified valves should be manually operated by their respective control switches on radwaste control console and their position lights should be illuminated on control switches.
- 5.6 Alarm, pump shutdown, and valve closure should be automatically operated upon detection of a high radiation signal.

- 5.7 Alarms should be annunciated at radwaste control console upon specified conditions.
- 5.8 When specified cross-tie valves are operated manually at local panel, their respective position lights should be indicated on radwaste control console.
- 5.9 The process flow rate, decontamination factor and filtration efficiency of major process components are equal to or greater than the design basis.

14.2.12.1.104 Solid Waste Management System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the operation of the system valves
 - 1.2 To demonstrate the failed position of system valves
 - 1.3 To demonstrate system alarms and status lights and instruments
 - 1.4 To demonstrate the system resin charging and transfer capabilities
 - 1.5 To demonstrate that residual amounts of free liquid present in process packaged wastes conform with regulatory requirements and waste acceptance criteria
 - 1.6 To demonstrate the hydraulic integrity of connections carrying radioactive fluids between mobile processing equipment and permanently installed plant subsystems.

2.0 PREREQUISITES

- 2.1 Construction activities on the SWMS have been completed.
- 2.2 SWMS instrumentation has been calibrated.
- 2.3 Support systems required for operation of the SWMS are completed and operational.

- 2.4 Test Instrumentation is available and calibrated.
- 2.5 Simulated waste feed are prepared for verifying residual amounts of free liquid present in process packaged wastes.
- 2.6 Simulated waste feed are prepared for the hydraulic integrity test of connections carrying radioactive fluids between mobile processing equipment and permanently installed plant subsystems.

3.0 TEST METHOD

- 3.1 Verify the operation of the sluice pump and valves.
- 3.2 Verify the compound building crane can reach all design points.
- 3.3 Verify the operation of the solid waste compactor.
- 3.4 Verify the proper operation of the tank level alarms and interlocks.
- 3.5 Verify spent resin beds can be sluiced to high-integrity container.
- 3.6 Verify the operation of the high-integrity container fill/dewatering head.
- 3.7 Verify the proper operation of alarms, controls, instruments, status lights and interlocks.

4.0 DATA REQUIRED

- 4.1 Setpoints at which alarms and interlocks occur
- 4.2 High-integrity container fill/dewatering head level instrument data
- 4.3 Sluice pump operating data
- 4.4 Compound building crane data
- 4.5 Valve position indication
- 4.6 Leakage rate data at where fluid carrying is proceed between mobile processing equipment and permanently installed plant subsystems

- 5.1 Specified valves shall be manually opened and closed by their respective hand switches located at Information FPD on the radwaste control console and at local.
- 5.2 Specified valve strokes full open and full close in response to FIK-003 located at information FPD on the radwaste control console, and status is properly indicated.
- 5.3 Indications for tank level, tank pressure and demineralized water inlet flow rate of Low-Activity Spent Resin Tank shall be indicated in the Radwaste Control Room per Table 11.4-6.
- 5.4 New resin tank shall be capable of charging the specified equipment with new resin.
- 5.5 Spent resin shall be transferred from specified equipment to low activity spent resin Tanks.
- 5.6 Specified valves fail in the required position on loss of control power and loss of air, and return to the connect position on restoration of air or control power. Inoperable status indicates properly.
- 5.7 Wet solid wastes shall be stabilized or dewatered in accordance with 10 CFR 61.56 in as described Subsection 11.4.1.4.
- 5.8 No leakage occurs between mobile processing equipment and permanently installed plant subsystems.
- 5.9 Indication for tank level of the Spent Resin Long-Term Storage Tank shall be indicated in Radwaste Control Room per Table 11.4-6.
- 5.10 High alarms for tank level of the Low-Activity Spent Resin Tank and Spent Resin Long-Term Storage Tank shall be indicated in the Radwaste Control Room per Table 11.4-6.

14.2.12.1.105 Gaseous Waste Management System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the manual/auto operation of GRS equipment and components including valves
- 1.2 To demonstrate the verification of manual and automatic response to the system normal control, alarms, and indications.
- 1.3 To demonstrate the capability of the controlling the explosive gas mixture
- 1.4 To demonstrate the operation of isolation function for gaseous effluent discharge line

2.0 PREREQUISITES

- 2.1 Construction activities on the GRS have been completed.
- 2.2 Initial loading of the charcoal into the charcoal beds has been completed, and types and actual amounts of charcoal have been verified before the initial loading to ensure that the gaseous releases are within the regulatory limits.
- 2.3 GRS instrumentation has been calibrated.
- 2.4 Support systems required for operation of the GRS are completed and operational.
- 2.5 Test instrumentation is available and calibrated.

- 3.1 Operate control valves from all appropriate control positions. Observe valve operation and position indication.
- 3.2 Verify that alarms, indicating instruments, and status lights are functional.

- 3.3 Verify that operations of equipment in gaseous radwaste system package are functional.
- 3.4 The automatic nitrogen injection operation upon the receipt of high-high oxygen concentration signal, and low flow signal at the GRS discharge line is verified.
- 3.5 The automatic discharge isolation valve operation upon the receipt of high radiation signal and low-low ACU exhaust flow signal is verified.
- 3.6 The automatic drain isolation valve operation upon the receipt of low and high GRS header drain tank level signal is verified.
- 3.7 The test for the containment isolation valves in the GRS is conducted as described in Subsection 14.2.12.1.129.

4.0 DATA REQUIRED

- 4.1 The properties and verification data for loaded charcoal in charcoal beds.
- 4.2 Setpoints of alarms, interlocks, and controls
- 4.3 Gaseous radwaste system package design data

- 5.1 The GRS operates as described in Section 11.3.
- 5.2 GRS valves are opened and closed by their respective handswitches and by each setpoint as designed.
- 5.3 The GRS alarms, indicating instruments, and status lights are functional as designed.
- 5.4 The GRS discharge valve is closed automatically upon receipt of high radiation signal and low-low ACU exhaust flow signal. The verification for high radiation alarm actuation, including monitoring and indication, in main control room is conducted as described in Subsection 14.2.12.1.106. The verification for low-low ACU exhaust

flow alarm actuation, including monitoring and indication, in radwaste control room is conducted as described in Subsection 14.2.12.1.99.

- 5.5 The nitrogen injection valves are opened automatically upon receipt of a high-high oxygen concentration signal, and low flow signal at the GRS discharge line. The verification for a high-high oxygen concentration alarm actuation, including monitoring and indication, in main control room is conducted as described in Subsection 14.2.12.1.83.
- 5.6 The GRS header drain tank drain isolation valve is closed and opened automatically upon receipt of low and high GRS header drain tank level signal.

14.2.12.1.106 Process and Effluent Radiological Monitoring System Test

The COL applicant is to perform the appropriate interface testing of the gaseous PERMSS monitors with ERDS (COL 14.2(14)).

- 1.0 OBJECTIVES
 - 1.1 To verify that the PERMS can detect and record specific radiation levels, and to verify all alarms and interlocks
 - 1.2 To verify the power status of RMS computer, SRDC, Local units
 - 1.3 To verify the Rate-meter Communication conditions
 - 1.4 To verify the operation of parameter adjustment & control from OIU
 - 1.5 To verify the alarm detection & display function
 - 1.6 To verify the local SKID control function
 - 1.7 To verify the MMIS communication
 - 1.8 To verify the alarm verification functions of RMS computer & SRDC
 - 1.9 To verify the RMS computer hand over function
 - 1.10 To verify the interface between RMS computer and Perimeter computer

- 1.11 To verify the manual/automatic operation & closure time of all Monitor sample containment isolation valves
- 1.12 To demonstrate the operation of ESFAS-CREVAS at specified monitors

2.0 PREREQUISITES

- 2.1 Construction activities on the process and effluent radiological monitoring system have been completed and system software is installed.
- 2.2 Process and effluent radiological monitoring system instrumentation has been calibrated using a calibration source.
- 2.3 Support systems, including heat tracing, required for operation of the process and effluent radiological monitoring system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Calibration check source is available.

- 3.1 Using a simulated signal and external test equipment, verify calibration and operation of the monitor.
- 3.2 Check the self-testing feature of the monitor.
- 3.3 Where applicable, verify proper control actuation by the monitor and record the response time. Simulate a high-radiation signal to the appropriate radiation monitors to verify proper control actuations.
- 3.4 Verify proper alarm actuation in the main control room. Simulate a high-radiation signal to the radiation monitors to verify proper alarm actuations in the main control room or local control panel, as appropriate.

4.0 DATA REQUIRED

- 4.1 Monitor response to a simulated signal
- 4.2 Technical data associated with the source
- 4.3 Signal levels necessary to cause alarm actuation
- 4.4 Response time of the monitor to perform control functions

- 5.1 The process and effluent radiological monitoring system continuously monitors radiation level of process and effluent streams, provides alarm signals, and generates isolation and diversion signals when the measured radiation exceeds preset levels in accordance with the system design criteria and system description in Section 11.5.
- 5.2 Power shall be supplied to RMS computer cabinet, OJU, SRDC & local units as designed
- 5.3 Communications with Ratemeter, OJU, MMIS are verified
- 5.4 Parameter adjustment & control from OJU are verified
- 5.5 OJU shall indicate the alarm as designed
- 5.6 Local SKID control function is verified
- 5.7 MMIS communication shall be performed as designed
- 5.8 Alarm verification functions of RMS computer & SRDC is verified
- 5.9 When power fail, the network server shall be transferred to other computer as designed
- 5.10 Digital and analog input test shall be as designed
- 5.11 Monitor sample containment isolation valve operate as designed

5.12 ESFAS-CREVAS is operated from the high radiation alarm of control room intake radiation monitor.

14.2.12.1.107 Area Radiation Monitoring System Test

1.0 OBJECTIVES

- 1.1 To verify the functional performance of the area radiation monitoring system
- 1.2 To verify the power status of RMS computer, SRDC, Local units
- 1.3 To verify the Rate-meter Communication conditions
- 1.4 To verify the operation of parameter adjustment & control from OIU
- 1.5 To verify the alarm detection & display function
- 1.6 To verify the local SKID control function
- 1.7 To verify the MMIS communication
- 1.8 To verify the alarm verification functions of RMS computer & SRDC
- 1.9 To verify the RMS computer hand over function
- 1.10 To verify the interface between RMS computer and Perimeter computer
- 1.11 To verify the manual/automatic operation & closure time of all Monitor sample containment isolation valves
- 1.12 To demonstrate the operation of ESFAS-CPIAS at specified monitors
- 1.13 To demonstrate the operation of ESFAS-FHEVAS at specified monitors

2.0 PREREQUISITES

2.1 Construction activities on the area radiation monitoring system have been completed and system software is installed.

- 2.2 Area radiation monitoring system instrumentation has been calibrated using a calibration source.
- 2.3 Support systems required for operation of the area radiation monitoring system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Calibration check source is available.

3.0 TEST METHOD

- 3.1 Using a simulated signal and external test equipment, verify the calibration and operation of the monitor.
- 3.2 Check the self-testing feature of the monitor.
- 3.3 Compare local and remote indications.
- 3.4 Verify proper local and remote alarm actuations.
- 3.5 Simulate automatic initiation signals and verify proper control actuations.

4.0 DATA REQUIRED

- 4.1 Monitor response to a simulated signal
- 4.2 Technical data associated with the source
- 4.3 Local and remote responses to test signals
- 4.4 Signals levels necessary to cause alarm actuation

- 5.1 The area radiation monitors perform as described in Subsection 12.3.4.
- 5.2 Power shall be supplied to RMS computer cabinet, OJU, SRDC & local units as designed
- 5.3 Communications with Ratemeter, OJU, MMIS are verified
- 5.4 Parameter adjustment & control from OJU are verified
- 5.5 OJU shall indicate the alarm as designed
- 5.6 Local SKID control function is verified
- 5.7 MMIS communication shall be performed as designed
- 5.8 Alarm verification functions of RMS computer & SRDC is verified
- 5.9 When power fail, the network server shall be transferred to other computer as designed
- 5.10 Digital and analog input test shall be as designed
- 5.11 Monitor sample containment isolation valve operate as designed
- 5.12 ESFAS-CPIAS is operated from the high radiation alarm of containment operating/upper operating area radiation monitor
- 5.13 ESFAS-FHEVAS is operated from the high radiation alarm of spent fuel pool area radiation monitor
- 5.14 Alarm form monitor to MMI display is verified

14.2.12.1.108 <u>4,160V Class 1E Auxiliary Power System Test</u>

- 1.0 OBJECTIVES
 - 1.1 To verify the local and/or remote operation of the Class 1E 4,160V switchgear (SWGR) breaker
 - 1.2 To verify the automatic transfer (fast and residual voltage) of the buses from the unit auxiliary transformer (UAT) to the standby auxiliary transformer (SAT)
 - 1.3 To verify the manual transfer operation of SWGR incoming breakers

- 1.4 To verify the operation of the protective relays
- 1.5 To verify the operation of system instrumentation and controls
- 1.6 To verify the operation of system annunciation

2.0 PREREQUISITES

- 2.1 Construction activities including construction acceptance tests on the 4,160V Class 1E auxiliary power system have been completed.
- 2.2 The 4,160V Class 1E auxiliary power system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the 4,160V Class 1E auxiliary power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The voltage of all 4,160V feeders and buses are tested and within acceptable limits.
- 2.6 The 4,160V power is available from the UAT and SAT.
- 2.7 SWGR assembly, breakers, control and protective equipment/circuits have been inspected and tested, and are capable of being placed into service.
- 2.8 The emergency diesel generator and alternate ac power sources are available.

3.0 TEST METHOD

- 3.1 Demonstrate the operability of the 4,160V SWGR breakers breakers locally and/or remotely.
- 3.2 Demonstrate the operability of the bus interlocks, alarms, and protective relays.
- 3.3 Verify the operation of meters and annunciators.

- 3.4 Verify the 4,160V safety-related systems load shed as designed on undervoltage condition (loss of voltage and degraded voltage condition).
- 3.5 Verify the 4,160V Class 1E buses can be energized from power sources including the UAT, SAT emergency diesel generators, and the alternate ac power source.
- 3.6 Demonstrate the automatic transfer of the Class 1E 4,160V SWGR from the UAT to SAT.
- 3.7 Demonstrate the manual transfer of the Class 1E 4,160V SWGR from the UAT to SAT and from the SAT to UAT.

4.0 DATA REQUIRED

- 4.1 Setpoints at which alarms, interlocks, and protective relays activate
- 4.2 System response to low bus voltage

- 5.1 The 4,160V Class 1E auxiliary power system operates as described in Subsection 8.3.1.1.2.
- 5.2 The 4,160V SWGR breakers are operated correctly locally and/or remotely.
- 5.3 Power supply to the 4,160V SWGR is transferred manually from UAT source to SAT source and from SAT source to UAT source.
- 5.4 With the 4,160V bus voltage and SAT voltage synchronized, a fast automatic transfer within specified time from UAT to SAT breaker occurs when the unit protection trip circuit is actuated.
- 5.5 With the 4,160V bus voltage and SAT voltage not synchronized, a residual voltage transfer from UAT source to SAT source occurs when unit protection trip and bus residual voltage are actuated.
- 5.6 Actuation of the protection trip relays, trip and block their associated breakers, and their statuses are indicated.

14.2.12.1.109 <u>480V Class 1E Auxiliary Power System Test</u>

1.0 OBJECTIVES

- 1.1 To verify the local and/or remote operation of the Class 1E 480V load center (LC) and motor control center (MCC) breakers
- 1.2 To verify the operation of the protective relays
- 1.3 To verify the operation of system instrumentation and controls
- 1.4 To verify the operation of system annunciation

2.0 PREREQUISITES

- 2.1 Construction activities including construction acceptance tests on the 480V Class 1E auxiliary power system have been completed.
- 2.2 The 480V Class 1E auxiliary power system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the 480V Class 1E auxiliary power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The voltage of all 480V feeders and buses are tested and within acceptable limits.
- 2.6 The 4,160V Class 1E auxiliary power is available.

3.0 TEST METHOD

- 3.1 Demonstrate the operability of the 480V LC and MCC breakers locally and/or remotely.
- 3.2 Demonstrate the operability of the bus interlocks, alarms, and protective relays.
- 3.3 Verify the operation of meters and annunciators.

3.4 Perform energization of 480V Class 1E auxiliary power system.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms, interlocks, and protective relays activate

5.0 ACCEPTANCE CRITERIA

- 5.1 The 480V Class 1E auxiliary power system operates as described in Subsection 8.3.1.1.2.
- 5.2 The 480V LC and MCC breakers are operated correctly locally and/or remotely.
- 5.3 Actuation of the protection trip relays, trip and block their associated breakers, and their statuses are indicated.

14.2.12.1.110 <u>Unit Main Power System Test</u>

1.0 OBJECTIVES

1.1 To demonstrate that the unit main power system is capable of supplying power to designated loads and transmitting power from the main generator to the transmission system

2.0 PREREQUISITES

- 2.1 Construction activities including construction acceptance tests on the unit main power system have been completed.
- 2.2 The offsite power system is available.
- 2.3 Support systems required for operation of the unit main power system are operational.
- 2.4 The turbine and main generator, switchyard, and switchgears are available for synchronized operation.
- 2.5 Meters, relays, and protective devices have been calibrated and tested.

3.0 TEST METHOD

- 3.1 Demonstrate the ability of the main transformer to transmit power from the main generator to the offsite power system.
- 3.2 Demonstrate the ability of the main generator to generate power.
- 3.3 Demonstrate the ability of the unit auxiliary transformers to supply station auxiliaries.
- 3.4 Verify the operation of the generator circuit breaker.
- 3.5 Verify the operation of interlocks, alarms, and protective relays.
- 3.6 Verify the operation of the main generator auxiliary systems.

4.0 DATA REQUIRED

- 4.1 Main generator operating data
- 4.2 Main transformer operating data
- 4.3 Unit auxiliary transformer operating data
- 4.4 Generator circuit breaker operating data
- 4.5 Setpoints at which alarm, interlocks, and protective relays activate

- 5.1 The unit main power system operates as described in Subsection 8.2.1.
- 5.2 The main transformer transmits power from the main generator to the offsite power system.
- 5.3 The main generator generates power as designed.
- 5.4 The unit auxiliary transformers supply station auxiliaries.
- 5.5 The generator circuit breaker operates as designed.
- 5.6 The interlocks, alarms, and protective relays operate as designed.

5.7 The main generator auxiliary systems operate as designed.

14.2.12.1.111 <u>13,800V Non-Class 1E Auxiliary Power System Test</u>

1.0 OBJECTIVES

- 1.1 To verify the local and/or remote operation of the non-Class 1E 13,800V switchgear (SWGR) breakers
- 1.2 To verify the automatic transfer (fast and residual voltage) of the buses from the unit auxiliary transformer (UAT) to the standby auxiliary transformer (SAT)
- 1.3 To verify the manual transfer operation of SWGR incoming breakers
- 1.4 To verify the operation of the protective relays
- 1.5 To verify the operation of system instrumentation and controls
- 1.6 To verify the operation of system annunciation

2.0 PREREQUISITES

- 2.1 Construction activities including construction acceptance tests on the 13,800V non-Class 1E auxiliary power system have been completed.
- 2.2 The13,800V non-Class 1E auxiliary power system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the 13,800V non-Class 1E auxiliary power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The 13,800V power is available from the UAT and SAT.
- 2.6 The voltage of all 13,800V feeders and buses are tested and within acceptable limits.

2.7 SWGR assembly, breakers, control and protective equipment/circuits have been inspected and tested and are capable of being placed into service.

3.0 TEST METHOD

- 3.1 Demonstrate the operability of the 13,800V SWGR breakers locally and/or remotely.
- 3.2 Demonstrate the operability of the bus interlocks, alarms, and protective relays.
- 3.3 Verify the operation of meters and annunciators.
- 3.4 Verify the 13,800V buses can be energized from power sources including the UAT and SAT.
- 3.5 Demonstrate the automatic transfer of the non-Class 1E 13,800V SWGR from the UAT to SAT.
- 3.6 Demonstrate the manual transfer of the Class 1E 4,160V SWGR from the UAT to SAT and from the SAT to UAT.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms, interlocks, and protective relays activate.

- 5.1 The 13,800V non-Class 1E auxiliary power system operates as described in Subsection 8.3.1.1.1.
- 5.2 The 13,800V SWGR breakers are operated correctly locally and/or remotely.
- 5.3 Power supply to the 13,800V SWGR is transferred manually from UAT source to SAT source and from SAT source to UAT source.

- 5.4 With the 13,800V SWGR voltage and SAT voltage synchronized, the fast automatic transfer within specified time from UAT source to SAT source occurs only when the unit protection trip actuated.
- 5.5 With the 13,800V SWGR voltage and SAT voltage not synchronized, a residual voltage transfer from UAT source to SAT source occurs when unit protection trip and bus residual voltage are actuated.
- 5.6 Actuation of the protection trip relays, trip and block their associated breakers, and their statuses are indicated.

14.2.12.1.112 <u>4,160V Non-Class 1E Auxiliary Power System Test</u>

1.0 OBJECTIVES

- 1.1 To verify the local and/or remote operation of the non-Class 1E 4,160V switchgear (SWGR) breakers
- 1.2 To verify the automatic transfer (fast and residual voltage) of the buses from the unit auxiliary transformer (UAT) to the standby auxiliary transformer (SAT)
- 1.3 To verify the manual transfer operation of SWGR incoming breakers
- 1.4 To verify the operation of the protective relays
- 1.5 To verify the operation of system instrumentation and controls
- 1.6 To verify the operation of system annunciation
- 2.0 PREREQUISITE
 - 2.1 Construction activities including construction acceptance tests on the 4,160V non-Class 1E auxiliary power system have been completed.
 - 2.2 The 4,160V non-Class 1E auxiliary power system instrumentation has been calibrated.

- 2.3 Support systems required for operation of the 4,160V non-Class 1E auxiliary power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The voltage of all 4,160V feeders and buses are tested and within acceptable limits.
- 2.6 The 4,160V power is available from the UAT and SAT to the 4,160V non-Class 1E auxiliary power system.
- 2.7 The 4,160V power is available from the alternate ac power source to the 4,160V permanent non safety buses.
- 2.8 SWGR assembly, breakers, control and protective equipment/circuit have been inspected and tested and are capable of being placed into service.
- 2.9 The alternate ac source is available.

3.0 TEST METHOD

- 3.1 Demonstrate the operability of the 4,160V SWGR breakers locally and/or remotely.
- 3.2 Demonstrate the operability of the bus interlocks, alarms, and protective relays.
- 3.3 Verify the operation of meters and annunciators.
- 3.4 Verify the non-Class 1E 4,160V SWGRs can be energized from power sources including the UAT and SAT.
- 3.5 Verify the permanent non-safety buses can be energized from the UAT, SAT, and alternate ac power source.
- 3.6 Demonstrate the automatic transfer of the non-Class 1E 4,160V SWGR from the UAT to SAT.

3.7 Demonstrate the manual transfer of the Class 1E 4,160V SWGR from the UAT to SAT and from the SAT to UAT.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms, interlocks, and protective relays activate

5.0 ACCEPTANCE CRITERIA

- 5.1 The 4,160V non-Class 1E auxiliary power system supplies the loads as described in Subsection 8.3.1.1.1.2.
- 5.2 The 4,160V SWGR breakers are operated correctly locally and/or remotely.
- 5.3 Power supply to the 4,160V SWGR is transferred manually from UAT source to SAT source and from SAT source to UAT source.
- 5.4 With the 4,160V SWGR bus voltage and SAT voltage synchronized, the fast automatic transfer from UAT source to SAT source occurs within specified time only when the unit protection trip is actuated.
- 5.5 With the 4,160V SWGR voltage and SAT voltage not synchronized, a residual voltage transfer from UAT source to SAT source occurs when unit protection trip and bus residual voltage are actuated.
- 5.6 Actuation of the protection trip relays, trip and block their associated breakers, and their statuses are indicated.

14.2.12.1.113 <u>480V Non-Class 1E Auxiliary Power System Test</u>

1.0 OBJECTIVES

- 1.1 To verify the local and/or remote operation of the non-Class 1E 480V load center (LC) and motor control center (MCC) breakers
- 1.2 To verify the operation of the protective relays
- 1.3 To verify the operation of system instrumentation and controls

1.4 To verify the operation of system annunciation

2.0 PREREQUISITES

- 2.1 Construction activities including construction acceptance tests on the 480V non-Class 1E auxiliary power system have been completed.
- 2.2 The 480V non-Class 1E auxiliary power system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the 480V non-Class 1E auxiliary power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The voltage of all 480V feeders and buses are tested and within acceptable limits.
- 2.6 4,160V non-Class 1E auxiliary power is available.

3.0 TEST METHOD

- 3.1 Demonstrate the operability of the 480V LC and MCC breakers locally and/or remotely.
- 3.2 Demonstrate the operability of the bus interlocks, alarms, and protective relays.
- 3.3 Verify the operation of meters and annunciators.
- 3.4 Perform energization of 480V non-Class 1E auxiliary power system.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms, interlocks, and protective relays activate

5.0 ACCEPTANCE CRITERIA

5.1 The 480V non-Class 1E auxiliary power system operates as described in Subsection 8.3.1.1.1.3.

- 5.2 The 480V LC and MCC breakers are operated correctly locally and/or remotely.
- 5.3 Actuation of the protection trip relays, trip and block their associated breakers, and their statuses are indicated.

14.2.12.1.114 <u>Non-Class 1E DC Power Systems Test</u>

1.0 OBJECTIVES

- 1.1 To verify the capacity and capability of the batteries to carry the worst case load profiles.
- 1.2 To verify the battery chargers have sufficient capacity to supply the power to the specified bus loads while simultaneously recharging the batteries after its duty cycle test.
- 1.3 To verify the proper performance of the battery chargers in the float and equalization mode.
- 1.4 To verify that the battery does not discharge through the battery charger during a loss of ac input power to the battery charger
- 1.5 To determine the voltage which would be available at the non-Class 1E inverters if the batteries were discharged to the minimum voltage limit.
- 1.6 To verify that the voltage available to non-Class 1E inverters exceed the design minimum.
- 1.7 To verify proper operation of the non-Class 1E dc system alarms and status indications
- 1.8 To verify proper operation of the battery chargers with its output voltage regulation and ripple within design value
- 1.9 To verify the standby battery chargers can supply the proper voltage to the non-Class 1E dc control center.

2.0 PREREQUISITES

- 2.1 Construction activities including construction acceptance tests on the non-Class 1E dc power system have been completed.
- 2.2 Non-Class 1E dc power system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the non-Class 1E dc power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Batteries are fully charged.
- 2.6 Load banks are available for discharge test.
- 2.7 The non-Class 1E inverters are operable.
- 2.8 Required load test devices for the non-Class 1E inverters are available.
- 2.9 Operation of all breakers and cables has been verified.
- 2.10 Battery room ventilation is available.

3.0 TEST METHOD

- 3.1 Demonstrate that the batteries and battery chargers meet design capacities by performing discharge and charging tests as follows:
 - 3.1.1 Perform battery modified performance test or service test per IEEE Std. 450-2010 (Reference 12) as endorsed by NRC RG 1.129 (Reference 13).
 - 3.1.2 Perform battery charger capacity test to verify battery charger output meets design requirements.
- 3.2 Verify that battery bank minimum voltage limit and individual cell limits are not exceeded during battery discharge tests.
- 3.3 After the non-Class 1E inverter is loaded to its design capacity, measure the voltage drop from the battery to the inverter input.

- 3.4 Determine the minimum available voltage at the non-Class 1E inverters from the measured voltage drops and the battery minimum voltage limit.
- 3.5 Verify the performance of battery chargers (including standby battery chargers), batteries, and dc control centers meets design requirements.
- 3.6 Verify the proper operation of all protective devices, controls, interlocks, alarms, status indications, computer inputs, and ground detection.

4.0 DATA REQUIRED

- 4.1 Records of discharge test for battery terminal voltage, current, temperature, capacity, and individual cell voltages
- 4.2 Records of charging test for battery charger float voltage and current, and charging time
- 4.3 Records of the non-Class 1E inverter input voltages
- 4.4 Setpoints at which alarms, interlocks, and controls activate
- 4.5 System status indications

- 5.1 The non-Class 1E dc power system supplies the loads as described in Table 8.3.2-2.
- 5.2 The battery chargers (including standby battery chargers) are capable of operating within design requirements.
- 5.3 The battery shall demonstrate its ability to meet the duty cycle test requirements.
- 5.4 The battery chargers (including standby battery chargers) can supply the designed load current, and at the same time, can charge the battery within 24 hours after the battery duty cycle test.
- 5.5 With the battery charger in the float mode and battery connected, each battery charger supplies constant setting voltage.

- 5.6 With the battery charger in the equalization mode and battery connected, each battery charger supplies constant setting voltage.
- 5.7 Simulation of the non-Class 1E dc control center bus ground protective relay and under voltage relay initiates the actuation of annunciator alarm and indicating light.
- 5.8 Open/Trip of battery feeder breakers initiates the actuation of annunciator alarm and indicating light.
- 5.9 Open/Trip of battery charger incoming breakers with opening of standby battery chargers incoming breaker initiates the actuation of annunciator alarm and indicating light.
- 5.10 Closure of the battery test panel breakers initiates the actuation of annunciator alarm and indicating light.
- 5.11 Open/Trip of battery charger output breaker initiates the actuation of annunciator alarms and indicating light.
- 5.12 Simulation of the dc output failure (under current) of the battery charger initiates the actuation of annunciator alarm and indicating light.
- 5.13 Simulation of the dc under voltage and over voltage of the battery charger initiates the actuation of annunciator alarm and indicating light.
- 5.14 Simulation of the ac input failure of the battery chargers initiates the actuation of annunciator alarm and indicating light.
- 5.15 The battery does not discharge through the battery charger during a loss of ac input power to the battery charger.
- 5.16 The minimum available input voltage for the non-Class 1E inverters equals or exceeds 100 V for 125 Vdc system or 200 V for 250 Vdc system.
- 5.17 The proper operation of the non-Class 1E dc system alarms and status indications.

14.2.12.1.115 Class 1E DC Power System Test

1.0 OBJECTIVES

- 1.1 To verify the capacity and capability of the batteries to carry the worst case load profiles.
- 1.2 To verify the battery chargers have sufficient capacity to supply the power to the specified bus loads while simultaneously recharging the batteries after its duty cycle test.
- 1.3 To verify the proper performance of the battery chargers in the float and equalization mode
- 1.4 To verify that the battery does not discharge through the battery charger during a loss of ac input power to the battery charger.
- 1.5 To determine the voltage which would be available at the Class 1E inverters if the batteries were discharged to the minimum voltage limit.
- 1.6 To verify that the voltage available to Class 1E inverters exceed the design minimum.
- 1.7 To verify proper operation of the Class 1E dc system alarms and status indications
- 1.8 To verify the proper operation of the battery charger with its output voltage regulation and ripple within design value
- 1.9 To verify the standby battery chargers can supply the proper voltage to the Class 1E 125Vdc control center.
- 1.10 To verify the electrical independence and redundancy of the Class 1E dc power supplies for safety-related functions.

2.0 PREREQUISITES

2.1 Construction activities including construction acceptance tests on the Class 1E dc power system have been completed.

- 2.2 Class 1E dc power system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the Class 1E dc power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Batteries are fully charged.
- 2.6 Load banks are available for discharge test.
- 2.7 The Class 1E inverters are operable.
- 2.8 Required load test devices for the Class 1E inverters are available.
- 2.9 Operation of all breakers and cables has been verified.
- 2.10 Battery room ventilation is available.

3.0 TEST METHOD

- 3.1 Demonstrate that the batteries and battery chargers meet design capacities by performing discharge and charging tests as follows:
 - 3.1.1 Perform battery modified performance test or service test per IEEE Std. 450-2010 (Reference 12) as endorsed by NRC RG 1.129 (Reference 13).
 - 3.1.2 Perform battery charger capacity test to verify battery charger output meets design requirements.
- 3.2 Verify that battery bank minimum voltage limit and individual cell limits are not exceeded during battery discharge test.
- 3.3 After the Class 1E inverter is loaded to its design capacity, measure the voltage drop from the battery to the inverter input.
- 3.4 Determine the minimum available voltage at the Class 1E inverters from the measured voltage drops and the battery minimum voltage limit.

- 3.5 Verify the performance of battery chargers (including standby battery chargers), batteries, and dc control centers meets design requirements.
- 3.6 Verify the proper operation of all protective devices, controls, interlocks, alarms, status indications, computer inputs, and ground detection.
- 3.7 Verify the electrical independence and redundancy of the Class 1E dc power supplies for safety-related functions in accordance with NRC RG 1.41 (Reference 14).

4.0 DATA REQUIRED

- 4.1 Records of discharge test for battery terminal voltage, current, temperature, capacity, and individual cell voltages
- 4.2 Records of charging test for battery charger float voltage and current, and charging time
- 4.3 Records of the Class 1E inverter input voltages
- 4.4 Setpoints at which alarms, interlocks, and controls activate
- 4.5 System status indications

- 5.1 The Class 1E dc power system supplies the loads as described in Table 8.3.2-1.
- 5.2 The battery chargers (including standby battery chargers) are capable of operating within design requirements.
- 5.3 The battery shall demonstrate its ability to meet the duty cycle test requirements.
- 5.4 The battery chargers (including standby battery chargers) can supply the designed load current, and at the same time, can charge the battery within 24 hours after the battery duty cycle test.

- 5.5 With the battery charger in the float mode and battery connected, each battery charger supplies constant setting voltage.
- 5.6 With the battery charger in the equalization mode and battery connected, each battery charger supplies constant setting voltage.
- 5.7 Simulation of the Class 1E dc control center bus ground protective relay and under voltage relay initiates the actuation of annunciator alarm and indicating light.
- 5.8 Open/Trip of battery feeder breakers initiates the actuation of annunciator alarm and indicating light
- 5.9 Open/Trip of battery charger incoming breakers with opening of standby battery charger incoming breaker initiates the actuation of annunciator alarm and indicating light.
- 5.10 Closure of battery test panel breakers initiates the actuation of annunciator alarm and indicating light.
- 5.11 Open/Trip of battery charger output breaker initiates the actuation of annunciator alarms and indicating light.
- 5.12 Simulation of the dc output failure (under current) of the battery charger initiates the actuation of annunciator alarm and indicating light.
- 5.13 Simulation of the dc under voltage and over voltage of the battery charger initiates the actuation of annunciator alarm and indicating light.
- 5.14 Simulation of the ac input failure of the battery chargers initiates the actuation of annunciator alarm and indicating light.
- 5.15 The battery does not discharge through the battery charger during a loss of ac input power to the battery charger.
- 5.16 The minimum available input voltage for the Class 1E inverters equals or exceeds 100 Vdc.

- 5.17 The proper operation of the Class 1E 125 Vdc system alarms and status indications.
- 5.18 Each electrical division operates independently of other divisions.

14.2.12.1.116 Offsite Power System Test

- 1.0 OBJECTIVES
 - 1.1 To verify that the offsite power system is capable of supplying the power as designed to the station auxiliaries through the two preferred power circuits

2.0 PREREQUISITES

- 2.1 Construction activities including construction acceptance tests on the offsite power system have been completed.
- 2.2 The offsite power system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the offsite power system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Verify the operation of the switchyard protective relaying system.
- 3.2 Verify the operation of the switchyard power circuit breakers and disconnect switches from main control room, switchyard local control panels, and its local control cabinet as designed.
- 3.3 Verify the operation of the switchyard dc power system and its associated controls, alarms, and annunciators.
- 3.4 Verify the operation of the switchyard ac auxiliary power system and its associated controls, alarms, and annunciators.

- 3.5 Verify the operation of the protective relaying, alarm, and associated control devices of the main, unit auxiliary, and standby auxiliary transformers.
- 3.6 Demonstrate the ability of the normal and alternate preferred power circuits to supply power from the offsite power source to the station auxiliaries.

4.0 DATA REQUIRED

- 4.1 Setpoints at which alarms, interlocks, and protective relays activate
- 4.2 Switchyard operating data
- 4.3 Main transformer operating data
- 4.4 Unit auxiliary transformer operating data
- 4.5 Standby auxiliary transformer operating data

- 5.1 The offsite power system operates as described in Subsection 8.2.1.
- 5.2 The switchyard protective relaying system operates as designed.
- 5.3 The switchyard power circuit breakers and disconnect switches from main control room, switchyard local control panels, and its local control cabinet operate as designed.
- 5.4 The switchyard dc power system and its associated controls, alarms, and annunciators operate as designed.
- 5.5 The switchyard ac auxiliary power system and its associated controls, alarms, and annunciators operate as designed.
- 5.6 The protective relaying, alarm, and associated control devices of the main, unit auxiliary, and standby auxiliary transformers operate as designed.

5.7 The normal and alternate preferred power circuits supply power from the offsite power source to the station auxiliaries.

14.2.12.1.117 Balance-of-Plant Piping Thermal Expansion Measurement Test

1.0 OBJECTIVES

- 1.1 To verify that the following piping systems expand within acceptable limits during heat-up and return to an acceptable position when cooled down without adverse constraint.
 - 1.1.1 Chemical volume and control system
 - 1.1.2 Safety injection/Shutdown cooling system
 - 1.1.3 Reactor coolant system branch piping
 - 1.1.4 Reactor coolant gas vent system
 - 1.1.5 Steam generator blow down system
 - 1.1.6 Main steam system (Steam generator to MSIVs)
 - 1.1.7 Main feed water system (Inside containment)
 - 1.1.8 Auxiliary feed water system (Inside containment)
 - 1.1.9 Auxiliary steam system
 - 1.1.10 Auxiliary feed water pump turbine system

2.0 PREREQUISITES

- 2.1 This test is carried out in conjunction with the initial reactor coolant system (RCS) heatup and all the conditions for initial heatup must be established.
- 2.2 Construction activities are complete on the pipes to be measured.

- 2.3 Adjustment, setting, and marking of initial positions of spring hangers, hydraulic restraints, and special devices of the systems have been completed.
- 2.4 Temporary scaffolding and ladders are installed as required to perform the observations and record the data.

3.0 TEST METHOD

- 3.1 During hot functional testing (HFT) and pre-critical heatup for power escalation, a visual inspection is performed to verify that spring supports are within design range (i.e., indicator within spring scale) and recorded. Visual inspection of snubbers is performed to provide reasonable assurance they have not contacted either stop and are within expected travel range. Snubber piston scales are read to provide reasonable assurance acceptance criteria for piston to stop gap are met. Also, system walkthroughs are performed during HFT to visually verify that piping and components are unrestricted from moving within their ranges. Hot displacement measurements of all snubbers are obtained and motion is compared with predicted values.
- 3.2 For systems that do not attain design operating temperature, verify by observation and/or calculation that the snubbers accommodate the predicted thermal movement.
- 3.3 Inspect small pipe in the vicinity of connections to large pipe to provide reasonable assurance that sufficient clearance and flexibility exists to accommodate thermal movements of the large pipe.
- 3.4 The feedwater system and auxiliary feedwater system hot displacement measurements are obtained during the initial startup and power escalation phase.
- 3.5 All snubbers and spring supports that required adjustments during the test are reinspected in their hot condition to provide reasonable assurance that proper adjustments are made.

4.0 DATA REQUIRED

4.1 Position measurements versus temperature for cold, heatup, steady-state, cooldown, and return to ambient conditions for designated piping, spring supports, and snubbers

5.0 ACCEPTANCE CRITERIA

- 5.1 The piping moves freely during the heat up to HFT temperatures and subsequent cool down, except at locations where supports/restraints designed to restrain pipe thermal movement as described in Subsection 3.9.2.
- 5.2 Thermal movement of pipe at the locations of spring hangers and snubbers are within the allowable travel range as described in Subsection 3.9.2.
- 5.3 The thermal movement of the pipe at restricted measurement locations is within the acceptable limits or the discrepant response is reconciled using acceptable reconciliation methods as described in Subsection 3.9.2.

14.2.12.1.118 Balance-of-Plant Piping Vibration Measurement Test

1.0 OBJECTIVES

- 1.1 To verify that vibrations in piping systems, induced by pipe flow, equipment operation and system transients do not exceed acceptable limits. The following systems tested for steady state and dynamic transient vibration.
 - 1.1.1 Component cooling water system
 - 1.1.2 Essential service water system
 - 1.1.3 Essential chilled water system
 - 1.1.4 Containment spray system

- 1.1.5 Chemical and volume control system
- 1.1.6 Safety injection/Shutdown cooling system
- 1.1.7 Auxiliary feed water system
- 1.1.8 Spent fuel pool cooling and cleanup system
- 1.1.9 Steam generator blow down system
- 1.1.10 Class 1 auxiliary piping
- 1.1.11 Condensate and turbine building closed cooling water and piping attached to emergency diesel generator systems that may have potential vibration problems based on plant operation experience.
- 1.2 Steady state vibration testing performed during specified operating modes of the piping systems.
- 1.3 During system starts, stops, and changes in operating modes the piping observed for unexpected transients.

2.0 PREREQUISITES

- 2.1 System components and piping supports have been installed in accordance with design drawings for the system to be tested.
- 2.2 System piping has been installed in accordance with design drawings for the system to be tested.
- 2.3 Hot functional testing and/or pre-critical heatup for power escalation is underway.
- 2.4 System piping has been filled for normal operation.

3.0 TEST METHOD

3.1 Perform an assessment of piping system vibration.

4.0 DATA REQUIRED

4.1 Pipe response data to include piping drawings, vibration measurements, and operating conditions

5.0 ACCEPTANCE CRITERIA

- 5.1 Acceptance criteria of steady state vibration testing based on conservatively estimated stresses, which derived from measured velocities and conservatively assumed mode shapes and steady-state vibration testing as described in Section 3.9.
- 5.2 No permanent deformation or damage in any system, structure, or component important to nuclear safety observed and transient vibration testing as described in Section 3.9
- 5.3 All suppressors and restraints respond within their allowable ranges, between stops or with indicators on scale.

14.2.12.1.119 Containment Integrated Leak Rate Test and Structural Integrity Test

1.0 OBJECTIVES

- 1.1 To verify the structural integrity of the containment
- 1.2 To demonstrate that the total leakage from the containment does not exceed the maximum allowable leakage rate at the calculated peak containment internal pressure

2.0 PREREQUISITES

- 2.1 The containment is operational and penetration local leak rate testing has been completed to the greatest extent possible.
- 2.2 All systems inside containment that have containment isolation valves identified are vented and drained as required by Table 6.2.4-1.
- 2.3 Leakage rate determination instrumentation is available and properly calibrated.

- 2.4 Containment inspection has been completed as required by ASME Code Section III, Division 2, and American National Standards Institute/American Nuclear Society (ANSI/ANS) 56.8-1994 (Reference 8).
- 2.5 Systems required, including station air for the test, are available.
- 2.6 Instrumentation to measure containment building movement is installed and calibrated.
- 2.7 Containment building heating, ventilation, and air conditioning (HVAC) system fans are capable of running for air circulation.

3.0 TEST METHOD

- 3.1 Close individual containment isolation valves by the means provided for normal operation of the valves as required by ASME section III, Division 2, and ANSI/ANS 56.8-1994 (Reference 8).
- 3.2 The internal pressure in the containment building is increased from atmospheric pressure to a test pressure of at least 1.15 times the design pressure in approximately five or more increments and depressurized in the same increments.
- 3.3 At each pressure level, during pressurization and depressurization, data are recorded and an evaluation of the deflections is made to determine whether the response deviates significantly from the expected response.
- 3.4 A visual inspection of the containment hatches, penetrations, and gaskets is made.
- 3.5 The containment leak rate is determined at calculated peak accident pressure. Leakage is verified by reference vessel method and/or absolute pressure method. Test accuracy is verified by supplementary means.

4.0 DATA REQUIRED

4.1 Structural integrity data

- 4.1.1 The readings of instrumentation to measure containment building movement are recorded at selected pressure levels.
- 4.1.2 Radial displacements of the cylinder are measured at a minimum of five approximately equally spaced elevations. These measurements are made at a minimum of four approximately equally spaced azimuths. Radial displacements of the containment wall adjacent to the largest opening are measured at a minimum of 12 points, four equally spaced on each of three concentric circles. The increase in diameter of the opening is measured in the horizontal and vertical directions. Vertical displacement of the top of the cylinder relative to the base is measured at a minimum of four approximately equally spaced azimuths. Vertical displacements of the dome of the containment are measured at a point near the apex and two other approximately equally spaced intermediate points between the apex and the spring line on at least one azimuth.
- 4.2 Integrated leak rate data
 - 4.2.1 Containment temperature, pressure, and humidity
 - 4.2.2 Reference vessel temperature and pressure
 - 4.2.3 Atmospheric pressure and temperature
 - 4.2.4 "Known leakage" airflow

- 5.1 The containment performs as described in subsections 6.2.6, 6.2.4, and 3.8.2.
- 5.2 Structural integrity test
 - 5.2.1 Yielding of conventional reinforcement does not develop as determined from analysis of crack width and displacement data.

- 5.2.2 Visible signs of permanent damage to either the concrete structure or the steel liner are undetected.
- 5.2.3 Residual displacements at the points of maximum predicted radial and vertical displacement at the completion of depressurizing or specified condition.
- 5.2.4 The measured displacements at test pressure at points of predicted maximum radial and vertical displacements do not exceed predicted values. This requirement may be waived if the residual displacements within design value.
- 5.3 Integrated leak rate test
 - 5.3.1 The upper confidence limit, plus any local leakage rate additions, is less than specified value of the maximum allowed leakage rate.
 - 5.3.2 The verification test by removal of a quantity of air is acceptable if the mass calculated from the test instrumentation is within design value of the metered mass change.

14.2.12.1.120 <u>Fuel Transfer Tube Functional Test and Leak Test</u>

1.0 OBJECTIVES

- 1.1 To verify the measured leakage through the fuel transfer tube, when summed with the total of all other Type B and C leak rate tests, is within the limits as required by ANSI/ANS 56.8-1994 (Reference 8).
- 1.2 To demonstrate the function of the blind flange

2.0 PREREQUISITES

- 2.1 Construction activities on the fuel transfer tube have been completed.
- 2.2 Temporary pressurization equipment is installed and instrumentation calibrated.

3.0 TEST METHOD

- 3.1 Operate the blind flange in accordance with manufacturer's instructions. Verify the blind flange can be opened and closed within the stated amount of time.
- 3.2 Place the blind flange in the closed position and perform ANSI/ANS 56.8-1994 (Reference 8) Type B leak rate test on the fuel transfer tube seal integrity at calculated peak accident pressure.

4.0 DATA REQUIRED

- 4.1 Fuel transfer tube assembly leak data
- 4.2 Time to operate the blind flange
- 5.0 ACCEPTANCE CRITERIA
 - 5.1 The leak rate, when summed with the total of all other Type B and C leak rate tests, does not exceed the limits as required by and ANSI/ANS 56.8-1994 (Reference 8).
 - 5.2 The blind flange operates in accordance with manufacturer's instructions.
 - 5.3 The fuel transfer tube penetration and the blind flange performs their functions as designed.

14.2.12.1.121 Equipment Hatch Functional Test and Leak Test

1.0 OBJECTIVES

- 1.1 To verify the measured leakage through the containment equipment hatch, when summed with the total of all other Type B and C leak rate tests, is within the limits as required by ANSI/ANS 56.8-1994 (Reference 8).
- 1.2 To demonstrate the operation of the containment equipment hatch and movable shield wall assembly.

- 1.3 To verify proper operation of hoists for operating equipment hatch
- 1.4 To verify limit switch setting and functions for equipment hatch winches
- 1.5 To verify response of hoists to control pushbutton actuation

2.0 PREREQUISITES

- 2.1 Construction activities on the equipment hatch and shield wall have been completed.
- 2.2 Temporary pressurization equipment has been installed and instrumentation has been calibrated.

3.0 TEST METHOD

- 3.1 Demonstrate the operation of exterior shield wall assembly from its normal closed location to the open location and back.
- 3.2 Demonstrate the operation of the equipment hatch from its normal closed location to its open location and back.
- 3.3 Place the hatch in the closed position and perform ANSI/ANS 56.8-1994 (Reference 8) Type B leak rate test and seal structural integrity test at calculated peak accident pressure.

4.0 DATA REQUIRED

4.1 Equipment hatch leak data

- 5.1 The equipment hatch performs as described in subsections 3.8.1 and 6.2.4.
- 5.2 The leak rate, when summed with the total of all other Type B and C leak rate tests, does not exceed the limits as required by ANSI/ANS 56.8-1994 (Reference 8).

- 5.3 The equipment hatch and movable shield wall assembly operate in accordance with manufacturer's instructions.
- 5.4 The hoists move the equipment hatch smoothly and level in the upward and downward direction.
- 5.5 The geared and gravity limit switches stop hoists motion without any contact.
- 5.6 Hoists move up and down individually and together in response to pushbutton commands. Brakes engage and disengage as required.

14.2.12.1.122 Containment Personnel Airlock Functional Test and Leak Test

1.0 OBJECTIVES

- 1.1 To verify the measured leakage through each containment personnel airlock is within the limits as required by ANSI/ANS 56.8-1994 (Reference 8).
- 1.2 To verify that the interlocks on the personnel access airlock doors operate as designed
- 1.3 To verify that the indications and alarms associated with personnel access airlock doors operate per design
- 1.4 To demonstrate the operation of the hydraulic closure of inner and outer doors on the personnel access airlock
- 1.5 To demonstrate the operation of differential pressure systems

2.0 PREREQUISITES

- 2.1 Construction activities on the containment personnel airlocks have been completed.
- 2.2 Temporary pressurization equipment is installed and instrumentation is calibrated.

2.3 Electrical checks are complete on the hatches.

3.0 TEST METHOD

- 3.1 Operate each airlock in accordance with manufacturer's instructions. Verify alarms, interlocks, and indications.
- 3.2 Place each airlock in the closed position and perform ANSI/ANS 56.8-1994 (Reference 8) Type B leak rate test and structural integrity test at calculated peak accident pressure.

4.0 DATA REQUIRED

4.1 Individual airlock leak data

- 5.1 The containment personnel airlocks perform as described in subsections 6.2.6 and 3.8.2.
- 5.2 The leak rates, when summed with the total of all other type B and C leak rate tests, do not exceed the limits as required by ANSI/ANS 56.8-1994 (Reference 8).
- 5.3 The personnel access inner and outer door open interlocks engaged properly and the personnel access outer door not opened.
- 5.4 Operator control stations indication lights properly indicate the status of the inner and outer doors of personnel access airlock.
- 5.5 The inner and outer doors of personnel access airlock close and latch hydraulically in response to door close button.
- 5.6 Personnel access airlock outer and inner door status is alarmed per design when the outer/inner doors are open.
- 5.7 Personnel access airlock outer and inner door de-energized when inner/outer differential pressure is within design value.

5.8 Personnel access airlock outer and inner door energized when inner/outer differential pressure is within design value.

14.2.12.1.123 Containment Electrical Penetration Assemblies Test

1.0 OBJECTIVES

1.1 To verify the integrity of the electrical penetration O-ring seals, and to verify that a summation of the Type B and C leak rate test results does not exceed the limits as required by ANSI/ANS 56.8-1994 (Reference 8).

2.0 PREREQUISITES

2.1 Containment electrical penetration assemblies must be complete with no identified exceptions or discrepancies that would affect the test.

3.0 TEST METHOD

3.1 Perform ANSI/ANS 56.8-1994, Type B leak rate test at calculated peak accident pressure.

4.0 DATA REQUIRED

4.1 Electrical penetration leak data

- 5.1 Containment electrical penetration assemblies perform as described in subsection 8.3.1.1.9.
- 5.2 The sum of the containment electrical penetration assembly leak rate tests, when summed with all other Type B and C tests, does not exceed limits as required by ANSI/ANS 56.8-1994 (Reference 8).
- 5.3 Containment electrical penetration assemblies perform within their design values.

14.2.12.1.124 Containment Isolation Valves Leakage Rate Test

1.0 OBJECTIVES

1.1 To verify that the measured leakage through each containment penetration isolation valve, when summed with the total of all other Type B and C leak rate tests, is within the limits as required by ANSI/ANS 56.8-1994 (Reference 8).

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested have been completed.
- 2.2 Temporary pressurization equipment has been installed and instrumentation has been calibrated.

3.0 TEST METHOD

- 3.1 Close the individual containment isolation valves by the means provided for normal operation of valve.
- 3.2 Perform ANSI/ANS 56.8-1994, Type C test, by local pressurization of each penetration.

4.0 DATA REQUIRED

4.1 Individual penetration leak data

- 5.1 The containment isolation valves operate as described in subsection 6.2.4.
- 5.2 The leak rates, when summed with the total of all other Type B and C leak rate tests, must not exceed the allowable limits as required by ANSI/ANS 56.8-1994 (Reference 8).
- 5.3 The containment isolation valves operate within design value.
14.2.12.1.125 Loss of Instrument Air Test

1.0 OBJECTIVES

1.1 To demonstrate that a reduction and loss of instrument air pressure causes fail-safe operation of active safety-related pneumatically operated equipment

2.0 PREREQUISITES

- 2.1 Construction activities on items to be tested have been completed.
- 2.2 Individual valves and equipment are operable.
- 2.3 The instrument air system is in service at rated pressure with support systems operational to the extent necessary to conduct the test. All pneumatic loads are cut-in to the extent possible at the time test begins.
- 2.4 Components to be tested are given in Table 9.3.1-1. Table 9.3.1-1 is a listing of the air-operated active safety-related equipment important to safety, which also includes both the loss-of-air failed position and fail-safe position of each component.
- 2.5 The compressed air system test, in conjunction with this test, satisfies the requirements of NRC RG 1.68.3 (Reference 5), Regulatory Position C.1-C.11.
- 2.6 Loss-of-air-supply tests should be conducted on all branches of the instrument air system simultaneously, if practicable, or on the largest number of branches of the system that can be adequately managed.

- 3.1 Place the valves in the normal operating position, and maintain plant in as close to normal conditions as is practicable.
- 3.2 Where safe to personnel and equipment, conduct a loss of air test on integrated systems by performing the following tests:

- 3.2.1 Shut off the instrument air system in a manner that would simulate a sudden air pipe break and verify that the affected components respond properly.
- 3.2.2 Repeat step 3.2.1 but shut the instrument air system off very slowly to simulate a gradual loss of pressure.
- 3.3 Where deemed necessary, depressurize individual components. Note component response.
- 3.4 Return instrument air to the depressurized systems and components. Note responses.

4.0 DATA REQUIRED

4.1 Responses of systems and components to loss of instrument air and subsequent restoration

5.0 ACCEPTANCE CRITERIA

5.1 All valves fail to their designated fail position upon loss of air and remain in the design position upon restoration.

14.2.12.1.126 <u>Mid-Loop Operations Verification Test</u>

1.0 OBJECTIVES

- 1.1 To verify that installed instrumentation for operations at reduced reactor coolant system inventory is accurate and reliable
- 1.2 To verify the shutdown cooling system pumps operated at reduced RCS level without cavitation or air entrainment in the suction lines

- 2.1 Construction activities on the RCS mid-loop instrumentation system have been completed.
- 2.2 RCS mid-loop system instrumentation has been calibrated.

- 2.3 Support systems required for mid-loop operations are completed and operational.
- 2.4 Test instrumentation of high accuracy to measure RCS level changes is available and calibrated.
- 2.5 The RCS is at normal shutdown level in the pressurizer and depressurized.
- 2.6 The SCS is operable.

3.0 TEST METHOD

- 3.1 Verify the operation of the RCS mid-loop level instrumentation indication and alarms.
- 3.2 Verify the operation of the SCS pumps while operating at mid-loop level.
- 3.3 Establish the minimum level at which the SCS pumps can operate without cavitation.
- 3.4 Establish the maximum flow the SCS pumps can operate at mid-loop without cavitation.

4.0 DATA REQUIRED

- 4.1 Setpoints of alarms
- 4.2 Mid-loop instrumentation data
- 4.3 Minimum level and maximum flow limits for the SCS pumps

5.0 ACCEPTANCE CRITERIA

- 5.1 The mid-loop instrumentation provides accurate indication of RCS parameters as described in subsections 7.7.1.1 and 19.2.2.2.
- 5.2 The temporary ultrasonic flow meter can be installed and can measure flow.

14.2.12.1.127 <u>Seismic Monitoring Instrumentation System Test</u>

1.0 OBJECTIVES

1.1 To demonstrate proper operation of the seismic monitoring instrumentation system

2.0 PREREQUISITES

- 2.1 Construction activities on the seismic monitoring instrumentation system have been completed and system software is installed.
- 2.2 Seismic monitoring instrumentation system instrumentation has been calibrated.
- 2.3 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Verify operability of internal calibration devices by recording calibration records on all applicable sensors.
- 3.2 Verify system response to simulated seismic events by actuating the appropriate trigger units, recording accelerograph outputs, and playing back all records for analysis.
- 3.3 Verify and calibrate all system alarms and indicators.
- 3.4 Verify the proper operation and installation of all peak recording accelerographs.

4.0 DATA REQUIRED

4.1 Recorded sensor response to simulated seismic inputs

5.0 ACCEPTANCE CRITERIA

5.1 The seismic monitoring instrumentation system operates as designed and described in subsection 3.7.4.

14.2.12.1.128 <u>Auxiliary Steam System Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate the auxiliary steam system provides the steam to various plant components at designed pressures and flow
- 1.2 Demonstrate the manual and automatic operation of system pumps
- 1.3 Demonstrate the manual and automatic operation of system valves
- 1.4 Demonstrate all status lights
- 1.5 Demonstrate the fail positions of system valves
- 1.6 Demonstrate all system alarms
- 1.7 To demonstrate system responses to PR-RE/RT-103 signal

2.0 PREREQUISITES

- 2.1 Construction activities on the auxiliary steam system have been completed.
- 2.2 Auxiliary steam system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the auxiliary steam system are completed and operational.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 Sufficient loads are available to allow loading to the auxiliary boiler to its designed capacity.

3.0 TEST METHOD

3.1 Verify proper operation of designated components such as protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.

- 3.2 Operate control valves from all appropriate control positions. Observe valve operation and position indication and measure opening and closing times.
- 3.3 Verify power-operated valves fail to their appropriate position upon loss of motive power.
- 3.4 Demonstrate proper operation and flow rates for all design flow paths.
- 3.5 Verify proper operation of system pumps.
- 3.6 Perform measurements of the auxiliary boiler performance using American Society of Mechanical Engineers (ASME) PTC-4 (fired steam generators, 1998).

4.0 DATA REQUIRED

- 4.1 Boiler operating data per PTC-4
- 4.2 Valve opening and closing times, where required
- 4.3 Valve position indication
- 4.4 Response of power-operated valves to loss of motive power
- 4.5 Setpoints at which alarms and interlocks occur
- 4.6 Pump operating data

5.0 ACCEPTANCE CRITERIA

- 5.1 The auxiliary steam system provides steam flow to designated components and systems.
- 5.2 The auxiliary steam system meets manufacturers design performance.
- 5.3 The auxiliary steam system performs as described in Subsection 10.4.10

14.2.12.1.129 Containment Isolation Valves Test

1.0 OBJECTIVES

- 1.1 To demonstrate that containment isolation valves can be operated manually and operate in response to automatic actuation
- 1.2 To verify that upon loss of actuating power, the valves fail as designed
- 1.3 To verify that all valves operate in less than the time specified in the valve test procedure

2.0 PREREQUISITES

- 2.1 Construction activities on the containment isolation valves have been completed.
- 2.2 Support system required to operate the containment isolation valves are operable.
- 2.3 Test instrumentation is available and calibrated.

- 3.1 Operate containment isolation valves from all appropriate control positions. Verify position indication, and measure opening and closing times, including at rated flow and no-flow conditions.
- 3.2 Verify containment isolation valves fail to the position specified in the safety analysis upon loss of motive power.
- 3.3 Initiate the following simulated activation signals and verify the appropriate valves move to the design positions.
 - CIAS containment isolation actuation signal
 - CSAS containment spray actuation signal
 - MSIS main steam isolation signal

AFAS	auxiliary feedwater actuation signal
AAFAS	alternate auxiliary feedwater actuation signal
HRAS	high-radiation actuation signal
HHAS	high-humidity actuation signal
SIAS	safety injection actuation signal
CCWLLSTAS	component cooling water low-low surge tank actuation signal

4.0 DATA REQUIRED

- 4.1 Valve opening and closing times under differential pressure, flow, and temperature conditions as applicable
- 4.2 Valve position indications
- 4.3 Position response of valves to loss of motive power
- 4.4 Valve response to a simulated actuation signal

5.0 ACCEPTANCE CRITERIA

- 5.1 The containment isolation valves operate as described in subsection 6.2.4.
- 5.2 The containment isolation valves can be operated manually and operate in response to automatic actuation as designed.
- 5.3 The containment isolation valves fail to the position specified in the safety analysis upon loss of motive power.
- 5.4 The containment isolation valves move to the design positions by simulated activation signals.

14.2.12.1.130 Post-Accident Monitoring Instrumentation Test

1.0 OBJECTIVES

1.1 To verify that the post-accident monitor instrumentation is installed properly, responds correctly to external inputs, and provides proper outputs to the distributed display and recording equipment

2.0 PREREQUISITES

- 2.1 Construction activities on the systems to be tested are complete.
- 2.2 Applicable operating manuals are available.
- 2.3 Required software is installed and operable.
- 2.4 External test equipment and instrumentation is available and calibrated.
- 2.5 Plant systems required to support testing are operable to the extent necessary to perform the testing or suitable simulation of the systems is used.

- 3.1 Verify power sources to all related equipment.
- 3.2 Validate that external inputs are received and processed correctly by the appropriate system devices.
- 3.3 Verify that alarms and indication displays respond correctly to actual or simulated inputs.
- 3.4 Verify the operability of required software application programs.
- 3.5 Verify the correct operation of data output devices and displays at applicable workstations and terminals.
- 3.6 Evaluate processing system loading under actual or simulated operating conditions.

4.0 DATA REQUIRED

4.1 Computer-generated summaries of external input data, data processing, analysis functions, displayed information, and permanent data records

5.0 ACCEPTANCE CRITERIA

- 5.1 The post-accident monitor instrumentation performs as described in subsection 7.5.1.1.
- 5.2 The alarms and indication displays respond correctly to actual or simulated inputs is operates as designed.
- 5.3 The required software application programs are operable as designed.
- 5.4 The data output devices and displays at applicable workstations and terminals are operable as designed.

14.2.12.1.131 Electrical and I&C Equipment Areas HVAC System Test

1.0 OBJECTIVES

- 1.1 Demonstrate the manual and automatic operation of fans and AHU.
- 1.2 Demonstrate the operation of electric duct heaters and cubicle coolers and humidifiers
- 1.3 Demonstrate the operation of status lights and alarms
- 1.4 Demonstrate that system equipment meets design requirements.
- 1.5 To verify trouble/disabled functions and BISI inputs

- 2.1 Construction activities on the electrical and I&C equipment areas HVAC system have been completed.
- 2.2 Electrical and I&C equipment areas HVAC system instrumentation has been calibrated.

- 2.3 Support systems required for operation of the electrical and I&C equipment areas HVAC system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Verify all control logic.
- 3.2 Verify the system is at rated airflow and is air balanced.
- 3.3 Verify design temperature can be maintained in each electrical and I&C equipment room.
- 3.4 Verify alarms, indicating instruments, and status lights are functional.
- 3.5 Verify the operation of the AHU, fans, and cubicle coolers.
- 3.6 Demonstrate the operation of the battery room exhaust fan for the battery room.

4.0 DATA REQUIRED

- 4.1 Fan and damper operating data
- 4.2 Airflow verification
- 4.3 Setpoints at which alarms, interlocks, and controls activate
- 4.4 Temperature data of each electrical and I&C equipment room
- 4.5 Air balancing verification

5.0 ACCEPTANCE CRITERIA

- 5.1 The electrical and I&C equipment areas HVAC system operates as described in subsection 9.4.5.1.2
- 5.2 The control logic of electrical and I&C equipment areas HVAC system operates as designed.

- 5.3 The supply fans and AHU operate manually and automatically.
- 5.4 The exhaust fans and electric duct heaters and cubicle coolers and humidifiers operate as designed.
- 5.5 The status lights and alarms operate as designed.
- 5.6 Battery room exhaust fan limits the hydrogen accumulation to less than the 1 percent for the battery room.

14.2.12.1.132 Auxiliary Building Controlled Area HVAC System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the proper operation of the auxiliary building controlled area HVAC system to maintain design condition
- 1.2 To demonstrate the operation of fans and dampers and AHU and electric unit heaters and electric duct heaters and cubicle coolers
- 1.3 To demonstrate the operation of all system status lights and alarms
- 1.4 To verify areas maintained at a negative pressure
- 1.5 To demonstrate that airborne concentrations are capable of being maintained below Derived Air Concentration (DAC) limits.

- 2.1 Construction activities on the auxiliary building controlled area HVAC system have been completed.
- 2.2 Auxiliary building controlled area HVAC system instrumentation has been calibrated.
- 2.3 Support systems required for the operation of the auxiliary building controlled area HVAC system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.

2.5 HEPA filters, prefilters, and carbon adsorber material used during construction are completely replaced.

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation, stroking speed, and position indication of all dampers.
- 3.3 Verify the system maintains the auxiliary building controlled area at a negative pressure.
- 3.4 Verify the proper operation of the air handling units (AHUs).
- 3.5 Verify the proper operation of the air cleaning units (ACUs).
- 3.6 Verify the proper operation of all cubicle coolers.
- 3.7 Verify filter efficiency, carbon adsorber efficiency, and airflow capacity.
- 3.8 Verify the system is at rated airflow and is air balanced.
- 3.9 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms using actual or simulated inputs.
- 3.10 Verify the proper operation of the auxiliary building controlled area HVAC system radiation monitor and system response to a high-radiation signal.
- 3.11 Verify that the ACU performs in accordance with NRC RGs 1.140 (Reference 10), 1.52 (Reference 11), and ASME N511 (In-Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems).
- 3.12 Verify isolation of the safety-related dampers installed downstream of normal supply AHU and upstream of normal exhaust ACU on a simulated safety injection actuation signal (SIAS).

- 3.13 Testing of the leakage from ductwork and ACU housing is performed in accordance with TA-4300 of ASME AG-1-2009 with addenda (Code on Nuclear Air and Gas Treatment).
- 3.14 Verify exhaust airflow rates from radiologically controlled rooms.

4.0 DATA REQUIRED

- 4.1 Air balancing verification
- 4.2 Fan and damper operating data
- 4.3 Temperature data of building area
- 4.4 Setpoints of alarms, interlocks, and controls
- 4.5 Auxiliary building controlled area negative pressurization data
- 4.6 Filter and carbon adsorber data
- 4.7 Auxiliary building controlled area HVAC system radiation monitor performance data

5.0 ACCEPTANCE CRITERIA

- 5.1 The auxiliary building controlled area HVAC system operates as designed and described in subsection 9.4.5.1.3.
- 5.2 The auxiliary building controlled area HVAC system radiation monitors perform as designed and described in table 11.5-1.
- 5.3 The auxiliary building controlled area HVAC system meets ductwork and ACU housing leakage requirements.
- 5.4 The auxiliary building controlled area HVAC system maintains exhaust airflow rates from the radiologically controlled rooms located in the auxiliary building controlled area at a minimum of the HVAC flows in Table 12.2-26.

14.2.12.1.133 Auxiliary Building Clean Area HVAC System Test

1.0 OBJECTIVES

- 1.1 To demonstrate the proper operation of the auxiliary building clean area HVAC system to maintain design condition
- 1.2 To demonstrate the manual and automatic operation of fans and AHU's
- 1.3 To demonstrate the operation of electric duct heaters and cubicle coolers and electric unit heaters
- 1.4 To demonstrate the operation of status lights and alarms
- 1.5 To verify trouble/disabled functions of fans

2.0 PREREQUISITES

- 2.1 Construction activities on the auxiliary building clean area HVAC system have been completed.
- 2.2 Auxiliary building clean area HVAC system instrumentation has been calibrated.
- 2.3 Support systems required for operation of the auxiliary building clean area HVAC system are complete and operational.
- 2.4 Test instrumentation is available and calibrated.

- 3.1 Verify all control logic.
- 3.2 Verify the proper operation, stroking speed, and position indication of all dampers.
- 3.3 Verify the proper operation of the supply AHUs and fans.
- 3.4 Verify the proper operation of all cubicle coolers.
- 3.5 Verify the system is at rated airflow and is air balanced.

3.6 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms using actual or simulated inputs.

4.0 DATA REQUIRED

- 4.1 Air balancing verification
- 4.2 Fan and damper operating data
- 4.3 Temperature data of building area
- 4.4 Setpoints of alarms, interlocks, and controls

5.0 ACCEPTANCE CRITERIA

- 5.1 The control logic of the auxiliary building clean area HVAC system operates as described in section 9.4.3.
- 5.2 The fans and AHU's operate manually and automatically.
- 5.3 The electric duct heaters, cubicle coolers and electric unit heaters operate as designed.
- 5.4 The status lights and alarms operates as designed.
- 5.5 The trouble/disabled function of fans operate as designed.

14.2.12.1.134 Leakage Detection System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the operation of the various leakage detection system installed inside and outside reactor containment

- 2.1 Construction activities on the various sumps have been completed.
- 2.2 Leakage detection system instrumentation is available and calibrated.

2.3 Support systems required for operation of the leakage detection system are complete and operational.

3.0 TEST METHOD

3.1 Test the sump level switches and flow monitors, airborne radioactivity monitors, and/or atmosphere humidity monitors using simulated signals.

4.0 DATA REQUIRED

4.1 Alarms, indications, and control logic for sumps instrumentation

5.0 ACCEPTANCE CRITERIA

5.1 The leakage detection system operates as described in subsection 5.2.5.1.

14.2.12.1.135 Leakage Control and Detection of outside Containment System

- 1.0 OBJECTIVES
 - 1.1 To identify leaks in systems outside of containment that might contain radioactive materials after an accident with the systems at approximate operating pressures or higher
 - 1.2 To identify and quantify any remaining leaks after all practical repairs have been performed

- 2.1 Construction activities on the safety injection system, shutdown cooling system, containment spray system and primary sampling system have been completed.
- 2.2 Leakage control and detection of outside containment are available and calibrated.
- 2.3 Support systems required for operation of the leakage control and detection of systems outside containment system are complete and operational.

3.0 TEST METHOD

- 3.1 Verify proper operation of each pump with minimum flow established.
- 3.2 Perform a full flow test of the each system.
- 3.3 Perform a walkdown and visual inspection of all the piping.
- 3.3 If any leakage is found, perform corrective maintenance for all practically repairable leakage.
- 3.4 If the system must be shutdown for corrective maintenance, complete the system walkdown and record all the leakage information.

4.0 DATA REQUIRED

4.1 Alarms, indications, and control logic for safety injection system, shutdown cooling system, containment spray system and primary sampling system instrumentation

5.0 ACCEPTANCE CRITERIA

- 5.1 The leakage control and detection of outside containment system operates as described in section 9.3.3.
- 5.2 Leakages identified, all practical corrective maintenances performed, and all remaining leakages quantified.

14.2.12.1.136 <u>RCP Vibration Monitoring System</u>

1.0 OBJECTIVES

1.1 To verify the proper operation of the RCPVMS of the NIMS

- 2.1 Construction activities on the NIMS applicable to the RCPVMS are completed.
- 2.2 Sensors, cables, and signal conditioning electronics are installed and operable.

- 2.3 Power cabinets are operable to support testing requirements.
- 2.4 Required test equipment is operable.

3.0 TEST METHOD

- 3.1 Verify the ability to detect the RCP vibration and record the required data using simulated signals to the monitoring channels.
- 3.2 Verify all alarming functions.

4.0 DATA REQUIRED

- 4.1 Baseline vibration data
- 4.2 Alarm levels applicable to detection of RCP vibration

5.0 ACCEPTANCE CRITERIA

- 5.1 The RCPVMS performs as described in Subsection 7.7.1.
- 5.2 The alarm setpoints have been adjusted for power operation.
- 5.3 The alarms and indication operate as described in the related design specification.

14.2.12.1.137 <u>NSSS Integrity Monitoring System (Pre-core)</u>

- 1.0 OBJECTIVES
 - 1.1 To obtain baseline data for Acoustic Leak Monitoring system (ALMS), Loose Parts Monitoring system (LPMS) and RCP Vibration Monitoring system (RCPVMS) during pre-core HFT.
 - 1.2 To verify existing, or establish new alarm setpoints as required for the NSSS Integrity Monitoring System.

2.0 PREREQUISITES

2.1 Plant is stable at the required temperature and pressure plateau.

2.2 The NIMS is operational as applicable.

3.0 TEST METHOD

- 3.1 Collect baseline data during pre-core HFT.
- 3.2 Adjust setpoints, if required, based on the data collected.

4.0 DATA REQUIRED

- 4.1 Baseline data for ALMS, LPMS and RCPVMS
- 4.2 Alarm setpoints for ALMS, LPMS and RCPVMS
- 4.3 RCS temperature and pressure

5.0 ACCEPTANCE CRITERIA

- 5.1 Baseline data of ALMS, LPMS and RCPVMS are collected during precore HFT.
- 5.2 The alarm setpoints of each subsystem are adjusted as necessary.

14.2.12.1.138 Core Protection Calculator System Test

1.0 OBJECTIVES

The internal functions of the CPCS are confirmed through factory acceptance testing. The basis of this in-plant test is to confirm the correct installation of the CPCS, including inter-cabinet cable interfaces, and interfaces to other I&C systems.

- 1.1 To demonstrate the proper operation of DNBR and LPD trip functions of the CPCS
- 1.2 To verify the CPCS response times
- 1.3 To verify the CPCS related alarm functions
- 1.4 To verify the process input/output inter-connection and the input accuracy of the CPCS

- 1.5 To verify the operation of the CPCS interface to the MTP and ITP
- 1.6 To verify the operation of watchdog timer of CPCS
- 1.7 To verify the operation of redundant CPCS power supplies and the safe failure of the system on loss of power
- 1.8 To verify the redundancy and independence of the CPCS

- 2.1 Factory acceptance tests have been completed for the CPCS.
- 2.2 Construction activities for the CPCS have been completed. This includes:
 - a. Installation of CPCS software
 - b. Power-up of CPCS electronic components, including digital controllers, and I/O modules
 - c. Connection of digital data communication interfaces, both wired and fiber-optic, between CPCS internal components (e.g., operator modules) and to/from other plant systems such as PPS, QIAS-N, IPS
 - d. Connection of wired interfaces between CPCS internal components (e.g., conventional switches and indicators), to/from other plant systems
- 2.3 CPCS instrumentation has been calibrated.
- 2.4 External test instrumentation is available and calibrated.
- 2.5 There are no unexpected CPCS self-diagnostic alarms. Self-diagnostic alarms may exist for temporary test conditions; any self-diagnostic alarms are justified.

3.0 TEST METHOD

The CPCS tests are conducted to confirm the correct CPCS operation. To verify redundancy and electrical independence within the CPCS, these tests are conducted separately for each safety channel with observations within the channel under test and concurrent observations of the other channels.

- 3.1 Energize power supplies and verify output voltage.
- 3.2 Stimulate the sensor inputs to the CPCS using the I/O simulator. Observe the DNBR and LPD trip occurrences.
- 3.3 Verify proper operation of the CPCS by input/output and internal function tests. This includes:
 - a. The data communications between CPPs and CEACs of the other channels
 - b. The transmission of the trip and pre-trip signals to PPS
 - c. Interface functions with QIAS-N and IPS
 - d. OM and MTP functions including the modification of Addressable Constants and RDB
 - e. Watchdog timer operation
- 3.4 Simulate the loss of power by disconnecting the power connected to the CPCS cabinets in the channel under test. Observe the alarms and status of that channel and check if a proper safe failure occurs in that channel.

4.0 DATA REQUIRED

- 4.1 Power supply voltages
- 4.2 Indicator operation
- 4.3 Point of actuation and reset for DNBR and LPD trips

4.4 Point of actuation and reset for Penalty Factors

5.0 ACCEPTANCE CRITERIA

Test acceptance is confirmed for each separate safety channel under test, with confirmation of no unexpected interactions with other safety channels.

- 5.1 The CPCS performs the safety function as described in Sections 7.2.1.1.e, including the calculation of the DNBR, LPD and the transmission of trip and pre-trip output signals.
- 5.2 The total response time of the CPCS is verified with respect to the times used in the safety analysis.
- 5.3 Power Supplies are properly operated as specified in Subsection 7.2.2.3.
- 5.4 The data communications between CPPs and CEACs of the other channels properly isolated and separated using one-way SDL communication for the redundancy.
- 5.5 Outputs to the following systems are provided as specified in Subsection 7.2.1.1.e.
 - a. PPS
 - b. QIAS-N
 - c. IPS
- 5.6 The Addressable Constants and RDB can be manually changed according to administrative procedures.
- 5.7 The proper safe failure is provided upon the loss of power to the CPCS cabinets in the channel under test. The alarms and status of that channel is provided as specified in Table 7.2-7.

14.2.12.1.139 Diverse Indication System Test

1.0 OBJECTIVES

1.1 To verify that the DIS is installed properly, responds correctly to external input signals, and display plant parameters on the DIS display device.

2.0 PREREQUISITES

- 2.1 Construction activities on the system to be tested are completed, and DIS software is installed.
- 2.2 Vendor and owner manuals are available and up-to-date.
- 2.3 External test equipment and instrumentation are available and calibrated.
- 2.4 Plant systems required to support this test are operable to the extent necessary to perform the test.

- 3.1 Verify power sources to all related equipment.
- 3.2 Using appropriate test equipment, simulate and vary input signals to the DIS.
- 3.3 Verify that input signals are received and processed correctly by the appropriate system devices.
- 3.4 Verify the operability of the DIS application software
- 3.5 Verify the calculation of part of parameters by the DIS application software.
- 3.6 Verify that displays respond correctly to actual or simulated input signals.
- 3.7 Verify the correct operation of the DIS switch on the Safety Console.

- 3.8 Verify the calculation of the heated-junction thermocouple (HJTC) heater power control signal.
- 3.9 Verify the control of the HJTC heater power via the DIS switch.

4.0 DATA REQUIRED

- 4.1 All simulated input signal values, appropriate intermediate values, and outputs
- 4.2 HJTC heater power control status receiving from the interfacing system (QIAS-P).

5.0 ACCEPTANCE CRITERIA

- 5.1 The DIS performs as described in Subsection 7.8.2.3.
- 5.2 The test results of the DIS should meet the acceptance criteria for each test case that is specified in related design document.

14.2.12.1.140 <u>Pre-Core Pressurizer Surge Line Stratification Test</u>

1.0 OBJECTIVES

1.1 To demonstrate that the temperature measurements due to surge line stratification are within design limits during hot functional testing of the APR1400 plant

- 2.1 All required support systems such as CVCS, PLCS, and PPCS have been completed.
- 2.2 Pressurizer surge line insulation with removable plugs for instruments is installed.
- 2.3 The instruments for the real-time measurements of the surge line temperatures are installed at several major locations in the axial and circumferential directions.

3.0 TEST METHOD

3.1 Record the real-time surge line temperatures and the plant data such as hot leg and pressurizer temperatures, pressurizer pressure and level, charging and letdown flows as well as the status of RCPs, pressurizer heaters and spray valves.

4.0 DATA REQUIRED

- 4.1 Surge line temperature time-history
- 4.2 Time-history plant data such as hot leg and pressurizer temperatures, pressurizer pressure and level, charging and letdown flows as well as the status of RCPs, pressurizer heaters, and spray valves

5.0 ACCEPTANCE CRITERIA

5.1 Verification that surge line temperatures are within design limits

14.2.12.1.141 Location of vital equipment

- 1.0 OBJECTIVE
 - 1.1 To document the location of each vital area so that vital equipment can be validated to be located inside a vital area.

2.0 PREREQUISITES

- 2.1 Construction activities on the major plant structures have been completed.
- 2.2 Vital equipment has been determined and a listing is available.

- 3.1 Each component of vital equipment will be located and the area where it is located will be examined to determine it is within a vital area.
- 3.2 Results of the examination of the vital equipment location will be documented.

4.0 DATA REQUIRED

4.1 List of all vital equipment.

5.0 ACCEPTANCE CRITERIA

5.1 All vital equipment is determined to be located within a vital area.

6.0 SPECIAL PRECAUTIONS

6.1 The vital equipment list and the Inspection Test Acceptance (ITA) document will be SGI and will need to be protected in accordance with appropriate requirements.

14.2.12.1.142 Access to vital equipment

- 1.0 OBJECTIVE
 - 1.1 Verify that access to vital equipment requires passage through at least two physical barriers.

2.0 PREREQUISITES

- 2.1 Construction activities on the major plant structures and the protected area barrier have been completed.
- 2.2 Security barriers are in place.

3.0 TEST METHOD

- 3.1 Locate each component of vital equipment.
- 3.2 Verify that access to each component requires passage through two physical barriers one of which can be the protected area barrier.

4.0 DATA REQUIRED

4.1 List of vital equipment and set of as built general arrangement drawings.

5.0 ACCEPTANCE CRITERIA

5.1 Access to each component of vital equipment requires passage through at least two physical barriers one of which can be the protected area barrier.

6.0 SPECIAL PRECAUTIONS

- 6.1 The vital equipment list will be SGI and the GA drawings will be SRI so they will need to be protected in accordance with appropriate requirements.
- 14.2.12.1.143 Equipment to permit observation of abnormal presence or activity of persons or vehicles

1.0 OBJECTIVE

1.1 Verify that CCTV equipment is in place and adequate illumination is provided to observe exterior areas of the protected area for abnormal presence or activity of persons and/or vehicles.

2.0 PREREQUISITES

- 2.1 Construction activities on the security CCTV system and security lighting have been completed.
- 2.2 Display monitors in the CAS and SAS are operational and camera controls are functioning.
- 2.3 Security lighting is functioning to provide the illumination needed for observation in the exterior areas of the protected area.

- 3.1 Observe subject individuals on the TV monitors as they position themselves in the exterior areas of the protected area.
- 3.2 Determine the clarity and visual range of the CCTV cameras and the lighting levels.

3.3 Exercise the zoom and pan capability of those cameras equipped with that capability.

4.0 DATA REQUIRED

4.1 Specifications on the cameras and their capabilities.

5.0 ACCEPTANCE CRITERIA

- 5.1 Camera fields of observation are verified that will allow the observation of abnormal presence or activity of persons and/or vehicles within the exterior areas of the protected area .
- 5.2 Illumination levels are sufficient to allow observation of persons and/or vehicles.

6.0 SPECIAL PRECAUTIONS

- 6.1 The location of cameras and their fields of view will be SRI and will need to be protected in accordance with appropriate requirements.
- 14.2.12.1.144 <u>Vehicle barrier system to protect against the design basis threat vehicle</u> bombs
 - 1.0 OBJECTIVE
 - 1.1 Determine that a vehicle barrier is installed and located at the MSSD to protect against the design basis vehicle bombs.
 - 2.0 PREREQUISITES
 - 2.1 Construction activities on the vehicle barrier system have been completed.
 - 2.2 MSSD calculation has been completed to establish the required distance from plant structures.
 - 2.3 Certified test report showing the stopping capability of the barrier components that are part of the vehicle barrier system.

3.0 TEST METHOD

- 3.1 Validate that the vehicle barrier components are install at the MSSD or a distance greater than the MSSD taking the stopping capability of each component into consideration.
- 3.2 Determine that the vehicle barrier components are installed in accordance with manufacturer's specifications.

4.0 DATA REQUIRED

4.1 Test data on the individual vehicle barrier components certifying their stopping capability.

5.0 ACCEPTANCE CRITERIA

5.1 A continuous vehicle barrier with the certified stopping capability has been properly installed at the MSSD or greater distance from key plant structures.

6.0 SPECIAL PRECAUTIONS

6.1 The MSSD calculation will be SGI and will need to be protected in accordance with appropriate requirements.

14.2.12.1.145 <u>Vital areas with active intrusion detection systems</u>

- 1.0 OBJECTIVE
 - 1.1 Determine that vital areas have locked and alarmed personnel access barriers and that unauthorized access is detected and data sent to the CAS and SAS.

- 2.1 Construction activities on the structures containing vital equipment have been completed.
- 2.2 The intrusion alarms and electronic locks have been installed on the vital area doors.

2.3 The alarm annunciator computer has been installed and is operational.

3.0 TEST METHOD

- 3.1 Test the unauthorized opening of each vital area access door to verify that an intrusion alarm is generated.
- 3.2 Verify that the alarm is detected by the alarm annunciator computer and displayed in the CAS and SAS.
- 3.3 Verify that the required alarm information is displayed to the CAS and SAS operators.
- 3.4 Verify that an authorized access is allowed by the computer system with no alarm and that the authorized access is logged by the computer with the appropriate information.

4.0 DATA REQUIRED

4.1 Location of all the vital area doors and the installed intrusion detection hardware and electronic locking device installed.

5.0 ACCEPTANCE CRITERIA

5.1 Verification that each vital area door generates an alarm upon unauthorized access and displays the required alarm information to the CAS and SAS operators.

6.0 SPECIAL PRECAUTIONS

6.1 The location of the vital area doors will be SGI and will need to be protected in accordance with appropriate requirements

14.2.12.1.146 Security alarm annunciation and video assessment information

- 1.0 OBJECTIVE
 - 1.1 Verify that the intrusion alarm system at the protected area perimeter generates the appropriate alarms and that the video assessment

equipment captures the necessary images to perform an assessment of the alarm.

2.0 PREREQUISITES

- 2.1 Construction activities on the security intrusion alarm annunciation and video assessment systems have been completed.
- 2.2 Both CAS and SAS are completed and are operational.

3.0 TEST METHOD

- 3.1 Create an alarm on each protected area zone by using the appropriate run, crawl or walk tests in each zone.
- 3.2 Observe the alarm being generated by the system and the data displayed in the CAS and SAS.
- 3.3 Observe the captured video from the alarm zone to verify that there is sufficient information to assess the cause of the alarm.
- 3.4 Test several of the video images being captured in varying lighting situations to determine that assessment capability is available in all expected lighting circumstances.

4.0 DATA REQUIRED

- 4.1 Zone layout of the protected area and the video cameras that are synchronized to each zone.
- 4.2 Display images that are synchronized to each zone and the retrieval information for those images.

5.0 ACCEPTANCE CRITERIA

5.1 Intrusion into each protected area zone is alarmed and video images are captured of the zone in alarm that are sufficient for the CAS and SAS operators to perform assessments of what caused the alarms.

6.0 SPECIAL PRECAUTIONS

6.1 The zone layout and camera synchronized information will be SRI and will need to be protected in accordance with appropriate requirements

14.2.12.1.147 Location and equipment of the central and secondary alarm stations

1.0 OBJECTIVE

1.1 Verify the location of the CAS and SAS meet regulatory requirements and that the equipment located in each station is equivalent and redundant.

2.0 PREREQUISITES

2.1 Construction activities on the CAS and SAS are complete and the systems and installation of equipment located in each alarm station have been completed.

- 3.1 Determine the location of the CAS to be sure it is in a vital area, the inside is not visible from outside the protected area, has equipment for alarm annunciation and assessment, and has all the required communication equipment.
- 3.2 Determine the location of the SAS to be sure it is in a vital area, the inside is not visible from outside the protected area, has equipment for alarm annunciation and assessment, and has all the required communication equipment.
- 3.3 Determine that the location of both the CAS and SAS is such that when a vehicle barrier is in place at the minimum safe standoff distance, at least one of the stations will survive a single act and remain functional to detect intrusion, assess alarms, and communicate with onsite and offsite response personnel.

4.0 DATA REQUIRED

- 4.1 Final site GA drawings showing the location of the CAS and SAS.
- 4.2 List of all the equipment needed to be installed in the CAS and the SAS.
- 4.3 Minimum safe standoff distance for the location of the vehicle barrier system.

5.0 ACCEPTANCE CRITERIA

5.1 The CAS and the SAS are located and equipped to meet all the regulatory requirements for the design of alarm stations.

6.0 SPECIAL PRECAUTIONS

- 6.1 The site GAs and the CAS/SAS installed equipment listing will be SRI and will need to be protected in accordance with appropriate requirements
- 6.2 The minimum safe standoff distance is SGI and must be protected in accordance with regulatory requirements.

14.2.12.1.148Secondary security power supply system

1.0 OBJECTIVE

1.1 Verify that the secondary security power supply system is located in a vital area and is switched on when the normal power is lost.

- 2.1 Construction activities on the security annunciation secondary power system have been completed.
- 2.2 Final GA drawing showing the location of the security secondary power supply system and a single line electrical drawing showing the normal power and secondary power configuration.

3.0 TEST METHOD

- 3.1 Locate the security secondary power supply equipment and verify that it is within a vital area.
- 3.2 Switch off the normal power to the security alarm annunciation equipment and verify that the secondary power supply system switched on to repower the alarm annunciation equipment.

4.0 DATA REQUIRED

4.1 None.

5.0 ACCEPTANCE CRITERIA

5.1 Verify that the security secondary power supply equipment is located in a vital area and that when normal power is lost to the security alarm annunciation equipment the secondary power supply picks up the load such that there is no interruption in the alarm system function.

6.0 SPECIAL PRECAUTIONS

6.1 The location of the security secondary power supply system will be SGI and will need to be protected in accordance with appropriate requirements. The electrical single line may be SRI and may need to be controlled appropriately.

14.2.12.1.149 Intrusion detection and assessment systems

- 1.0 OBJECTIVE
 - 1.1 Verify the intrusion detection system at the protected area perimeter and the video assessment system are capable of detecting and assessing penetrations or attempted penetrations of the protected area barrier.

2.0 PREREQUISITES

2.1 Construction activities on the protected area intrusion detection system and the video assessment system have been completed.

- 2.2 Intrusion detection alarm computer system and video recording systems are operational.
- 2.3 CAS and SAS alarm monitoring and video assessment monitoring equipment is installed and operational.

3.0 TEST METHOD

- 3.1 Have an individual use both tactical and stealth maneuvers to penetrate the protected area barrier and isolations zones.
- 3.2 Observe that the intrusion detection system generates the appropriate alarm and the alarm station operators are able to review the video of the area before, during, and after the penetration to assess the details of the penetration or attempted penetration.
- 3.3 Record the test results and the documented capability of the intrusion detection and assessment systems for each of the zones.

4.0 DATA REQUIRED

4.1 Zone maps and the cameras assigned to each zone so that the system synchronization can be verified during the testing of each zone.

5.0 ACCEPTANCE CRITERIA

5.1 The intrusion detection system for each zone is capable of detecting penetration or attempted penetration of the protected area barrier covered by that zone and the video assessment equipment assigned to that zone are capable of recording and playing back video images to allow assessment of the penetration or attempted penetration.

6.0 SPECIAL PRECAUTIONS

6.1 The zone maps and camera assignments will be SRI and will need to be protected in accordance with appropriate requirements. The test report will also be SRI and must be protected.
14.2.12.1.150 Equipment and emergency exits

1.0 OBJECTIVE

1.1 Verify that each of the emergency exits from protected and vital areas have installed locking devices which will allow emergency egress and installed alarms that will notify the alarm station operators that the door has been opened.

2.0 PREREQUISITES

- 2.1 Construction activities on the locking systems and alarm monitoring systems on the protected and vital area emergency exit doors have been completed.
- 2.2 Intrusion alarm computer system is installed and operational.
- 2.3 CAS and SAS alarm monitoring systems are installed and operational.

3.0 TEST METHOD

- 3.1 Operate the emergency egress locking mechanism on the inside of each emergency exit door or mechanism in the protected area barrier or vital area buildings to insure the capability to exit the building to ground elevation or to exit the protected area.
- 3.2 Observe that an alarm is generated when the door is opened and the door alarm information is displayed in both the CAS and SAS.

4.0 DATA REQUIRED

4.1 Location of each emergency exit door or mechanism and the hardware and alarm monitoring installed.

5.0 ACCEPTANCE CRITERIA

5.1 Each vital area building emergency exit door allows emergency egress through the door to ground elevation or allows egress from the protected area and that an exit open alarm is generated and displayed to both alarm station operators.

6.0 SPECIAL PRECAUTIONS

6.1 The location of the vital area emergency exit doors and the exits to the protected area will be SGI and will need to be protected in accordance with appropriate requirements.

14.2.12.1.151 <u>Security communication systems</u>

1.0 OBJECTIVE

1.1 Verify the regulatory required capabilities of the installed communication systems to support security requirements.

2.0 PREREQUISITES

- 2.1 Construction activities on the public address system, plant telephone system, and wireless communication system have been completed.
- 2.2 Construction activities on the CAS and SAS and control room have been completed and the security communication equipment in these locations is operational.

3.0 TEST METHOD

- 3.1 Use the public address system to broadcast a security alert message to the plant and verify that the message is heard in several key locations where plant personnel are located.
- 3.2 Use the plant telephone system to establish phone calls to the control room from the CAS and SAS.
- 3.3 Use the plant telephone system to establish phone calls to local law enforcement agencies (police, sheriff, FBI, etc.).
- 3.4 Use the wireless communication system (radios) to establish communication with security personnel located inside the plant structures, within the site protected area, and outside the protected area in the areas that are under patrol by the security officers.

- 3.5 Use the non-portable portion of the wireless communication system to communicate with security officers after the normal power to the system has been lost and the system is being powered by the secondary power system.
- 3.6 Use the local law enforcement remote radio system provided to the CAS and/or SAS to communicate with the local law enforcement agency.
- 3.7 Determine the location of the non-portable communication equipment secondary power supply and verify it is located in a vital area.

4.0 DATA REQUIRED

4.1 None.

- 5.1 Communication between the CAS, SAS, and the control room can be accomplished using the plant telephone system and remains operable in the event of loss of normal power.
- 5.2 The public address system can be used to broadcast security alert messages and instructions to plant areas.
- 5.3 The plant telephone system can communicate with local law enforcement agencies to call for assistance.
- 5.4 The wireless communication system provides continuous communication with the security force members and remains operable from the secondary power supply in the event of loss of normal power.
- 5.5 The secondary power supply to the non-portable wireless communication system components is located in a vital area.
- 5.6 The local law enforcement remote radio equipment provided to the CAS and/or SAS can be used to contact local law enforcement during an emergency.

6.0 SPECIAL PRECAUTIONS

6.1 The location of the secondary power supply for the non-portable communication system components is SGI and must be protected accordingly.

14.2.12.1.152 <u>Bullet-Resisting Barriers</u>

- 1.0 OBJECTIVE
 - 1.1 To document the bullet resistance capability of the external walls, doors, ceilings, and floors in the main control room, the CAS, and the SAS.

2.0 PREREQUISITES

2.1 Construction activities on the main control room and the CAS and SAS have been completed.

3.0 TEST METHOD

- 3.1 Examine the walls, doors, ceilings and floors of the main control room and the two alarm stations to verify they are bullet resisting to UL 752, Level IV.
- 3.2 Results of the examination of the bullet resistance of the walls, doors, ceilings, and floors is documented in an acceptance report.

4.0 DATA REQUIRED

4.1 Copies of the as built drawings, specifications, and procurement certification documents for the walls, doors, ceilings, and floors of the main control room and the two alarm stations.

5.0 ACCEPTANCE CRITERIA

5.1 All walls, doors, ceilings and floors of the main control room and the two alarm stations are constructed of materials and other aspects such that they are bullet resistant to UL 752, Level IV.

6.0 SPECIAL PRECAUTIONS

6.1 The bullet resistant details of the walls, doors, ceilings and floors of the main control room and the two alarm stations and the Inspection Test Acceptance (ITA) document will be SRI and will need to be protected in accordance with appropriate requirements.

14.2.12.1.153 Security Alarm Devices and Transmission Lines

1.0 OBJECTIVE

- 1.1 Verify that security alarm devices including transmission lines to the alarm annunciation system are tamper indicating and self checking.
- 1.2 Verify that the alarm annunciation at the CAS and SAS indicates the type of alarm.

2.0 PREREQUISITES

- 2.1 Construction activities on the intrusion alarms system and CAS and SAS are completed..
- 2.2 Security intrusion alarm system has been checked for function and is operational.

3.0 TEST METHOD

- 3.1 Initiate several different types of alarms in the intrusion detection system to observe the displayed information within the CAS and SAS.
- 3.2 Initiate a tamper alarm and an interruption of a transmission line alarm to observe if the system displays the alarm and distinguishes the type of alarm.

4.0 DATA REQUIRED

4.1 Drawings showing intrusion detection alarm devices, tamper devices, and transmission line supervision devices.

5.0 ACCEPTANCE CRITERIA

- 5.1 The initiated alarm is displayed in both the CAS and SAS.
- 5.2 The alarm information displayed indicates the type of alarm being generated.

6.0 SPECIAL PRECAUTIONS

6.1 The drawings will be SRI or SGI depending on the level of detail contained on the drawing so they will need to be protected in accordance with appropriate requirements.

14.2.12.1.154 <u>Plant Communication Systems</u>

- 1.0 OBJECTIVES
 - 1.1 To verify the communication systems provide reliable and effective interplant communications and plant-to-offsite communications.

2.0 PREREQUISITES

- 2.1 Construction activities on paging phone system, evacuation alarm address system, public address system, sound powered telephone system, telephone system, plant time synchronizing system, LAN and VPN systems, and wireless communication system have been completed.
- 2.2 Communication system equipment is operational.

3.0 TEST METHOD

- 3.1 Verify the proper operation of the paging phone system.
- 3.2 Verify the proper operation of the evacuation alarm address system.
- 3.3 Verify the proper operation of the public address system.
- 3.4 Verify the proper operation of the sound powered telephone system.
- 3.5 Verify the proper operation of the telephone system.

- 3.6 Verify the proper operation of the plant time synchronizing system.
- 3.7 Verify the proper operation of the LAN and VPN systems.
- 3.8 Verify the proper operation of the wireless communication system.
- 3.9 Verify the proper operation of equipment expected to function under abnormal conditions including loss of power.
- 4.0 DATA REQUIRED
 - 4.1 None
- 5.0 ACCEPTANCE CRITERIA
 - 5.1 The plant communication systems function as described in Subsection 9.5.2.
- 14.2.12.2 Initial Fuel Loading and Post-Core Hot Function Tests
- 14.2.12.2.1 Initial Fuel Loading
 - 1.0 OBJECTIVE
 - 1.1 To provide a safe, organized method of accomplishing the initial fuel loading.
 - 1.2 To establish the conditions under which the initial fuel loading is to be accomplished.

2.0 PREREQUISITES

- 2.1 All personnel shall read and understand the basic fuel load procedures.
- 2.2 Boron concentration shall be high enough to meet required shutdown margin.
- 2.3 The fuel loading evolution shall be controlled by use of approved plant procedure. The evolution is supervised by a licensed senior reactor operator.

- 2.4 Throughout "dry" core loading, the RCS water level shall be maintained above the top of the reactor vessel hot leg nozzle and below the vessel flange.
- 2.5 The proper seating and guide tube location of the two (2) neutron sources within their first cycle host assemblies shall be verified both before and after fuel loading.
- 2.6 The Integrated Head Assembly (IHA) and Upper Guide Structure (UGS) are removed from the reactor and stored.
- 2.7 The Reactor Coolant System (RCS) water quality has been verified to meet requirements of RCS chemistry and purity check.
- 2.8 The temporary fuel loading channel and permanent startup channels have been setup and calibrated.
- 2.9 At least one (1) permanent startup channel and one (1) temporary fuel loading channel are equipped with audible count rate indicators.
- 2.10 Neutron Response and Background Count Rates have been completed prior to the initiation of fuel loading. Channel Check prior to first fuel assembly loaded has been performed every 12 hours.
- 2.11 The collection of boron samples from the in-service SCS loop shall be started at one (1) hour intervals within 8 hours of commencement of initial fuel loading.
- 2.12 All fuel handling equipment pre-operation tests have been completed.
- 2.13 Continuous voice communications have been verified operational between the control room, refueling area in the containment building, and the fuel storage area within one (1) hour prior to the start of fuel loading.
- 2.14 The overload/Underload setpoints for Refueling Machine and Spent Fuel Handling Machine are adjusted to wet and/or operating conditions.

2.15 Continuous area radiation monitoring will be provided during fuel handling and fuel loading operations.

3.0 TEST METHOD

- 3.1 Fuel assemblies and neutron sources are inserted in the reactor vessel in accordance with the pre-specified and approved loading sequence.
- 3.2 Verify the fuel assembly serial numbers, orientations, and locations including the location of neutron sources using underwater TV camera.
- 3.3 Perform the final review of all hoist position data after all fuel is loaded into the core.
- 3.4 Perform the final review of the axial centerlines of the fuel assembly upper end fittings in all row locations.
- 3.5 Maintain a display for indicating the status of the core and spent fuel pool, as well as appropriate records of core loading.
- 3.6 Collect representative boron sample from the in-service SCS loop at one(1) hour intervals within 8 hours of commencement of initial fuel loading.
- 3.7 Cease fuel loading and initiate emergency boration, if RCS boron concentration has been possible dilution as indicated by unexplained increase in water level in the reactor vessel.
- 3.8 Maintain constant communication between fuel handling personnel and the control room within one hour prior to the start of fuel loading.
- 3.9 ICRR is plotted through the fuel loading using temporary and permanent startup detectors to predict the possibility of approach to criticality. New base count rate data is determined after neutron source or temporary startup detector is moved.

4.0 DATA REQUIRED

4.1 The Z-axis elevation of the dummy fuel assembly during final indexing.

- 4.2 The as-built bridge and trolley coordinates for each core location.
- 4.3 As-built core load map.
- 4.4 Signals of two temporary fuel loading channels and two permanent startup channels.

5.0 ACCEPTANCE CRITERIA

- 5.1 The serial numbers, orientations, and locations of all fuel assemblies and the locations of the neutron sources are visually verified following completion of core loading.
- 5.2 All fuel assemblies loaded are in allowable range of the Z-axis elevation (hoist readings on the refueling machine) measured during final indexing.
- 5.3 A check of the centerlines of all fuel assemblies is confirmed them to be aligned in allowable range of their as-built positions, thereby permitting proper engagement of the upper end fitting with the Upper Guide Structure (UGS).

14.2.12.2.2 Post-Core Hot Functional Test Controlling Document

1.0 OBJECTIVES

- 1.1 To demonstrate the proper integrated operation of plant primary, secondary, and auxiliary systems with fuel loaded in the core
- 1.2 To identify the Post-Core Hot Functional Test (HFT) sequences which are defined by each of the test procedures.
- 1.3 To verify that the plant condition transfer from cold shutdown condition to hot standby condition using the appropriate operation procedures.

2.0 PREREQUISITES

- 2.1 All pre-core hot functional testing has been completed as required.
- 2.2 Fuel loading has been completed.

- 2.3 All permanently installed instrumentation on systems to be tested is available and calibrated in accordance with Technical Specifications and test procedures.
- 2.4 All necessary test instrumentation is available and calibrated in accordance with Technical Specifications and test procedures.
- 2.5 All cabling between the control element drive mechanisms (CEDMs) and the CEDM control system (CEDMCS) is connected.
- 2.6 Steam generators are in wet layup in accordance with the nuclear steam supply system (NSSS) chemistry manual.
- 2.7 The reactor coolant system (RCS) has been borated to the proper concentration.

3.0 TEST METHOD

3.1 Determine the plant conditions and coordinate the execution of the related post-core hot functional test listed in Table 14.2-2.

4.0 DATA REQUIRED

4.1 As specified by the individual post-core hot functional test

- 5.1 Integrated operation of the primary, secondary, and related auxiliary systems is in accordance with the system descriptions.
- 5.2 All HFTs have been performed and have met their respective acceptance criteria.
- 5.3 The integrated operation is demonstrated by the successful heat up and pressurization of the plant from cold shutdown to hot standby.

14.2.12.2.3 NSSS Integrity Monitoring System (Post-core)

1.0 OBJECTIVES

- To obtain baseline data for Acoustic Leak Monitoring system (ALMS), Loose Parts Monitoring system (LPMS) and RCP Vibration Monitoring system (RCPVMS) during post-core HFT.
- 1.2 To verify existing, or establish new alarm setpoints as required for the NSSS Integrity Monitoring System.

2.0 PREREQUISITES

- 2.1 Plant is stable at the required temperature and pressure plateau.
- 2.2 The NIMS is operational as applicable.

3.0 TEST METHOD

- 3.1 Collect baseline data during post-core HFT.
- 3.2 Adjust setpoints, if required, based on the data collected.

4.0 DATA REQUIRED

- 4.1 Baseline data for ALMS, LPMS and RCPVMS
- 4.2 Alarm setpoints for ALMS, LPMS and RCPVMS
- 4.3 RCS temperature and pressure

- 5.1 Baseline data of ALMS, LPMS and RCPVMS are collected during postcore HFT.
- 5.2 The alarm setpoints of each subsystem are adjusted as necessary.

14.2.12.2.4 Post-Core Reactor Coolant System Flow Measurements

1.0 OBJECTIVES

- 1.1 To determine the post-core reactor coolant system (RCS) flow rate and flow coastdown characteristics
- 1.2 To establish reference post-core RCS pressure drops
- 1.3 To adjust flow-related constants of the core protection calculators (CPCs) as required
- 1.4 To collect data on the operation of the flow-related portions of the core operating limit supervisory system (COLSS) and the CPCs for steady-state and transient conditions

2.0 PREREQUISITES

- 2.1 Construction activities have been completed.
- 2.2 All permanently installed instrumentation is properly calibrated and operational.
- 2.3 All test instrumentation is available and properly calibrated.
- 2.4 RCS operating at nominal hot zero-power (HZP) conditions.
- 2.5 Required reactor coolant pumps (RCPs) are operational.
- 2.6 COLSS and CPCs are in operation.

3.0 TEST METHOD

- 3.1 Measure RCS flow for all operationally allowed RCP combinations and collect the necessary data to calculate RCS flow.
- 3.2 Perform RCS flow coastdown measurements by tripping the allowable RCP(s) for collection of coastdown data.
- 3.3 Verify the CPC and COLSS flow-related data by comparison with measured flows.

4.0 DATA REQUIRED

- 4.1 COLSS and CPCs flow-related data
- 4.2 RCP differential pressure and speed
- 4.3 Reactor vessel and steam generator differential pressure
- 4.4 RCS temperature and pressure
- 4.5 RCP coastdown curve

5.0 ACCEPTANCE CRITERIA

- 5.1 Measured RCS flow is between design minimum and maximum values considering the uncertainties with the margin for flow degradation during the plant lifetime.
- 5.2 Measured RCS flow coastdown is conservative with respect to the coastdown used in the safety analysis.
- 5.3 CPC and COLSS flow constants are adjusted to be conservative with respect to the measured flows.

14.2.12.2.5 Post-Core Control Element Drive Mechanism Performance

- 1.0 OBJECTIVES
 - 1.1 To demonstrate the proper operation of the control element drive mechanisms (CEDMs) and control element assemblies (CEAs) under hot shutdown and hot zero-power (HZP) conditions
 - 1.2 To verify proper operation of the CEA position indicating system and alarms
 - 1.3 To measure CEA drop times

2.0 PREREQUISITES

- 2.1 The CEDM control system (CEDMCS) pre-core performance test has been completed.
- 2.2 All test instrumentation is available and has been calibrated.
- 2.3 The information processing system is operational.
- 2.4 The CEDM cooling system is operational.
- 2.5 CEDM coil resistance has been measured.

3.0 TEST METHOD

- 3.1 Perform the following at hot shutdown conditions:
 - 3.1.1 Withdraw and insert each CEA to verify proper operation of CEDMs.
- 3.2 Perform the following at HZP conditions:
 - 3.2.1 Withdraw and insert each CEA to verify proper operation of CEDMs.
 - 3.2.2 Measure and record drop time for each CEA.
 - 3.2.3 Perform three measurements of drop time for each of those CEAs falling outside the two-sigma limit for similar CEAs.
- 3.3 Perform the following at any time:
 - 3.3.1 Withdraw and insert each CEA while recording position indications and alarms.

4.0 DATA REQUIRED

- 4.1 CEA drop time
- 4.2 RCS temperature and pressure to be taken during measurement and recording of drop time for each CEA

- 4.3 CEA position and alarm indications
- 4.4 CEA withdrawal speed
- 4.5 CEDM coil resistance

5.0 ACCEPTANCE CRITERIA

- 5.1 The CEDM/CEAs and their associated position indications operate as designed.
- 5.2 CEA drop times are in agreement with the Technical Specifications.
- 5.3 CEA withdrawal speed meets Subsection 4.3.1.7.
- 5.4 CEDM upper/lower electrical limit is satisfied
- 5.5 IPS major/minor deviation alarm operates as designed.
- 5.6 CEA Deviation and out-of-sequence alarms operate as designed.

14.2.12.2.6 Post-Core Reactor Coolant and Secondary Water Chemistry Data

1.0 OBJECTIVES

- 1.1 To maintain the proper water chemistry for the RCS and secondary system during post-core hot functional testing
- 1.2 To verify the adequacy of sampling and analysis procedures in establishing and maintaining proper chemistry
- 1.3 To establish baseline data for the RCS and the secondary system chemistry

2.0 PREREQUISITES

- 2.1 The primary and secondary sampling systems are operable.
- 2.2 Chemicals and test equipment to support hot functional testing are available.

2.3 The primary and secondary chemical addition systems are operable.

3.0 TEST METHOD

- 3.1 The sampling frequency is modified as required to provide reasonable assurance of the proper RCS and secondary system water chemistry.
- 3.2 Perform RCS and secondary system sampling and chemistry analysis after every significant change in plant conditions (i.e., heatup, cooldown, chemical additions).

4.0 DATA REQUIRED

- 4.1 Plant conditions
- 4.2 Secondary system chemistry analysis
- 4.3 RCS chemistry analysis

5.0 ACCEPTANCE CRITERIA

- 5.1 RCS and secondary system water chemistry are maintained within design limits as specified in subsection 9.3.4 and 10.3.5.
- 5.2 Baseline data for the RCS and secondary system is established.

14.2.12.2.7 Post-Core Pressurizer Spray Valve and Control Adjustments

- 1.0 OBJECTIVES
 - 1.1 To establish the proper settings of continuous spray valves
 - 1.2 To measure the rate at which the pressurizer pressure can be reduced using pressurizer spray

2.0 PREREQUISITES

- 2.1 The RCS is operated at nominal HZP conditions.
- 2.2 All permanently installed instrumentation is available and calibrated.

2.3 Test instrumentation is available and calibrated.

3.0 TEST METHOD

- 3.1 Adjust continuous spray valves to obtain specified delta-T between the RCS temperature and pressurizer spray line temperature.
- 3.2 Using various combinations of pressurizer spray valves, measure and record the rate at which the pressurizer pressure can be reduced.

4.0 DATA REQUIRED

- 4.1 RCS temperature and pressure
- 4.2 Spray line temperature
- 4.3 Continuous spray valve settings
- 4.4 Spray valve combinations

5.0 ACCEPTANCE CRITERIA

- 5.1 Continuous spray flow is adjusted such that the temperature difference between temporary thermocouples located on the PZR spray line near the top of the PZR and the cold legs is no greater than design limits as described in Subsections 7.7.1 and 5.4.10.
- 5.2 After continuous spray flow is set, the PZR pressure is automatically maintained at steady state condition by the PPCS
- 5.2 The average slope of the test data is within the max/min allowable limit.

14.2.12.2.8 Post-Core Reactor Coolant System Leak Rate Measurement

1.0 OBJECTIVES

1.1 To measure the post-core RCS leakage at HZP conditions

2.0 PREREQUISITES

- 2.1 Hydrostatic testing of the RCS and associated systems has been completed.
- 2.2 The RCS and chemical and volume control system (CVCS) are operating as a closed system.
- 2.3 The RCS is at HZP conditions.
- 2.4 All permanently mounted instrumentation is properly calibrated.

3.0 TEST METHOD

3.1 Measure and record the changes in water inventory of the RCS and CVCS for a specified interval of time.

4.0 DATA REQUIRED

- 4.1 Pressurizer pressure, level, and temperature
- 4.2 Volume control tank level, temperature, and pressure
- 4.3 Reactor drain tank level, temperature, and pressure
- 4.4 RCS temperature and pressure
- 4.5 Safety injection tank level and pressure
- 4.6 Time interval

5.0 ACCEPTANCE CRITERIA

5.1 Identified and unidentified leakage are within the limits described in the Technical Specifications and as described in Subsection 5.2.5.

14.2.12.2.9 Post-Core In-Core Neutron Flux Detector Test

- 1.0 OBJECTIVES
 - 1.1 To measure the leakage resistance of the fixed in-core detectors

- 1.2 To verify the proper insulation of the entire Fixed In-core Detector Amplifier System (FIDAS) signal cable network including detectors, mineral insulated cables, and organic cables to the FIDAS Cabinet.
- 1.3 To verify the proper operation of the FIDAS

2.0 PREREQUISITES

- 2.1 All permanently installed in-core neutron flux detectors are properly calibrated.
- 2.2 Installation and preoperational checkout of the in-core neutron flux detectors are completed.
- 2.3 Special test equipment is available and calibrated.

3.0 TEST METHOD

3.1 Measure and record the leakage resistance of each in-core detector at the nominal HZP condition.

4.0 DATA REQUIRED

4.1 Resistance measurements

- 5.1 Insulation resistance of the in-core neutron flux detectors is as described in manufacturer's recommendations.
- 5.2 Each of test item listed below shall be satisfied.
 - Rhodium detector raw signal quality
 - Background detector raw signal quality
 - Rhodium detector charge quality
 - Rhodium detector sensitivity quality
 - Compensated/uncompensated neutron flux quality

14.2.12.2.10 <u>Post-Core Instrument Correlation</u>

1.0 OBJECTIVES

1.1 To verify the installed instrumentation is functional for the plant protection system (PPS), core protection calculators (CPCs), information processing system (IPS), and qualified indication and alarm system (QIAS).

2.0 PREREQUISITES

- 2.1 PPS and CPCs are in operation.
- 2.2 IPS, QIAS, and core operating limit supervisory system (COLSS) are in operation.
- 2.3 Permanently installed main control room instrumentation for the CPCs, COLSS, PPS, IPS, and QIAS has been calibrated and is in operation.

3.0 TEST METHOD

- 3.1 When specified, obtain PPS, CPC, IPS, and QIAS readouts.
- 3.2 Obtain main control room instrument readings.

4.0 DATA REQUIRED

- 4.1 IPS and QIAS readout
- 4.2 PPS and CPC data
- 4.3 Main control room instrument readings

- 5.1 The IPS, QIAS, PPS, and CPCs perform as described in Sections 7.2 and 7.7.
- 5.2 Process variables listed below are indicated properly.
 - RCS pressure

- RCS Hot Leg/Cold Leg Temperature
- RCP differential pressure
- RCP speed
- Pressurizer level
- Steam generator level
- Steam generator pressure
- Steam generator primary side differential pressure
- Reactor vessel differential pressure
- Containment pressure

14.2.12.2.11 Post-Core Acoustic Leak Monitoring System

- 1.0 OBJECTIVES
 - 1.1 To obtain baseline data on the acoustic leak monitoring system (ALMS) at various power level
 - 1.2 To adjust ALMS alarm setpoints as necessary
 - 1.3 To obtain the ALMS sensor baseline data
 - 1.4 To verify the crack detection function at various power level

2.0 PREREQUISITES

- 2.1 Preoperational tests on ALMS have been completed.
- 2.2 All ALMS instrumentation has been calibrated and is operable.

3.0 TEST METHOD

3.1 Collect baseline data using the ALMS during plant heatup and at normal operation conditions.

4.0 DATA REQUIRED

- 4.1 Baseline data using ALMS
- 4.2 ALMS alarm setpoints
- 4.3 RCS temperature and pressure

5.0 ACCEPTANCE CRITERIA

- 5.1 The ALMS performs leak/crack detection functions.
- 5.2 The ALMS alarm setpoints have been adjusted as necessary.
- 5.3 The baseline data of background noise shall be obtained.

14.2.12.3 Initial Criticality and Low-Power Physics Test

14.2.12.3.1 Initial Criticality Test

1.0 OBJECTIVE

- 1.1 To attain initial criticality with a safe, organized method.
- 1.2 To verify that a one decade (or larger) overlap exists between the ex-core startup channels and the ex-core safety log power channels.

2.0 PREREQUISITES

The final calibration of the startup channels is conducted before the initial criticality. The ex-core detectors are calibrated to have signal to noise ratio greater than 2.

- 2.1 All CEAs are inserted.
- 2.2 The RCS boron concentration is sufficiently high.
- 2.3 The measuring devices for Inverse Count Rate Ratio (ICRR) are set up and operable.

2.4 The reactor coolant system temperature and pressure are stable at the hot zero power.

3.0 TEST METHOD

- 3.1 Perform initial criticality with boron dilution. CEAs are withdrawn before the boron dilution begins.
- 3.2 At specific hold points during CEA withdrawal and boron dilution, collect plant data to plot ICRR which is used to predict the critical point.
- 3.3 When criticality is achieved, verify that one decade overlap exists between the startup channels and the safety log power channels.

4.0 DATA REQUIRED

- 4.1 Excore instrumentation Startup channels signal and Safety log power channels signal.
- 4.2 RCS and Pressurizer boron concentration
- 4.3 CEA Position
- 4.4 RCS pressure and temperature

- 5.1 The initial criticality is obtained with safe and predicted manner.
- 5.2 1/2 counts per seconds is registered on startup channels before the effective multiplication factor (k-eff) is 0.98.
- 5.3 A minimum of one decade overlap exists between the startup channels and the safety log power channels.
- 14.2.12.3.2
 Baseline Biological Shield (Primary Shield) Radiation Measurements

 Test
 - 1.0 OBJECTIVES
 - 1.1 To demonstrate the effectiveness of the primary shield.

1.2 To obtain baseline radiation levels in areas adjacent to the reactor, the steam generators, the reactor coolant pumps, and the pressurizer; and high and very high radiation areas inside the Auxiliary Building and the Compound Building for comparison with future measurements of radioactivity level buildup with operation.

2.0 PREREQUISITES

- 2.1 The required preoperational tests have been completed and plant management has approved the initiation of radiation measurement testing.
- 2.2 Radiation survey instruments have been calibrated.

3.0 TEST METHOD

- 3.1 Measure baseline gamma and neutron dose rates before initial power operation.
- 3.2 The radiation levels outside the biological (primary) shield are determined via a radiation survey. The radiation tests include gamma dose rates as well as neutron dose rates. Radiation surveying is conducted in all accessible areas including potentially high and very high radiation areas where intermittent activities have the potential to produce transient high exposure conditions.

4.0 DATA REQUIRED

- 4.1 Gamma dose rate in accessible locations
- 4.2 Neutron dose rate in accessible locations

- 5.1 Radiation levels are acceptable and meet design requirements.
- 5.2 Administrative control procedures are in place to ensure that the occupancy times in the radiation zones during power operation are

consistent with the design and the guidance of 10 CFR 20, "Standards for Protection Against Radiation."

14.2.12.3.3 Isothermal Temperature Coefficient Test

1.0 OBJECTIVES

- 1.1 To measure the ITC for various CEA configurations
- 1.2 To determine the MTC from the measured ITC

2.0 PREREQUISITES

- 2.1 The reactor is critical with a stable boron concentration and the desired CEA configuration and RCS temperature and pressure.
- 2.2 The reactivity computer is operable.

3.0 TEST METHOD

- 3.1 Changes in RCS temperature are introduced and the resultant changes in reactivity measured.
- 3.2 Power is limited with the CEA motion when necessary.

4.0 DATA REQUIRED

- 4.1 ITC is calculated with the following data:
 - 4.1.1 Reactivity
 - 4.1.2 RCS temperature
- 4.2 MTC is calculated from the measured ITC.

5.0 ACCEPTANCE CRITERIA

5.1 The measured ITCs shall be within the design values of the predicted ITCs.

5.2 The MTCs derived from the measured ITCs shall be within the design values of the predicted MTCs.

14.2.12.3.4 Shutdown and Regulating Control Element Assembly Group Worth Test

1.0 OBJECTIVES

- 1.1 To determine regulating and shutdown CEA group worths necessary to demonstrate shutdown margin
- 1.2 To demonstrate that the shutdown margin is adequate

2.0 PREREQUISITES

- 2.1 The reactor is critical.
- 2.2 The reactivity computer is operating.

3.0 TEST METHOD

- 3.1 Measurement of regulating and shutdown CEA groups:
 - 3.1.1 The CEA group worths are measured either by the dilution/boration of the RCS or by using the CEA exchange method.
 - 3.1.2 Worths may be determined by the CEA drop or insertion.

4.0 DATA REQUIRED

- 4.1 Reactivity variation depending on CEA movement
- 4.2 CEA group worths and total CEA worth are calculated with the reactivity data.

5.0 ACCEPTANCE CRITERIA

5.1 The measured CEA group worths shall be within the design values of the predicted worths.

5.2 The measured total CEA worth shall be within the design values of the predicted worth.

14.2.12.3.5 Differential Boron Worth Test

- 1.0 OBJECTIVES
 - 1.1 To measure the differential boron reactivity worth for various CEA configurations
- 2.0 PREREQUISITES
 - 2.1 CEA group worth tests are completed.
 - 2.2 Critical configuration boron concentration tests are completed.
- 3.0 TEST METHOD
 - 3.1 The differential boron worths are determined from the measured boron concentrations associated with the state points measured during the CEA group worth tests.

4.0 DATA REQUIRED

- 4.1 Boron concentration change between state points
- 4.2 Integral reactivity changes between state points

5.0 ACCEPTANCE CRITERIA

5.1 The measured boron worths shall be within the design values of the predicted values.

14.2.12.3.6 Critical Boron Concentration Test

1.0 OBJECTIVES

1.1 To measure the critical boron concentration for various CEA configurations at appropriate temperatures and associated pressures

2.0 PREREQUISITES

2.1 The reactor is critical at the test conditions.

3.0 TEST METHOD

- 3.1 The reactor is critical with the desired CEA configuration (arrived at as endpoints for selected plateaus in the CEA group worth tests).
- 3.2 Coolant samples are taken and chemically analyzed for boron content until the equilibrium state is achieved.

4.0 DATA REQUIRED

- 4.1 Critical conditions:
 - 4.1.1 Boron concentration
 - 4.1.2 CEA positions
 - 4.1.3 RCS temperature
 - 4.1.4 Pressurizer pressure

5.0 ACCEPTANCE CRITERIA

5.1 The measured critical boron concentrations shall be within the design values of the predicted critical boron concentrations.

14.2.12.3.7 Control Element Assembly Symmetry Test

1.0 OBJECTIVES

1.1 To demonstrate that no loading or fabrication errors that result in measurable CEA worth asymmetries have occurred

2.0 PREREQUISITES

- 2.1 The reactivity computer is in operation.
- 2.2 The reactor is critical at the desired conditions.

3.0 TEST METHOD

- 3.1 Conduct CEA symmetry test.
 - 3.1.1 Insert the first CEA of a symmetric group with all remaining CEAs withdrawn except the controlling group, which is positioned for zero reactivity.
 - 3.1.2 Withdraw the inserted CEA while another CEA in the symmetric group is inserted and determine the differences in worth (net reactivity) of the CEAs from the reactivity computer.
 - 3.1.3 Sequentially swap the remainder of the CEAs.
 - 3.1.4 Repeat steps 3.1.1, 3.1.2, and 3.1.3 for the remainder of the symmetric groups.

4.0 DATA REQUIRED

4.1 Reactivity differences between CEAs within the symmetric group

5.0 ACCEPTANCE CRITERIA

5.1 The reactivity differences between symmetric CEAs shall be within the design values.

14.2.12.4 Power Ascension Tests

14.2.12.4.1 Variable Tavg (Isothermal Temperature Coefficient and Power Coefficient) Test

1.0 OBJECTIVES

- 1.1 To measure the ITC and power coefficient at selected power plateaus
- 1.2 To determine the MTC from the ITC
- 1.3 To project the MTC to higher power level to ensure conformance to Technical Specifications limit

2.0 PREREQUISITES

2.1 The reactor is at the desired power level with equilibrium xenon and boron concentration and the desired CEA configuration.

3.0 TEST METHOD

- 3.1 The ITC is measured by changing the core average temperature and the power without CEA movement.
- 3.2 The ITC is measured by changing the core average temperature and using CEA movement to maintain the power essentially constant.
- 3.3 The power coefficient is measured by changing the core power using CEA movement to maintain the core average temperature essentially constant.

4.0 DATA REQUIRED

- 4.1 Reactor thermal power
- 4.2 RCS temperature
- 4.3 CEA positions

- 5.1 The measured ITC shall be within the design values.
- 5.2 The measured power coefficient shall be within the design values.
- 5.3 The MTC determined from the measured ITC shall be within the design values.
- 5.4 The MTC shall be within the bounds specified in technical specifications limiting conditions for operation.

14.2.12.4.2 Unit Load Transient Test

1.0 OBJECTIVES

- 1.1 To demonstrate that load changes can be made at the desired rates
 - 1.1.1 To demonstrate the capability of the NSSS to accommodate a 10% step decrease in power
 - 1.1.2 To demonstrate the capability of the NSSS to accommodate a 10% step increase in power
 - 1.1.3 To demonstrate the capability of the NSSS to accommodate a 5% per minute ramp decrease in power
 - 1.1.4 To demonstrate the capability of the NSSS to accommodate a 5% per minute ramp increase in power

2.0 PREREQUISITES

- 2.1 The reactor is operating at the desired power level.
- 2.2 The RRS, PPCS, PLCS, FWCS, SBCS, and RPCS are in automatic operation.

3.0 TEST METHOD

3.1 Load increases and decreases (steps and ramps) are performed by changing turbine load at power levels in the 70 to 95 percent range and in the 25 to 50 percent range.

4.0 DATA REQUIRED

4.1 Many plant data are obtained including reactor power, CEA positions, RCS temperatures, pressurizer pressure and level, steam generator pressures and levels, steam and feedwater flows, POSRV and MSSV opening status, etc.

5.0 ACCEPTANCE CRITERIA

- 5.1 The NSSS control systems shall restore NSSS parameters within acceptable limits.
- 5.2 The reactor shall not trip.
- 5.3 The primary (POSRV) and/or secondary (MSSV) safety valves shall not open.

14.2.12.4.3 Control Systems Checkout Test

1.0 OBJECTIVES

- 1.1 To demonstrate that the FWCS will control Steam Generator (SG) levels within acceptable bands
- 1.2 To demonstrate that the RRS will control TAVG within an acceptable tolerance of TREF
- 1.3 To demonstrate that the FWCS, SBCS, DRCS, PLCS and PPCS will control the plant within acceptable tolerances of their programmed values

2.0 PREREQUISITES

- 2.1 The reactor is operating at the desired conditions.
- 2.2 The RRS, PPCS, PLCS, FWCS, SBCS, and RPCS are in automatic operation.
- 2.3 The CEDM control system is operational.

3.0 TEST METHOD

- 3.1 Control system setpoints are changed to initiate transients.
- 3.2 Performance of the control systems is monitored during steady-state and transient conditions to demonstrate that the systems are operating satisfactorily.

4.0 DATA REQUIRED

4.1 Many plant data are obtained including reactor power, CEA positions, RCS temperatures, pressurizer pressure and level, steam generator pressures and levels, steam and feedwater flows, etc.

5.0 ACCEPTANCE CRITERIA

5.1 The control systems maintain the reactor power, RCS temperature, pressurizer pressure and level, and steam generator pressure and level, and feedwater flow split within their control bands during steady-state operation and are capable of returning these parameters to within their control bands in response to transient operation.

14.2.12.4.4 Reactor Coolant and Secondary Chemistry and Radiochemistry Test

1.0 OBJECTIVES

- 1.1 To determine that chemistry treatment can be established and performed in accordance with approved chemistry procedures
- 1.2 To verify that primary and secondary water quality are maintained within the limits and also to establish baseline data for each chemistry parameters at various power levels
- 1.3 To verify that radioactivity levels in the primary and the secondary systems are maintained within the limits of technical specification and those as within the limits specified in chemistry control procedures

2.0 PREREQUISITES

- 2.1 The reactor is stable at the desired power level.
- 2.2 The primary and secondary sampling systems are operable.

3.0 TEST METHOD

- 3.1 Samples are collected from the RCS and secondary system at various power levels and analyzed in the laboratory using applicable sampling and analysis procedures.
- 3.2 Samples are collected at the process radiation monitor at various power levels, analyzed in the laboratory, and compared with the process radiation monitor to verify proper operation.

4.0 DATA REQUIRED

- 4.1 Conditions of the measurement:
 - 4.1.1 Power
 - 4.1.2 RCS temperature
 - 4.1.3 Boron concentration
 - 4.1.4 Core average burnup
- 4.2 Samples for measurement of the gross activities and isotopic activities

- 5.1 Reactor coolant and secondary chemistry and radiochemistry test performs in accordance with test procedure.
- 5.2 Results of analysis on primary and secondary system water samples shall be met within the specifications.
- 5.3 Chemical treatment for primary and secondary water is appropriately performed and maintained as specified in the chemistry control procedure.
- 5.4 The purification capability of the cleansing system is verified via decontamination factor and its capacity shall be sufficient to remove impurities while in power operation.

5.5 The basis of radioactivity levels are established and measured radioactivity levels are met within the specified limits.

14.2.12.4.5 <u>Turbine Trip Test</u>

1.0 OBJECTIVES

- 1.1 To demonstrate that the plant responds and is controlled as designed following a turbine trip without the RPCS in service
- 1.2 To verify that the DPS will initiate a reactor trip upon sensing a turbine trip without the RPCS in service

2.0 PREREQUISITES

- 2.1 The reactor is operating above 95 percent power.
- 2.2 The RRS, PPCS, PLCS, FWCS, and SBCS are in automatic operation.
- 2.3 The RPCS is in Out of Service.

3.0 TEST METHOD

- 3.1 The turbine is tripped.
- 3.2 The plant behavior is monitored to provide reasonable assurance that the SBCS, FWCS and pressurizer pressure and level control systems maintain the NSSS within operating limits.

4.0 DATA REQUIRED

- 4.1 Many plant data are obtained including reactor power, CEA positions, RCS temperatures, pressurizer pressure and level, steam generator pressures and levels, steam and feedwater flows, POSRV and MSSV opening status, etc.
- 4.2 Sequence of events data are obtained.
5.0 ACCEPTANCE CRITERIA

- 5.1 The DPS initiates a reactor trip upon a turbine trip with the RPCS out of service
- 5.2 Following turbine and subsequent reactor trips, NSSS automatically shall stabilize the plant in hot standby.
- 5.3 The primary (POSRV) or secondary (MSSV) safety valves shall not open.

14.2.12.4.6 Unit Load Rejection Test

1.0 OBJECTIVES

- 1.1 To demonstrate that full load rejections from 100% power can be accommodated without initiating a Reactor Protection System (RPS) signal or an ESFAS signal, without opening any primary and/or secondary safety valves
- 1.2 To demonstrate that the house load operation is capable during the load rejection transient
- 1.3 To assess the performance of SBCS, FWCS, RRS, PPCS & PLCS, RPCS, DRCS and TCS following full load rejection from 100% power

2.0 PREREQUISITES

- 2.1 The reactor is operating above 95 percent power.
- 2.2 The RRS, PPCS, PLCS, FWCS, SBCS, DRCS and RPCS are in automatic operation.

3.0 TEST METHOD

3.1 A switchyard breaker(s) is tripped so as to subject the turbine to the maximum credible overspeed condition.

3.2 Plant behavior is monitored to provide reasonable assurance that the RRS, CEDMCS, SBCS, RPCS, FWCS, and pressurizer pressure and level control systems maintain the monitored parameters.

4.0 DATA REQUIRED

- 4.1 Many plant data are obtained including reactor power, CEA positions, RCS temperatures, pressurizer pressure and level, steam generator pressures and levels, steam and feedwater flows, POSRV and MSSV opening status, etc.
- 4.2 Sequence of events data are obtained.

5.0 ACCEPTANCE CRITERIA

- 5.1 The RPS shall not initiate a reactor trip.
- 5.2 The ESFAS shall not be actuated.
- 5.3 The primary (POSRV) and/or secondary (MSSV) safety valves shall not open.
- 5.4 The RPCS shall drop the selected CEA groups into the core.
- 5.5 The 100% power load rejection shall be accommodated without tripping the turbine and with the turbine generator supplying house loads.

14.2.12.4.7 Shutdown from Outside the Main Control Room Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate that the reactor can be tripped from outside the control room
 - 1.2 To demonstrate that the plant can be cooled down to the hot shutdown condition from outside the control room

1.3 To demonstrate that the plant can be controlled and maintained in the hot shutdown condition for at least 30 minutes from outside the control room

2.0 PREREQUISITES

- 2.1 The reactor is operating in the range of 10 to 25 percent of rated power with plant systems in their normal configuration with the turbine-generator in operation.
- 2.2 The capability to cool down the plant to the cold shutdown condition from the remote shutdown room (RSR) has been demonstrated during pre-core or post-core hot functional tests.
- 2.3 The remote shutdown console instrumentation is operating properly.
- 2.4 The communication system between the MCR and RSR has been demonstrated to be operational.
- 2.5 The remote shutdown instrumentation controls and systems have been pre-operationally tested.

3.0 TEST METHOD

- 3.1 The operating crew evacuates the MCR (standby crew remains in the MCR).
- 3.2 The reactor is tripped from outside the MCR.
- 3.3 Transfer of the control from the MCR to the RSR.
- 3.4 The plant is stabilized in hot standby condition from the RSR. After the stabilization, cool down the plant to hot shutdown condition from the RSR.
- 3.5 Maintain the plant in hot shutdown condition for at least 30 minutes.
- 3.6 Transfer of the control back from the RSR to the MCR.

4.0 DATA REQUIRED

4.1 Many plant data are obtained including reactor power, boron concentration, RCS temperatures, pressurizer pressure and level, steam generator pressures and levels, steam and feedwater flows, etc..

5.0 ACCEPTANCE CRITERIA

- 5.1 Reactor trip shall be achieved from outside the control room.
- 5.2 Control of the plant shall be transferred from the MCR to the RSR.
- 5.3 The plant shall be cooled down and maintained in the hot shutdown condition for at least 30 minutes from the RSR.

14.2.12.4.8 Loss of Offsite Power Test

1.0 OBJECTIVES

- 1.1 To demonstrate that the reactor can be shut down and maintained in hot standby conditions following a simulated loss of the main generator and offsite power.
- 1.2 To demonstrate the satisfactory performance of the auxiliary feedwater system following a simulated loss of the main generator and offsite power

2.0 PREREQUISITES

2.1 Reactor is operating in the range of 10 to 20 percent rated power.

3.0 TEST METHOD

- 3.1 The plant is tripped in a manner that produces a loss of generator and offsite power.
- 3.2 The plant is maintained in hot standby for at least 30 minutes before restoring power.

4.0 DATA REQUIRED

- 4.1 Many plant data are obtained including reactor power, CEA positions, RCS temperatures, pressurizer pressure and level, steam generator pressures and levels, steam and feedwater flows, POSRV and MSSV opening status, etc.
- 4.2 Sequence of events data are obtained.

5.0 ACCEPTANCE CRITERIA

- 5.1 NSSS shall be maintained in hot standby for at least thirty (30) minutes on emergency power following a simulated loss of main generator and offsite power.
- 5.2 The AFWS automatically shall initiate auxiliary feedwater flow to both steam generators and maintain the desired steam generator levels within the design value.

14.2.12.4.9 Biological Shield (Primary Shield) Radiation Measurements Test

1.0 OBJECTIVES

- 1.1 To obtain radiation levels for comparison with measurements of radioactivity level buildup with operation.
- 1.2 To measure the radiation levels in areas adjacent to the reactor, the steam generators, the reactor coolant pumps, and the pressurizer; and high and very high radiation areas inside the Auxiliary Building and the Compound Building at selected power levels in accessible locations of the plant to assure the protection of personnel during plant operation.

2.0 PREREQUISITES

2.1 The required preoperational tests have been completed and plant management has approved the initiation of radiation measurement testing.

- 2.2 Results of background radiation and surveys performed at less than 5% power conditions are available.
- 2.3 Radiation survey instruments have been calibrated.
- 2.4 For each testing iteration, the plant has been set-up to the appropriate operational configuration.

3.0 TEST METHOD

- 3.1 Measure gamma and neutron dose rates at 5, 50, and 100 percent power levels.
- 3.2 The radiation levels outside the biological (primary) shield are determined via a radiation survey at various power levels. The radiation tests include gamma dose rates as well as neutron dose rates. Radiation surveying is conducted in all accessible areas including potentially high and very high radiation areas where intermittent activities have the potential to produce transient high exposure conditions.

4.0 DATA REQUIRED

- 4.1 Power Level
- 4.2 Gamma dose rate in accessible locations at each power level
- 4.3 Neutron dose rate in accessible locations at each power level

5.0 ACCEPTANCE CRITERIA

- 5.1 Radiation levels are acceptable and meet design requirements.
- 5.2 The occupancy times in the radiation zones during power operation shall be controlled to be within the radiation zone designated stay times to ensure that the radiation doses to plant personnel are consistent with the guidance of 10 CFR 20, "Standards for Protection Against Radiation."

14.2.12.4.10 Steady-State Core Performance Test

1.0 OBJECTIVES

1.1 To compare measured values with predicted parameters at the selected power plateaus for the radial power distribution, axial power distribution, and peaking factors

2.0 PREREQUISITES

- 2.1 The reactor is operating at the desired power level and CEA configuration with equilibrium xenon.
- 2.2 The in-core instrumentation system is in operation.

3.0 TEST METHOD

- 3.1 Selected IPS outputs including in-core detector signal are generated.
- 3.2 The core power distribution is obtained using the in-core detectors.

4.0 DATA REQUIRED

- 4.1 Conditions of the test:
 - 4.1.1 Reactor power
 - 4.1.2 CEA positions
 - 4.1.3 Boron concentration
 - 4.1.4 Core average burnup
 - 4.1.5 In-core detector data

5.0 ACCEPTANCE CRITERIA

5.1 Radial Power Distribution

- 5.1.1 The comparison of the measured radial power distribution with the predicted radial power distribution shall satisfy the specified criteria.
- 5.2 Axial Power Distribution
 - 5.2.1 The comparison of the measured axial power distribution with the predicted axial power distribution shall satisfy the specified criteria.
- 5.3 Peaking Factors
 - 5.3.1 The measured peaking factors F_{xy} , F_r , F_z and F_q shall be within the specified criteria of the predicted values.
- 14.2.12.4.11
 Intercomparison of Plant Protection System, Core Protection Calculator, Information Processing System, and Qualified Information and Alarm System Inputs
 - 1.0 OBJECTIVES
 - 1.1 To verify that the process variable inputs/outputs of the PPS, CPCs, IPS, and QIAS are consistent
 - 2.0 PREREQUISITES
 - 2.1 The plant is operating at the desired conditions.
 - 2.2 All CPCs, CEACs, and the IPS and QIAS are operable.
 - 3.0 TEST METHOD
 - 3.1 Process variable inputs/outputs of the PPS, CPCs, QIAS and IPS are read as near simultaneously as practical.
 - 4.0 DATA REQUIRED
 - 4.1 Conditions of the measurement:
 - 4.1.1 Power measurements

- 4.1.2 Boron concentration
- 4.1.3 RCS temperatures
- 4.1.4 Pressurizer pressure and level
- 4.1.5 Steam generator pressures and levels
- 4.1.6 RCP speeds and differential pressures

5.0 ACCEPTANCE CRITERIA

5.1 The process variable inputs/outputs from the PPS, CPCs, IPS and QIAS as described in Subsections 7.5.1 and 7.7.1, shall be within the limits of the uncertainty analysis.

14.2.12.4.12 Verification of Core Protection Calculator Power Distribution Related Constants Test

1.0 OBJECTIVES

- 1.1 To verify that the CPC constants installed in the CPCs for temperature annealing, planar radial peaking, CEA shadowing are valid
- 1.2 To determine the CPC constants for axial power distribution

2.0 PREREQUISITES

- 2.1 The reactor is at the desired power level and CEA configuration with equilibrium xenon.
- 2.2 The in-core detector system is in operation.
- 2.3 The ex-core safety channels have been properly calibrated.

3.0 TEST METHOD

3.1 The temperature shadowing factors are verified by comparing core power and ex-core detector responses for various RCS temperatures.

- 3.2 Planar radial peaking factors are verified for various CEA configurations by comparison of the CPC values with values measured with the in-core detector system.
- 3.3 The CEA shadowing factors are verified by comparing ex-core detector responses for various CEA configurations with the unrodded ex-core responses.
- 3.4 The shape annealing factors are measured by comparing in-core power distributions and ex-core detector responses during a free xenon oscillation.

4.0 DATA REQUIRED

- 4.1 Reactor power
- 4.2 RCS temperatures
- 4.3 CEA positions
- 4.4 In-core detector data
- 4.5 Ex-core detector reading

5.0 ACCEPTANCE CRITERIA

- 5.1 The measured temperature shadowing factor shall be within the allowable band used in CPC.
- 5.2 The measured radial peaking factors determined from the in-core power distribution shall be less than or equal to the values installed in CPC or the appropriate constants shall be adjusted in the CPC.
- 5.3 The measured rod shadowing factors shall be greater than the values installed in CPC or the appropriate constants shall be adjusted in the CPC.
- 5.4 The measure CPC constants for axial power distribution are installed in each CPC channel.

14.2.12.4.13 Feedwater and Auxiliary Feedwater Systems Test

1.0 OBJECTIVES

1.1 To demonstrate that operation of the feedwater and auxiliary feedwater systems during hot standby, startup, and other normal operations, transients, and plant trips is satisfactory. The list of transients that require monitoring of the FW and AFW system performance is provided below:

Evolution	FW	AFW
FW downcomer to economizer transfer	×	
Unit load transient test	×	
Control systems checkout test	×	
Turbine trip test	×	
Unit load rejection test	×	
Shutdown from outside control room	×	×
Loss of offsite power test	×	×
RPCS test	×	

2.0 PREREQUISITES

2.1 The SBCS, FWCS, RRS, RPCS, CEDMCS, and pressurizer pressure and level controls are operable in either manual or automatic mode.

3.0 TEST METHOD

- 3.1 Performance of the feedwater systems is monitored during normal operation, transients, and trips. Specifically, the downcomer to economizer transfer is monitored for noise or vibration due to water hammer.
- 3.2 Initiate AFW and throttle the flow to verify the throttle capability over the valve full operating position.

4.0 DATA REQUIRED

- 4.1 Conditions of the measurement:
 - 4.1.1 Reactor power
 - 4.1.2 RCS temperatures
 - 4.1.3 Pressurizer pressure
 - 4.1.4 Steam generator levels and pressures
 - 4.1.5 Steam and feedwater flows
 - 4.1.6 Feedwater temperature and pressure
 - 4.1.7 CEA position

5.0 ACCEPTANCE CRITERIA

- 5.1 The feedwater and auxiliary feedwater systems shall perform as designated by the system description and as described.
- 5.2 No effects due to water hammer shall be detected. Check for water hammer noise using appropriately placed personnel or check for water hammer vibration using suitable instrumentation. ⁽⁵⁾
- 5.3 The auxiliary feedwater flow rate shall decrease as the feedwater valves are throttled.

14.2.12.4.14 <u>Core Protection Calculator Verification</u>

1.0 OBJECTIVES

1.1 To verify the CPC DNBR and LPD calculations

⁽⁵⁾ Acceptance criteria can be satisfied by performing a system walkdown when conditions permit entry to containment.

2.0 PREREQUISITES

- 2.1 The reactor is at the desired power level and CEA configuration with equilibrium xenon.
- 2.2 The CPCs are operational.

3.0 TEST METHOD

- 3.1 CPC input and output parameters are obtained.
- 3.2 The values for the LPD and DNBR obtained from the CPCs are compared with the values calculated by the CPC program simulator with the input ranges.

4.0 DATA REQUIRED

- 4.1 CPC inputs and outputs
- 4.2 The allowable LPD and DNBR ranges calculated by CPC program simulator

5.0 ACCEPTANCE CRITERIA

5.1 The maximum and minimum observed values of the LPD and DNBR from the CPCs shall be within the range calculated by the CPC program simulator.

14.2.12.4.15 <u>Main Steam Atmospheric Dump and Turbine Bypass Valves Capacity</u> <u>Test</u>

1.0 OBJECTIVES

- 1.1 To verify that the maximum capacity of each MSADV and TBV is less than the assumed value in safety analysis
- 1.2 To verify that the capacity of each of the MSADV is greater than the required design value

1.3 To verify that the total capacity of the TBVs controlled by the SBCS is greater than the required design value

2.0 PREREQUISITES

- 2.1 The reactor power is above 25 percent full power with turbine in operation.
- 2.2 Control systems are in automatic where applicable.
- 2.3 The operations of the MSADVs and TBVs have been demonstrated as part of the hot functional testing.

3.0 TEST METHOD

- 3.1 Reactor power is increased until full open condition of one MSADV and plant data are obtained.
- 3.2 Exchange other MSADVs and TBVs with closing the opened valve and opening the closed valve, simultaneously. Reactor power is adjusted to full open condition of each valve in testing.
- 3.3 The capacities of each MSADV and TBV are calculated with the measured data.

4.0 DATA REQUIRED

- 4.1 Reactor power and turbine power
- 4.2 Feedwater and steam flow rates
- 4.3 Steam generator pressure
- 4.4 MSADV and TBV positions

5.0 ACCEPTANCE CRITERIA

5.1 The capacities of the individual MSADVs and TBVs shall be less than the value used in the safety analysis (Subsection 15.1.4).

- 5.2 The capacities of the individual MSADVs shall be greater than the required design value (Subsection 10.3.2.2.4).
- 5.3 The capacity of total TBVs is greater than the required design value (Subsection 10.4.4.2.2.1)

14.2.12.4.16 <u>In-Core Detector Test</u>

1.0 OBJECTIVES

1.1 To verify the operability of the fixed in-core detector system by intercomparing rhodium detector fluxes.

2.0 PREREQUISITES

- 2.1 The reactor is at the specified power level and conditions.
- 2.2 The IPS is operable.
- 2.3 The in-core detector system is operational.

3.0 TEST METHOD

- 3.1 Amplifier output signals are measured.
- 3.2 Group symmetric instrument signals are measured.
- 3.3 Background detector signals are recorded.

4.0 DATA REQUIRED

- 4.1 Reactor power
- 4.2 CEA position
- 4.3 Boron concentration
- 4.4 In-core detector system data

5.0 ACCEPTANCE CRITERIA

- 5.1 IPS and CECOR printouts of the fixed incore detector responses are obtained and reviewed to identify potential detector failures and miswirings.
- 5.2 The background detector signal is between 0 and 10% of the level three (mid-plane) rhodium detector signal (100% power test only).
- 5.3 At least 75% of all incore detector locations are operable and 75% of all detectors shall be operable, with at least one detector operable at each of five levels in each quadrant. In addition, a minimum of six tilt estimates shall be operable, with at least one at each of three levels.

14.2.12.4.17 Core Operating Limit Supervisory System Verification

1.0 OBJECTIVES

1.1 To verify the COLSS DNBR and LHR calculations at various power plateaus

2.0 PREREQUISITES

- 2.1 The reactor is at the desired power level and CEA configuration with equilibrium xenon.
- 2.2 The COLSS is operational.
- 2.3 The in-core detector system is operational.

3.0 TEST METHOD

- 3.1 COLSS detailed output including COLSS inputs and outputs is obtained.
- 3.2 The values of DNBR and LHR obtained from the COLSS are compared with independently calculated values using the COLSS algorithms.

4.0 DATA REQUIRED

4.1 COLSS detailed output including COLSS inputs and outputs

5.0 ACCEPTANCE CRITERIA

5.1 The values of DNBR and LHR obtained from COLSS shall agree with the independently calculated values within the uncertainties in computer processing contained in the COLSS uncertainty analysis.

14.2.12.4.18 NSSS Integrity Monitoring System

1.0 OBJECTIVES

- 1.1 To obtain baseline IVMS, ALMS, LPMS and RCPVMS data at various power plateaus
- 1.2 To verify existing, or establish new alarm setpoints as required for the NSSS integrity monitoring system

2.0 PREREQUISITES

- 2.1 Plant is stable at the applicable power level (0, 20, 50, 80, and 100 percent).
- 2.2 NIMS (IVMS, ALMS, LPMS, and RCPVMS) is operational as applicable.

3.0 TEST METHOD

3.1 Collect baseline data at the applicable power levels.

4.0 DATA REQUIRED

- 4.1 Reactor power level
- 4.2 Baseline data for ALMS, IVMS, LPMS, and RCPVMS

5.0 ACCEPTANCE CRITERIA

- 5.1 The baseline data is obtained at various power levels.
- 5.2 The alarm setpoints of each subsystem are adjusted as necessary for power operation.

14.2.12.4.19 Loss of One Main Feedwater Pump

1.0 OBJECTIVES

1.1 To demonstrate that the NSSS can accommodate the loss of one of three operating main feedwater at 100% power without decreasing reactor and turbine power

2.0 PREREQUISITES

- 2.1 Plant is operating above 95% power.
- 2.2 Three MFWPs are operating
- 2.3 The RRS, PPCS, PLCS, FWCS, SBCS, and RPCS are in automatic operation.

3.0 TEST METHOD

3.1 Trip one MFWP among three operating MFWPs.

4.0 DATA REQUIRED

- 4.1 Many plant data are obtained including reactor power, CEA positions, RCS temperatures, pressurizer pressure and level, steam generator pressures and levels, steam and feedwater flows, POSRV and MSSV opening status, etc.
- 4.2 Sequence of events data are obtained.

5.0 ACCEPTANCE CRITERIA

- 5.1 The control systems is stabilize the plant to normal operating control bands.
- 5.2 Safety actuation limits are not exceeded.
- 5.3 Reactor and turbine power remain unchanged.

14.2.12.4.20 Penetration Temperature Survey Test

1.0 OBJECTIVES

1.1 To verify concrete temperatures surrounding hot penetrations do not exceed design allowable temperatures

2.0 PREREQUISITES

2.1 Plant is stable at the applicable power level.

3.0 TEST METHOD

3.1 Collect data at the applicable power levels.

4.0 DATA REQUIRED

4.1 Penetration sleeve temperature adjacent to shield building concrete

5.0 ACCEPTANCE CRITERIA

5.1 Concrete temperature does not exceed allowable temperature per ANSI/ACI 349-97, "Code Requirements for Nuclear Safety Related Concrete Structures," 1998.

14.2.12.4.21 HVAC Capability Test

- 1.0 OBJECTIVES
 - 1.1 To verify that various HVAC systems for the reactor containment building, control room area, and each area in the auxiliary building continue to maintain design temperatures.

2.0 PREREQUISITES

2.1 The plant is operating at or near the desired power.

3.0 TEST METHOD

- 3.1 Record temperature readings in specified areas while operating with normal ventilation lineups
- 3.2 Record temperature readings in specified areas while operating the designated minimum number of HVAC components consistent with existing plant conditions
- 3.3 Record temperature readings in specified areas during the loss of offsite power test

4.0 DATA REQUIRED

- 4.1 Power levels
- 4.2 Temperature data at designated locations
- 4.3 Equipment operating data

5.0 ACCEPTANCE CRITERIA

5.1 The design temperatures in the reactor containment building, control room area, and each area in the auxiliary building and compound building are maintained in accordance with Section 9.4.

14.2.12.4.22 Liquid Waste Management System Test

- 1.0 OBJECTIVES
 - 1.1 To demonstrate that the operation of the LWMS for collection, processing, recycling, and preparation of liquid waste for release to the environment is satisfactory. A list of LWMS subsystems is provided below:
 - Floor drain subsystem
 - Equipment waste subsystem
 - Chemical waste subsystem

• Radioactive laundry subsystem

2.0 PREREQUISITES

2.1 The LWMS equipment, including all subsystem equipment, is operable in either manual and/or automatic modes, as desired.

3.0 TEST METHOD

3.1 Performance of the LWMS is monitored. Specifically, the capability to independently and simultaneously collect and process liquid waste is verified.

4.0 DATA REQUIRED

- 4.1 Conditions of measurement
 - 4.1.1 Reactor power history and RCS radioactivity level
 - 4.1.2 LWMS tank levels
 - 4.1.3 LWMS pump operating data
 - 4.1.4 LWMS ion exchanger data
 - 4.1.5 Effluent control monitor operating data
 - 4.1.6 LWMS filtration unit operating data

5.0 ACCEPTANCE CRITERIA

5.1 The LWMS equipment performs as described in Section 11.2.

14.2.12.4.23 Gaseous Waste Management System Test

1.0 OBJECTIVES

1.1 To demonstrate that the operation of the GWMS for collection and processing of radioactive gases vented from plant equipment is satisfactory

2.0 PREREQUISITES

2.1 The GWMS equipment is operable in either manual and/or automatic modes, as designed.

3.0 TEST METHOD

3.1 Performance of the GWMS is monitored. Specifically, the capability to independently and simultaneously collect and process gaseous waste is verified.

4.0 DATA REQUIRED

- 4.1 Conditions of measurement
 - 4.1.1 Reactor power history and RCS radioactivity level
 - 4.1.2 Containment temperature and humidity
 - 4.1.3 Condenser operating data
 - 4.1.4 Effluent control monitor operating data
 - 4.1.5 Gas analyzer operating data
 - 4.1.6 Gas transport times

5.0 ACCEPTANCE CRITERIA

- 5.1 The GWMS equipment performs as described in Section 11.3.
- 14.2.12.4.24 <u>Pseudo-Ejected CEA Test</u>

1.0 OBJECTIVES

- 1.1 To determine the power distribution associated with the CEA ejection from about the full PDIL CEA configuration
- 2.0 PREREQUISITES
 - 2.1 The fuel has been preconditioned at 80 percent power.

- 2.2 Power level is stable and within the range of 50 ± 1 percent with a required CEA position.
- 2.3 The in-core detector system is in service.

3.0 TEST METHOD

- 3.1 The full-strength CEA chosen to be ejected is the one that results in the highest peaking factor relative to steady state.
- 3.2 Record the in-core and ex-core detector signals before and after the CEA withdrawal at stable condition.
- 3.3 Restore the CEAs to the normal position.

4.0 DATA REQUIRED

- 4.1 Conditions of the measurement:
 - 4.1.1 Reactor thermal power
 - 4.1.2 RCS temperature
 - 4.1.3 Pressurizer pressure
 - 4.1.4 CEA configuration
 - 4.1.5 Boron concentration
- 4.2 Time-dependent information:
 - 4.2.1 Reactivity variation
 - 4.2.2 CEA positions
 - 4.2.3 Relative power density (RPD)

5.0 ACCEPTANCE CRITERIA

5.1 The difference between the measured and predicted detector level 4 relative power density ratios shall be less than or equal to the design values for all assemblies

14.2.12.4.25 <u>Pseudo-Dropped CEA Test</u>

1.0 OBJECTIVES

- 1.1 To determine the power distribution resulting from a "dropped" CEA with the reactor at 50% of rated thermal power
 - The Full-Strength CEA is selected, based on calculations, to best verify the dropped rod assumptions used in the safety analysis.
- 1.2 To determine the power distribution resulting from a "dropped" Part-Strength CEA with the reactor at 50% of rated thermal power
 - The part-strength CEA is selected, based on calculations, to best verify the dropped rod assumptions used in the safety analysis.

2.0 PREREQUISITES

- 2.1 The fuel has been preconditioned at 80 percent power
- 2.2 Power level is stable and within the range of 50±1 percent with ARO condition.
- 2.3 The in-core detector system is in service.

3.0 TEST METHOD

- 3.1 The full-strength CEA chosen to be dropped is the one that results in the highest peaking factor relative to steady-state, ARO conditions.
 - a. Insert the selected CEA to the lower electrical limit in one continuous movement.

- b. Stabilize and maintain the system about the new reactor power level.
- c. Record the in-core and ex-core detector signals before and after the CEA insertion.
- 3.2 The part-strength CEA chosen to be dropped is the one that results in the highest peaking factor relative to steady-state, ARO conditions.
 - a. Insert the selected CEA to the lower electrical limit in one continuous movement.
 - b. Stabilize and maintain the system about the new reactor power level.
 - c. Record the in-core and ex-core detector signals before and after the CEA insertion.

4.0 DATA REQUIRED

- 4.1 Conditions of the measurement:
 - 4.1.1 Reactor thermal power
 - 4.1.2 RCS temperature
 - 4.1.3 Pressurizer pressure
 - 4.1.4 CEA configuration
 - 4.1.5 Boron concentration
- 4.2 Time-dependent information:
 - 4.2.1 Reactivity variation
 - 4.2.2 CEA positions
 - 4.2.3 Relative power density

5.0 ACCEPTANCE CRITERIA

5.1 The difference between the measured and predicted assembly average relative power density ratios remains less than or equal to the design value for all assemblies.

14.2.12.4.26 <u>Fatigue Monitoring System Test</u>

- 1.0 OBJECTIVES
 - 1.1 To demonstrate that Fatigue Monitoring System (FMS) functions as designed
 - 1.2 To monitor the fatigue usages for the early identified locations including the surge line which will experience thermal stratification

2.0 PREREQUISITES

- 2.1 FMS has been constructed.
- 2.2 Supporting systems for the operation of FMS are available.

3.0 TEST METHOD

- 3.1 Collect initial plant operation data from existing instrumentation.
- 3.2 Verify the functions of FMS modules such as Data Acquisition System (DAS), Automatic Cycle Counting (ACC), Cycle-Based Fatigue (CBF) and Stress-Based Fatigue (SBF).

4.0 DATA REQUIRED

4.1 Input data to FMS and output data

5.0 ACCEPTANCE CRITERIA

5.1 FMS functions as designed for the modules of DAS, ACC, CBF, and SBF.

14.2.12.4.27 <u>Ex-Core Neutron Flux Monitoring System Calibration</u>

1.0 OBJECTIVE

1.1 To calibrate the ex-core linear powers of the safety channels and the excore control powers to agree with the reactor thermal power.

2.0 PREREQUISITES

- 2.1 Reactor thermal power is verified.
- 2.2 Ex-core neutron detectors and support systems are operational.

3.0 TEST METHOD

- 3.1 Plant is maintained in stable condition.
- 3.2 Measure the reactor thermal power and ex-core powers.
- 3.3 Adjust the ex-core linear powers of the safety channels to meet the reactor thermal power. Variable Overpower Trip (VOPT) of the Plant Protection System (PPS) should be bypassed for the channel during adjustment.
- 3.4 Adjust the ex-core control powers channels to meet the reactor thermal power. Un-select the control channel in Reactor Regulating System (RRS) during adjustment.

4.0 DATA REQUIRED

- 4.1 Ex-core linear powers of the safety channels
- 4.2 Ex-core control powers
- 4.3 Reactor thermal power

5.0 ACCEPTANCE CRITERIA

5.1 Ex-core linear powers of the safety channels are adjusted within $\pm 0.5\%$ of the reactor thermal power.

- 5.2 Ex-core control powers are adjusted within $\pm 2\%$ of the reactor thermal power.
- 14.2.13 <u>Combined License Information</u>
- COL 14.2(1) The COL applicant is to develop the site-specific organization and staffing level appropriate for its facility to implement the initial test program. The COL's plant operating and plant technical staff should participate, to the extent practical, in developing and conducting the Initial Test Program and evaluating the test results.
- COL 14.2(2) The COL applicant is to prepare the site-specific preoperational and startup test specifications and test procedures and/or guidelines that is to be used for the conduct of the plant Initial Test Program. The preoperational and startup test procedures should have controls in place to ensure that test procedures include appropriate prerequisites, objectives, safety precautions, initial test conditions, methods to direct and control test performance and test acceptance criteria by which the test is evaluated. Testing performed at other than design operating conditions for systems is to be reconciled either through the test acceptance criteria or post-test data analysis. These procedures are to be submitted at least 60 days prior to their intended use to the NRC staff for review as described in Subsection 14.2.11.
- The COL applicant is to prepare a startup administrative manual (SAM) COL 14.2(3) which contains administrative controls that govern the conduct of each major phase of the ITP. This description should include the administrative controls used to ensure that necessary prerequisites are satisfied for each major phase and for individual tests. The COL applicant should also describe the methods to be followed in initiating plant modifications or maintenance tasks that are deemed to be necessary to conduct the ITP. This description should include methods used to ensure retesting following such modifications or maintenance. In addition, the description should discuss the involvement of design organizations with the COL applicant in reviewing and approving proposed plant modifications. The COL applicant should also describe in the SAM adherence to approved test procedures during the conduct of the ITP as well as the methods for effecting changes to approved test procedures.

- COL 14.2(4) The COL applicant is to develop the test procedure including a listing of the high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program.
- COL 14.2(5) The COL applicant is to develop the test procedure including a listing of the different flow modes to which the systems will be subjected during the vibration, thermal expansion, and dynamic effects testing program to confirm that the piping systems, restraints, components, and supports have been adequately designed to withstand flow-induced dynamic loadings under the steady-state and operational transient conditions anticipated during service.
- COL 14.2(6) The COL applicant is to develop the test procedure including a description of the thermal motion monitoring program for verification of snubber movement, adequate clearances and gaps, the acceptance criteria, and the method regarding how motion will be measured.
- COL 14.2(7) The COL applicant is to perform review and evaluation of individual test results in a test report made available to NRC personnel after preoperational and startup tests are completed. The specific test acceptance criteria for determining success or failure of a test shall be included in the test report approval of the test results. The test report should also include test results associated with any license conditions in the plant specific Initial Test Program.
- COL 14.2(8) The COL applicant is responsible for establishing hold points at selected milestones throughout the power ascension test phase to ensure that designated personnel or groups evaluate and approve relevant test results before proceeding to the next power ascension test phase. At a minimum, the COL applicant should establish hold points at approximately 25-percent, 50-percent, and 75-percent power-level test conditions for pressurized-water reactors.
- COL 14.2(9) The COL applicant is responsible for retaining preoperational and startup test procedures and test results as part of the plant's historical records in accordance with 10 CFR 50.36, "Technical Specification," 10 CFR 50.71,

"Maintenance of Records, Making of Reports," 10 CFR 50, Appendix B, Criterion XVII, "Test Records," and RG 1.28, "Quality Assurance Program Criteria (Design and Construction)."

The preoperational and startup testing procedures and test results are to be retained for the life of the plant be the COL applicant.

- COL 14.2(10) The COL applicant is to describe its program for reviewing available information on reactor operating and testing experiences and discusses how it used this information in developing the initial test program. The description is to include the sources and types of information reviewed, the conclusions or findings, and the effect of the review on the initial test program.
- COL 14.2(11) The COL applicant is to provide a schedule for the development of plant procedures, as well as a description of how, and to what extent, the plant operating, emergency, and surveillance procedures are use-tested during the initial test program.
- COL 14.2(12) The COL applicant that references the APR1400 design certification is to identify the specific operator training to be conducted as part of the lowpower testing program related to the resolution of TMI Action Plan Item I.G.1, as described in (1) NUREG-0660 – NRC Action Plans Developed as a Result of the TMI-2 Accident, Revision 1, August 1980 and (2) NUREG-0737 – Clarification of TMI Action Plan Requirements.
- COL 14.2(13) The COL applicant is to develop a sequence and schedule for the development of the plant operating and emergency procedures should allow sufficient time for trial use of these procedures during the Initial Test Program. The sequence and schedule for plant startup is to be developed by the COL applicant to allow sufficient time to systematically perform the required testing in each phase.
- COL 14.2(14) The COL applicant is to perform the appropriate interface testing of the PERMSS and ARMS monitors with ERDS.

- COL 14.2(15) The COL applicant is to prepare the preoperational test of cooling tower and associated auxiliaries, and raw water and service water cooling systems.
- COL 14.2(16) The COL applicant is to develop the test program of personnel monitors, radiation survey instruments, and laboratory equipment used to analyze or measure radiation levels and radioactivity concentrations.
- COL 14.2(17) The COL applicant is to prepare the site-specific preoperational and startup test specification and test procedure and/or guideline for offsite communication system.
- COL 14.2(18) The COL applicant is to prepare the pre-operational test of ultimate heat sink pump house.
- COL 14.2(19) The COL applicant is to prepare the testing and verification of ultimate heat sink cooling chains.

14.2.14 <u>References</u>

- 1. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," U.S. Nuclear Regulatory Commission.
- 2. Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction)," Rev. 4, U.S. Nuclear Regulatory Commission, June 2010.
- 3. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2013.
- 4. Regulatory Guide 1.68.2, "Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants, U.S. Nuclear Regulatory Commission, April 2010.
- 5. Regulatory Guide 1.68.3, "Preoperational Testing of Instrument and Control Air Systems," U.S. Nuclear Regulatory Commission, September 2012.
- 6. Regulatory Guide 1.79, "Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors, U.S. Nuclear Regulatory Commission, October 2013.

- ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Facility Components," The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.
- 8. ANSI/ANS-56.8-1994, "Containment System Leakage Testing Requirements," American Nuclear Society, 1994.
- Regulatory Guide 1.20, "Comprehensive Vibration Assessment (CVAP) Program for Reactor Internals during Pre-operational and Initial Startup Testing," Rev. 3, U.S. Nuclear Regulatory Commission, March 2007.
- Regulatory Guide 1.140, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," U.S. Nuclear Regulatory Commission, June 2001.
- Regulatory Guide 1.52, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, September 2012.
- 12 IEEE 450-2010, "IEEE Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications," Institute of Electrical and Electronics Engineers, 2010.
- 13 Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, September 2013.
- Regulatory Guide 1.41, "Preoperational Testing of Redundant On-site Electric Power Systems to Verify Proper Load Group Assignments," U.S. Nuclear Regulatory Commission, March 1973.

Table 14.2-1 (1 of 6)

Preoperational Tests

Subsection	Test
14.2.12.1.1	Reactor coolant pump motor initial operation test
14.2.12.1.2	Reactor coolant system test
14.2.12.1.3	Pressurizer pilot-operated safety relief valve test
14.2.12.1.4	Pressurizer pressure and level control systems test
14.2.12.1.5	Chemical and volume control system letdown subsystem test
14.2.12.1.6	Volume control tank subsystem test
14.2.12.1.7	Chemical and volume control system charging subsystem test
14.2.12.1.8	Chemical addition subsystem test
14.2.12.1.9	Reactor drain tank subsystem test
14.2.12.1.10	Equipment drain tank subsystem test
14.2.12.1.11	Boric acid batching tank subsystem test
14.2.12.1.12	Concentrated boric acid subsystem test
14.2.12.1.13	Reactor makeup subsystem test
14.2.12.1.14	Holdup subsystem test
14.2.12.1.15	Boric acid concentrator subsystem test
14.2.12.1.16	Gas stripper subsystem test
14.2.12.1.17	Boronometer subsystem test
14.2.12.1.18	Process radiation monitor subsystem test
14.2.12.1.19	Gas stripper effluent radiation monitor subsystem test
14.2.12.1.20	Shutdown cooling system test
14.2.12.1.21	Safety injection system test
14.2.12.1.22	Safety injection tank subsystem test
14.2.12.1.23	Engineered safety features – component control system test
14.2.12.1.24	Plant protection system test
14.2.12.1.25	Ex-core neutron flux monitoring system test
14.2.12.1.26	Fixed in-core nuclear signal channel test

Table 14.2-1 (2 of 6)

Subsection	Test
14.2.12.1.27	Digital rod control system test
14.1.12.1.28	Reactor regulating system test
14.2.12.1.29	Steam bypass control system test
14.2.12.1.30	Feedwater control system test
14.2.12.1.31	Core operating limit supervisory system test
14.2.12.1.32	Reactor power cutback system test
14.2.12.1.33	Fuel storage and handling system test
14.2.12.1.34	Auxiliary feedwater system test
14.2.12.1.35	Reactor coolant system hydrostatic test
14.2.12.1.36	Control element drive mechanism cooling system test
14.2.12.1.37	Reactor coolant gas vent system test
14.2.12.1.38	Containment spray system test
14.2.12.1.39	Integrated engineered safety features / loss of power test
14.2.12.1.40	In-containment water storage system test
14.2.12.1.41	Internals vibration monitoring system test
14.2.12.1.42	Loose parts monitoring system test
14.2.12.1.43	Acoustic leak monitoring system test
14.2.12.1.44	Information processing system and qualified information and alarm system test
14.2.12.1.45	Turbine generator building open cooling water system test
14.2.12.1.46	Pre-core hot functional test controlling document
14.2.12.1.47	Pre-core instrument correlation
14.2.12.1.48	Remote shutdown console test
14.2.12.1.49	Diverse protection system test
14.2.12.1.50	Pre-core test data record
14.2.12.1.51	Pre-core reactor coolant system expansion measurements
14.2.12.1.52	Pre-core reactor coolant and secondary water chemistry data
14.2.12.1.53	Pre-core pressurizer performance test

Table 14.2-1 (3 of 6)

Subsection	Test
14.2.12.1.54	Pre-core control element drive mechanism performance test
14.2.12.1.55	Pre-core reactor coolant system flow measurements
14.2.12.1.56	Pre-core reactor coolant system heat loss measurement
14.2.12.1.57	Pre-core reactor coolant system leak rate measurement
14.2.12.1.58	Pre-core chemical volume control system integrated test
14.2.12.1.59	Pre-core safety injection check valve test
14.2.12.1.60	Pre-core boration / dilution measurements
14.2.12.1.61	Downcomer feedwater system water hammer test
14.2.12.1.62	Main turbine systems test
14.2.12.1.63	Main steam safety valve test
14.2.12.1.64	Main steam isolation valves and MSIVBVs test
14.2.12.1.65	Main steam system test
14.2.12.1.66	Steam generator blowdown system test
14.2.12.1.67	Main condenser and condenser vacuum systems test
14.2.12.1.68	Feedwater system test
14.2.12.1.69	Condensate system test
14.2.12.1.70	Turbine steam seal system test
14.2.12.1.71	Circulating water system test
14.2.12.1.72	Steam generator hydrostatic test
14.2.12.1.73	Heater drains system test
14.2.12.1.74	Chilled water system test
14.2.12.1.75	Essential service water system test
14.2.12.1.76	Component cooling water system test
14.2.12.1.77	Spent fuel pool cooling and cleanup system test
14.2.12.1.78	Turbine generator building closed cooling water system test
14.2.12.1.79	Condensate storage system test
14.2.12.1.80	Normal lighting system test
14.2.12.1.81	Emergency lighting system test

Table 14.2-1 (4 of 6)

Subsection	Test
14.2.12.1.82	Compressed air system test
14.2.12.1.83	Process sampling system test
14.2.12.1.84	Heat tracing system test
14.2.12.1.85	Fire protection system test
14.2.12.1.86	Emergency diesel generator mechanical system test
14.2.12.1.87	Emergency diesel generator electrical system test
14.2.12.1.88	Emergency diesel engine fuel oil system test
14.2.12.1.89	Alternate AC source system test (mechanical)
14.2.12.1.90	Alternate AC source system test (electrical)
14.2.12.1.91	Containment polar crane test
14.2.12.1.92	Fuel handling area cranes test
14.2.12.1.93	Reactor containment building HVAC system test
14.2.12.1.94	Reactor containment purge HVAC system test
14.2.12.1.95	Control room area HVAC system test
14.2.12.1.96	Turbine generator building HVAC system test
14.2.12.1.97	Emergency diesel generator area HVAC system test
14.2.12.1.98	Fuel handling HVAC system test
14.2.12.1.99	Compound building HVAC system test
14.2.12.1.100	Balance of control room HVAC system test
14.2.12.1.101	Hydrogen mitigation system test
14.2.12.1.102	Containment hydrogen recombiner system test
14.2.12.1.103	Liquid waste management system test
14.2.12.1.104	Solid waste management system test
14.2.12.1.105	Gaseous waste management system test
14.2.12.1.106	Process and effluent radiological monitoring system test
14.2.12.1.107	Area radiation monitoring system test
Table 14.2-1 (5 of 6)

Subsection	Test
14.2.12.1.108	4,160V Class 1E auxiliary power system test
14.2.12.1.109	480V Class 1E auxiliary power system test
14.2.12.1.110	Unit main power system test
14.2.12.1.111	13,800V non-Class 1E auxiliary power system test
14.2.12.1.112	4,160V non-Class 1E auxiliary power system test
14.2.12.1.113	480V non-Class 1E auxiliary power system test
14.2.12.1.114	Non-Class 1E dc power systems test
14.2.12.1.115	Class 1E dc power systems test
14.2.12.1.116	Offsite power system test
14.2.12.1.117	Balance-of-plant piping thermal expansion measurement test
14.2.12.1.118	Balance-of-plant piping vibration measurement test
14.2.12.1.119	Containment integrated leak rate test and structural integrity test
14.2.12.1.120	Fuel transfer tube functional test and leak test
14.2.12.1.121	Equipment hatch functional test and leak test
14.2.12.1.122	Containment personnel airlock functional test and leak test
14.2.12.1.123	Containment electrical penetration assemblies test
14.2.12.1.124	Containment isolation valves leakage rate test
14.2.12.1.125	Loss of instrument air test
14.2.12.1.126	Mid-loop operations verification test
14.2.12.1.127	Seismic monitoring instrumentation test
14.2.12.1.128	Auxiliary steam system test
14.2.12.1.129	Containment isolation valves test
14.2.12.1.130	Post-accident monitoring instrumentation test
14.2.12.1.131	Electrical and I&C equipment areas HVAC system test
14.2.12.1.132	Auxiliary building controlled area HVAC system test
14.2.12.1.133	Auxiliary building clean area HVAC system test
14.2.12.1.134	Leakage detection system test
14.2.12.1.135	Leakage control and detection of system outside of containment

Table 14.2-1 (6 of 6)

Subsection	Test
14.2.12.1.136	RCP vibration monitoring system
14.2.12.1.137	NSSS integrity monitoring system (pre-core)
14.2.12.1.138	Core protection calculator system test
14.2.12.1.139	Diverse indication system test
14.2.12.1.140	Pre-core pressurizer surge line stratification test
14.2.12.1.141	Local of vital equipment
14.2.12.1.142	Access to vital equipment
14.2.12.1.143	Equipment to permit observation of abnormal presence or activity of persons or vehicles
14.2.12.1.144	Vehicles barrier system to protect against the design basis threat vehicle bombs
14.2.12.1.145	Vital areas with active intrusion detection systems
14.2.12.1.146	Security alarm annunciation and video assessment information
14.2.12.1.147	Location and equipment of the central and secondary alarm stations
14.2.12.1.148	Secondary security power supply system
14.2.12.1.149	Intrusion detection and assessment systems
14.2.12.1.150	Equipment and emergency exits
14.2.12.1.151	Security communication systems
14.2.12.1.152	Bullet-resisting barriers
14.2.12.1.153	Security alarm devices and transmission lines
14.2.12.1.154	Plant communication systems

Table 14.2-2

Initial Fuel Loading and Post-Core Hot Function Tests

Subsection	Test
14.2.12.2.1	Initial Fuel Loading
14.2.12.2.2	Post-core hot functional test controlling document
14.2.12.2.3	NSSS integrity monitoring system (post-core)
14.2.12.2.4	Reactor coolant system flow measurements
14.2.12.2.5	Post-core control element drive mechanism performance
14.2.12.2.6	Post-core reactor coolant and secondary water chemistry data
14.2.12.2.7	Post-core pressurizer spray valve and control adjustments
14.2.12.2.8	Post-core reactor coolant system leak rate measurement
14.2.12.2.9	Post-core in-core instrumentation test
14.2.12.2.10	Post-core instrument correlation
14.2.12.2.11	Post-core acoustic leak monitor system test

Table 14.2-3

Initial Criticality and Low-Power Physics Test

Subsection	Test
14.2.12.3.1	Initial Criticality
14.2.12.3.2	Low-power biological shield survey test
14.2.12.3.3	Isothermal temperature coefficient test
14.2.12.3.4	Shutdown and regulating control element assembly group worth test
14.2.12.3.5	Differential boron worth test
14.2.12.3.6	Critical boron concentration test
14.2.12.3.7	Control element assembly symmetry

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Table 14.2-4

Power Ascension Tests

Subsection	Test
14.2.12.4.1	Variable T _{avg} (isothermal temperature coefficient and power coefficient) test
14.2.12.4.2	Unit load transient test
14.2.12.4.3	Control systems checkout test
14.2.12.4.4	Reactor coolant and secondary chemistry and radiochemistry test
14.2.12.4.5	Turbine trip test
14.2.12.4.6	Unit load rejection test
14.2.12.4.7	Shutdown from outside the main control room test
14.2.12.4.8	Loss of offsite power test
14.2.12.4.9	Biological shield survey test
14.2.12.4.10	Steady-state core performance test
14.2.12.4.11	Intercomparison of plant protection system, core protection calculator, information processing system, and qualified information and alarm system inputs
14.2.12.4.12	Verification of core protection calculator power distribution related constants test
14.2.12.4.13	Feedwater and auxiliary feedwater system test
14.2.12.4.14	Core protection calculator verification
14.2.12.4.15	Main steam atmospheric dump and turbine bypass valve capacity test
14.2.12.4.16	In-core detector test
14.2.12.4.17	Core operating limit supervisory system verification
14.2.12.4.18	NSSS integrity monitoring system (post-core)
14.2.12.4.19	Loss of one main feedwater pump
14.2.12.4.20	Penetration temperature survey test
14.2.12.4.21	HVAC capability test
14.2.12.4.22	Liquid waste management system test
14.2.12.4.23	Gaseous waste management system test
14.2.12.4.24	Pseudo-ejected CEA test
14.2.12.4.25	Pseudo-dropped CEA test
14.2.12.4.26	Fatigue monitoring system test

Table 14.2-5

Power Ascension Test Plateaus

Test	Plateau
Variable T_{avg} (isothermal temperature coefficient and power coefficient) test	50, 100 % ⁽¹⁾
Unit load transient test	50, 100 %
Control systems checkout test	15, 20, 50, 80, 100 %
RCS and secondary chemistry and radiochemistry test	20, 50, 80, 100 %
Turbine trip test	100 %
Unit load rejection test	100 %
Shutdown from outside the main control room test	≥ 10 %
Loss of offsite power test	≥ 10 %
Biological shield survey test	50, 100 %
Steady-state core performance test	20, 50, 80, 100 %
Intercomparison of PPS, CPC, IPS, and QIAS inputs	20, 50, 80, 100 %
Verification of CPC power distribution related constants test	20, 50 %
Feedwater and auxiliary feedwater system test	≥ 10 %
CPC verification	20, 50, 80, 100 %
Main steam atmospheric dump and turbine bypass valve capacity test	≥ 15 %
In-core detector test	20, 50, 80, 100 %
COLSS verification	20, 50, 80, 100 %
Baseline NSSS integrity monitoring	20, 50, 80, 100 %
Loss of one main feedwater pump	100 %
Penetration temperature survey test	20, 50, 80, 100 %
HVAC capability test	50, 100 %
Natural circulation test	> 80 %
Liquid waste management system test	> 20 %
Gaseous waste management system test	> 20 %
Pseudo-ejected CEA test	50 %
Pseudo-dropped CEA test	50 %

(1) The temperature and measurements are done as close to 100 % as possible at a level where CEA motion is practicable, accounting for margin considerations.

Table 14.2-6

Physics (Steady-State) Test Acceptance Criteria Tolerances

Parameter	Tolerance	
Low Power Physics Test		
Symmetric CEA Worth	± 1.5 cent	
CEA Group Worths ⁽¹⁾	± 15 % or 0.1 % $\Delta \rho$, whichever is greater	
Total Worth (Net Shutdown)	± 10 %	
Temperature Coefficient	$\pm~0.36\times10^{-4}\Delta\rho/^{\circ}F$	
Critical Boron Concentration	± 50 ppm	
Boron Worth	\pm 15 ppm/ % $\Delta \rho$	
Power Ascension Physics Test		
Power Distribution (Radial and Axial)	RMS $^{(2)} \le 5\%(3\%)^{(3)}$	
Peaking Factors (F _{xy} , F _r , F _z , F _q)	± 7.5 %	
Temperature Coefficient	$\pm \ 0.36 \times 10^{-4} \ \Delta \rho/^\circ F$	
Power Coefficient	$\pm 0.2 \times 10^{-4} \Delta \rho / \%$ power	
Pseudo-ejected CEA	± 20 %	
Pseudo-dropped CEA	± 0.2	

- (1) If CEA exchange methods are used, the acceptance criterion for reference bank is \pm 10 %.
- (2) RMS = $\sqrt{\frac{\sum_{i}^{N} (RPD^{PAED} RPD^{MEAS})^2}{N}}$

where, N = total number of fuel assemblies in core or number of axial planes, as appropriate.

(3) At 50 % power and above.

Table 14.2-7 (1 of 18)

Conformance Matrix of RG 1.68 Appendix A versus Individual Test Descriptions

This table provides the matrix of applicable guidance of NRC RG 1.68 (Reference 3) Appendix A (Initial Test program) versus individual test descriptions listed in Subsection 14.2.12 so as to conform the key test parameters systematically.

RG 1.68 APP. A	Subsection #	Individual Test
1.a.1	14.2.12.1.46 14.2.12.1.51 14.2.12.1.141	Pre-core hot functional test controlling document Pre-core reactor coolant system expansion measurements Pre-Core pressurizer surge line stratification test
1.a2.a	14.2.12.1.4 14.2.12.1.53	Pressurizer pressure and level control systems test Pre-core pressurizer performance test
1.a.2.b	14.2.12.1.1 14.2.12.1.2	Reactor coolant pump motor initial operation test Reactor coolant system test
1.a.2.c	14.2.12.1.30 14.2.12.1.35 14.2.12.1.72	Feedwater control system test Reactor coolant system hydrostatic test Steam generator hydrostatic test
1.a.2.d	14.2.12.1.3 14.2.12.1.9 14.2.12.1.37	Pressurizer pilot-operated safety relief valve test Reactor drain tank subsystem test Reactor coolant gas vent system test
1.a.2.e	-	Not applicable MSIVs are not in the RCS of the APR1400 design.
1.a.2.f	14.2.12.1.46	Pre-core hot functional test controlling document
1.a.2.g	14.2.12.1.4 14.2.12.1.28	Pressurizer pressure and level control systems test Reactor regulating system test
1.a.2.h	14.2.12.1.2 14.2.12.1.37	Reactor coolant system test Reactor coolant gas vent system test
1.a.2.i	14.2.12.1.3	Pressurizer pilot-operated safety relief valve test
1.a.2.j	-	Not applicable This is not a design feature of the APR1400
1.a.2.k	-	Not applicable This is not a design feature of the APR1400

Table 14.2-7 (2 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.a.2.1	-	Not applicable
		This is not a design feature of the APR1400
1.a.3	14.2.12.1.41	Internals vibration monitoring system test
	14.2.12.1.42	Loose parts monitoring system test
	14.2.12.1.43	Acoustic leak monitoring system test
	14.2.12.1.51	Pre-core reactor coolant system expansion measurements
1.a.4	14.2.12.1.35	Reactor coolant system hydrostatic test
1.b.1.a	14.2.12.1.27	Digital rod control system test
	14.2.12.1.36	Control element drive mechanism cooling system test
1.b.1.b	14.2.12.1.32	Reactor power cutback system test
1.b.1.c	14.2.12.1.28	Reactor regulating system test
1.b.1.d	14.2.12.1.54	Pre-core control element drive mechanism performance test
1.b.2.a	14.2.12.1.12	Concentrated boric acid subsystem test
	14.2.12.1.13	Reactor makeup subsystem test
	14.2.12.1.84	Heat tracing system test
1.b.2.b	14.2.12.1.60	Pre-core boration / dilution measurements
1.b.2.c	14.2.12.1.58	Pre-core chemical volume control system integrated test
	14.2.12.1.112	4,160 V non-Class 1E auxiliary power system test
	14.2.12.1.113	480 V non-Class 1E auxiliary power system test
	14.2.12.1.114	Non-Class 1E dc power systems test
1.b.3	-	Not applicable
		This is not a design feature of the APR1400.
1.c.1	14.2.12.1.23	Engineered safety features – component control system test
	14.2.12.1.24	Plant protection system test
1.c.2	14.2.12.1.47	Pre-core instrument correlation
	14.2.12.1.54	Pre-core control element drive mechanism performance test
1.c.3	14.2.12.1.39	Integrated engineered safety features / loss of power test
	14.2.12.1.115	Class 1E dc power systems test
1.c.4	14.2.12.1.49	Diverse protection system test

Table 14.2-7 (3 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.d.1	14.2.12.1.29	Steam bypass control system test
	14.2.12.4.15	Main steam atmospheric dump and turbine bypass valve test
1.d.2	14.2.12.1.20	Shutdown cooling system test
1.d.3.a	14.2.12.1.29	Steam bypass control system test
1.d.3.b	14.2.12.1.65	Main steam system test
1.d.3.c	14.2.12.1.63	Main steam safety valve test
1.d.3.d	14.2.12.1.63	Main steam safety valve test
1.d.3.e	14.2.12.1.20	Shutdown cooling system test
1.d.3.f	-	Not applicable
		This is not a design of the APR1400.
1.d.3.g	14.2.12.1.64	Main steam isolation valves and MSIVBVs test
1.d.3.h	14.2.12.1.34	Auxiliary feedwater system test
1.d.3.i	14.2.12.1.79	Condensate storage system test
1.d.3.j	-	Exception
		The COL applicant is to prepare the pre-operational test of cooling tower and associated auxiliaries (COL 14.2(15)).
1.d.3.k	14.2.12.1.71	Circulating water system test
	14.2.12.1.75	Essential service water system test
	14.2.12.1.76	Component cooling water system test
	14.2.12.1.78	Turbine generator building closed cooling water system test
1.d.3.1	-	Not applicable
		This is not a design feature of the APR1400.
1.e.1	14.2.12.1.65	Main steam system test
1.e.2	14.2.12.1.65	Main steam system test
1.e.3	14.2.12.1.64	Main steam isolation valves and MSIVBVs test
1.e.4	14.2.12.1.63	Main steam safety valve test
1.e.5	14.2.12.1.62	Main turbine systems test
1.e.6	14.2.12.1.62	Main turbine systems test
	14.2.12.1.70	Turbine steam seal system test
1.e.7	14.2.12.1.69	Condensate system test

Table 14.2-7 (4 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.e.8	14.2.12.1.69	Condensate system test
1.e.9	14.2.12.1.68	Feedwater system test
1.e.10	14.2.12.1.73	Heater drains system test
1.e.11	14.2.12.1.52	Pre-core reactor coolant and secondary water chemistry data
	14.2.12.1.67	Main condenser and condenser vacuum systems test
	14.2.12.1.69	Condensate system test
1.e.12	14.2.12.1.67	Main condenser and condenser vacuum systems test
1.f.1	14.2.12.1.71	Circulating water system test
1.f.2	-	Exception
		The COL applicant is to prepare the pre-operational test of cooling tower and associated auxiliaries (COL 14.2(15)).
1.f.3	-	Exception
		The COL applicant is to prepare the pre-operational test of raw water and service water cooling systems (COL 14.2(15)).
1.g.1	14.2.12.1.110	Unit main power system test
	14.2.12.1.111	13,800 V non-Class 1E auxiliary power system test
	14.2.12.1.112	4,160 V non-Class 1E auxiliary power system test
	14.2.12.1.113	480 V non-Class 1E auxiliary power system test
	14.2.12.1.116	Offsite power system test
1.g.2	14.2.12.1.108	4,160 V Class 1E auxiliary power system test
	14.2.12.1.109	480 V Class 1E auxiliary power system test
	14.2.12.1.81	Emergency lighting system test
1.g.3	14.2.12.1.86	Emergency diesel generator mechanical system test
	14.2.12.1.87	Emergency diesel generator electrical system test
	14.2.12.1.88	Emergency diesel engine fuel oil system test
	14.2.12.1.89	Alternate AC source system test (mechanical) alternate AC source
	14.2.12.1.90	system test (electrical)
1.g.4	14.2.12.1.81	Emergency lighting system test
	14.2.12.1.114	Non-Class 1E dc power systems test
	14.2.12.1.115	Class 1E dc power systems test
1.h.1.a	14.2.12.1.117	BOP piping thermal expansion measurement test
	14.2.12.1.118	BOP piping vibration measurement test

Table 14.2-7 (5 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.h.1.b	14.2.12.1.20	Shutdown cooling system test
	14.2.12.1.21	Safety injection system test
1.h.1.c	14.2.12.1.22	Safety injection tank subsystem test
	14.2.12.1.59	Pre-core safety injection check valve test
	14.2.12.1.21	Safety injection system test
1.h.1.d	14.2.12.1.20	Shutdown cooling system test
1.h.1.e	14.2.12.1.20	Shutdown cooling system test
	14.2.12.1.21	Safety injection system test
1.h.2	-	Not applicable
		This is not a design of the APR1400.
1.h.3	14.2.12.1.38	Containment spray system test
1.h.4	14.2.12.1.101	Hydrogen mitigation system test
	14.2.12.1.102	Containment hydrogen recombiner system test
1.h.5	-	Not applicable
		This is not a design of the APR1400.
1.h.6	-	Not applicable
		This is not a design feature of the APR1400.
1.h.7	14.2.12.1.93	Reactor containment building HVAC system test
	14.2.12.1.94	Reactor containment purge HVAC system test
	14.2.12.1.95	Control room area HVAC system test
	14.2.12.1.98	Fuel handling area HVAC system test
	14.2.12.1.100	Balance of control room area HVAC system test
1.h.8	14.2.12.1.22	Safety injection tank subsystem test
	14.2.12.1.40	In-containment water storage system test
1.h.9	14.2.12.1.94	Reactor containment purge HVAC system test
1.h.10	14.2.12.1.69	Condensate system test
	14.2.12.1.75	Essential service water system test
1.h.11	-	Not applicable
		This is not a design feature of the APR1400
1.h.12	-	Not applicable
		This is not a design feature of the APR1400

Table 14.2-7 (6 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.i.1	14.2.12.1.119	Containment integrated leak rate test and structural integrity test
1.i.2	14.2.12.1.124	Containment isolation valves leakage rate test
1.i.3	14.2.12.1.124	Containment isolation valves leakage rate test
1.i.4	14.2.12.1.123	Containment electrical penetration assemblies test
1.i.5	14.2.12.1.122	Containment personnel airlock functional test and leak test
1.i.6	14.2.12.1.119	Containment integrated leak rate test and structural integrity test
1.i.7	-	Not applicable
		This is not a design feature of the APR1400.
1.i.8	14.2.12.1.129	Containment isolation valves test
1.i.9	14.2.12.1.94	Reactor containment purge HVAC system test
1.i.10	-	Not applicable
		This is not a design feature of the APR1400.
1.i.11	-	Not applicable
		This is not a design feature of the APR1400.
1.i.12	-	Not applicable
		This is not a design feature of the APR1400.
1.i.13	-	Not applicable
		This is not a design feature of the APR1400.
1.i.14	-	Not applicable
		This is not a design feature of the APR1400.
1.i.15	-	Not applicable
		This is not a design feature of the APR1400.
1.i.16	14.2.12.1.36	Control element drive mechanism cooling system test
	14.2.12.1.93	Reactor containment building HVAC system test
	14.2.12.1.94	Reactor containment purge HVAC system test
1.i.17	-	Not applicable
		This is not a design feature of the APR1400.
1.i.18	14.2.12.1.93	Reactor containment building HVAC system test
1.i.19	-	Not applicable
		This is not a design feature of the APR1400.

Table 14.2-7 (7 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.i.20	-	Not applicable
		This is not a design feature of the APR1400.
1.i.21	-	Not applicable
		This is not a design feature of the APR1400.
1.j.1	14.2.12.1.4	Pressurizer pressure and level control systems test
	14.2.12.1.53	Pre-core pressurizer performance test
1.j.2	14.2.12.1.30	Feedwater control system test
	14.2.12.1.34	Auxiliary feedwater system test
	14.2.12.1.68	Feedwater system test
1.j.3	14.2.12.1.29	Steam bypass control system test
	14.2.12.1.65	Main steam system test
1.j.4	-	Not applicable
		This is not a design feature of the APR1400.
1.j.5	14.2.12.1.9	Reactor Drain Tank Subsystem Test
	14.2.12.1.41	Internals Vibration Monitoring System Test
	14.2.12.1.42	Loose Parts Monitoring System Test
	14.2.12.1.43	Acoustic Leak Monitoring System Test
1.j.6	14.2.12.1.42	Loose parts monitoring system test
1.j.7	14.2.12.1.134	Leakage detection system test
	14.2.12.1.135	Leakage control and detection of system outside of containment
1.j.8	14.2.12.1.28	Reactor regulating system test
1.j.9	14.2.12.1.94	Reactor containment purge HVAC system test
1.j.10	14.2.12.1.127	Seismic monitoring instrumentation test
1.j.11	-	Not applicable
		This is not a design feature of the APR1400.
1.j.12	-	Not applicable
		This is not a design feature of the APR1400.
1.j.13	14.2.12.1.25	Ex-core neutron flux monitoring system test
	14.2.12.1.26	Fixed in-core nuclear signal channel test
1.j.14	14.2.12.1.23	Engineered safety features – component control system test

Table 14.2-7 (8 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.j.15	-	Not applicable
		This is not a design feature of the APR1400.
1.j.16	14.2.12.1.69	Condensate system test
1.j.17	14.2.12.1.68	Feedwater system test
	14.2.12.1.69	Condensate system test
	14.2.12.1.73	Heater drains system test
1.j.18	14.2.12.1.25	Ex-core neutron flux monitoring system test
1.j.19	14.2.12.1.48	Remote shutdown console test
1.j.20	14.2.12.1.134	Leakage detection system test
1.j.21	-	Not applicable
		This is not a design feature of the APR1400
1.j.22	14.2.12.1.130	Post-accident monitoring instrumentation test
1.j.23	14.2.12.1.101	Hydrogen mitigation system test
	14.2.12.1.102	Containment hydrogen recombiner system test
	14.2.12.1.130	Post-accident monitoring instrumentation test
1.j.24	14.2.12.1.23	Engineered safety features – component control system test
	14.2.12.1.24	Plant protection system test
1.j.25	-	Not Applicable
		This is not a design feature of the APR1400
1.j.26	14.2.12.1.76	Component Cooling Water System Test
	14.2.12.1.74	Chilled Water System Test
1.j.27	14.2.12.1.40	In-containment Water Storage System Test
1.j.28	14.2.12.1.85	Fire protection system test
1.j.29	14.2.12.1.27	Digital rod control system test
	14.2.12.1.28	Reactor regulating system test
	14.2.12.1.29	Steam bypass control system test
	14.2.12.1.30	Feedwater control system test
	14.2.12.1.31	Core operating limit supervisory system test
	14.2.12.1.32	Reactor power cutback system test
1.j.30	14.2.12.1.83	Process and Primary Sampling System Test
	14.2.12.1.106	Process and effluent radiological monitoring system test

Table 14.2-7 (9 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.j.31	14.2.12.1.31	Core operating limit supervisory system test
1.k.1	14.2.12.1.18	Process radiation monitor subsystem test
	14.2.12.1.106	Process and effluent radiological monitoring system test
	14.2.12.1.107	Area radiation monitoring system test
1.k.2	-	Exception
		The COL applicant is to develop the test program of personnel monitors and radiation survey instruments (COL 14.2(16)).
1.k.3	14.2.12.4.4	Reactor Coolant and Secondary Chemistry and Radiochemistry Test
1.k.4	14.2.12.1.94	Reactor containment purge HVAC system test
	14.2.12.1.95	Control room area HVAC system test
	14.2.12.1.98	Fuel handling area HVAC system test
	14.2.12.1.99	Compound building HVAC system test
1.k.5	14.2.12.1.57	Pre-core Reactor Coolant System Leak Rate Measurement
	14.2.12.1.134	Leakage detection system test
	14.2.12.1.106	Process and effluent radiological monitoring system test
1.k.6	14.2.12.1.18	Process radiation monitor subsystem test
	14.2.12.1.106	Process and effluent radiological monitoring system test
	14.2.12.1.107	Area radiation monitoring system test
1.k.7	14.2.12.1.18	Process radiation monitor subsystem test
	14.2.12.1.106	Process and effluent radiological monitoring system test
	14.2.12.1.107	Area radiation monitoring system test
1.1.1	14.2.12.1.135	Leakage control and detection of system outside of containment
1.1.2	14.2.12.1.135	Leakage control and detection of system outside of containment
1.1.3	14.2.12.1.135	Leakage control and detection of system outside of containment
1.1.4	14.2.12.1.135	Leakage control and detection of system outside of containment
1.1.5	14.2.12.1.135	Leakage control and detection of system outside of containment
1.1.6	-	Not applicable
		This is not a design feature of the APR1400.
1.1.7	14.2.12.1.57	Pre-core Reactor Coolant System Leak Rate Measurement
1.1.8	-	Not Applicable
		This is not a design feature of the APR1400

Table 14.2-7 (10 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.m.1	14.2.12.1.103	Liquid waste management system test
1.m.2	14.2.12.1.105	Gaseous waste management system test
1.m.3	-	Not Applicable
		This is not a design feature of the APR1400
1.m.4	14.2.12.1.104	Solid waste management system test
1.m.5	14.2.12.1.66	Steam generator blowdown system test
1.m.6	14.2.12.1.67	Main condenser and condenser vacuum systems test
1.m.7	14.2.12.1.94	Reactor containment purge HVAC system test
	14.2.12.1.95	Control room area HVAC system test
	14.2.12.1.98	Fuel handling area HVAC system test
	14.2.12.1.132	Auxiliary building controlled area HVAC system test
1.m.8	14.2.12.1.103	Liquid waste management system test
1.m.9	14.2.12.1.103	Liquid Waste Management System Test
	14.2.12.1.104	Solid Waste Management System Test
1.m.10	14.2.12.1.83	Process and Primary Sampling System Test
1.m.11	14.2.12.1.103	Liquid Waste Management System Test
	14.2.12.1.104	Solid Waste Management System Test
1.m.12	14.2.12.1.103	Liquid Waste Management System Test
	14.2.12.1.104	Solid Waste Management System Test
1.n.1	14.2.12.1.77	Spent fuel pool cooling and cleanup system test
	14.2.12.1.107	Area radiation monitoring system test
1.n.2	14.2.12.1.33	Fuel storage and handling system test
1.n.3	14.2.12.1.77	Spent fuel pool cooling and cleanup system test
1.n.4	14.2.12.1.33	Fuel storage and handling system test
1.n.5	14.2.12.1.33	Fuel storage and handling system test
1.n.6	14.2.12.1.98	Fuel handling area HVAC system test
1.n.7	14.2.12.1.33	Fuel storage and handling system test
1.n.8	14.2.12.1.33	Fuel storage and handling system test
1.0.1	14.2.12.1.75	Essential service water system test
1.0.2	14.2.12.1.78	Turbine generator building closed cooling water system test

Table 14.2-7 (11 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.0.3	14.2.12.1.74	Chilled water system test
	14.2.12.1.76	Component cooling water system test
1.0.4	14.2.12.1.13	Reactor makeup subsystem test
1.0.5	14.2.12.1.52	Pre-core reactor coolant and secondary water chemistry data
	14.2.12.1.83	Process sampling system test
1.0.6	14.2.12.1.7	Chemical and volume control system charging subsystem test
	14.2.12.1.66	Steam generator blowdown system test
1.0.7	14.2.12.1.85	Fire protection system test
1.0.8	14.2.12.1.7	Chemical and volume control system charging subsystem test
1.0.9	14.2.12.1.10	Equipment drain tank subsystem test
	14.2.12.1.103	Liquid waste management system test
1.0.10	14.2.12.1.5	Chemical and volume control system letdown subsystem test
1.0.11	14.2.12.1.82	Compressed air system test
1.0.12	14.2.12.1.15	Boric acid concentrator subsystem test
1.0.13	14.2.12.1.154	Plant communication systems test
		Exception
		The COL applicant is to prepare the site-specific preoperational and
		offsite communication system (COL 14.2(17))
1.o.14.a	14.2.12.1.132	Auxiliary building controlled area HVAC system test
1.o.14.b	14.2.12.1.93	Reactor containment building HVAC system test
	14.2.12.1.94	Reactor containment purge HVAC system test
1.o.14 .c	14.2.12.1.131	Electrical and I&C equipment room area HVAC systems test
1.o.14 .d	14.2.12.1.97	Emergency diesel generator area HVAC system test
1.o.14 .e	14.2.12.1.93	Reactor containment building HVAC system test
	14.2.12.1.94	Reactor containment purge HVAC system test
	14.2.12.1.96	Turbine generator building HVAC system test
	14.2.12.1.99	Compound building HVAC system test
	14.2.12.1.133	Auxiliary building clean area HVAC system test
1.o.14 .f	14.2.12.1.95	Control room area HVAC system test
	14.2.12.1.100	Balance of control room area HVAC system test

Table 14.2-7 (12 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
1.o.14 .g		Exception
		The COL applicant is to prepare the pre-operational test of ultimate heat sink pump house (COL 14.2(18))
1.o.14 .h	14.2.12.1.98	Fuel Handling Area HVAC System Test
1.0.15	-	Not applicable This is not a design feature of the APR1400.
1.0.16	-	Not applicable This is not a design feature of the APR1400.
1.0.17	-	Not applicable This is not a design feature of the APR1400.
1.0.18	14.2.12.1.84	Heat tracing system test
1.0.19	14.2.12.1.81	Emergency Lighting System Test
1.0.20	14.2.12.4.4	Reactor Coolant and Secondary Chemistry and Radiochemistry Test
1.0.21	-	Not Applicable
		This is not a design feature of the APR1400
1.0.22	-	Not Applicable
		This is not a design feature of the APR1400
1.0.23	-	Not Applicable This is not a design feature of the APP 1400
1 0 24		Not Applicable
1.0.24	-	This is not a design feature of the APR1400
1.0.25	14.2.12.1.120	Fuel Transfer Tube Functional Test and Leak Test
1.0.26	14.2.12.1.7	Chemical and Volume Control System Charging Subsystem Test
1.p.1	14.2.12.1.91	Containment polar crane test
	14.2.12.1.92	Fuel handling area cranes test
1.p.2	14.2.12.1.91	Containment polar crane test
	14.2.12.1.92	Fuel handling area cranes test
1.p.3	14.2.12.1.91	Containment polar crane test
	14.2.12.1.92	Fuel handling area cranes test
1.p.4	14.2.12.1.91	Containment polar crane test
	14.2.12.1.92	Fuel handling area cranes test

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RG 1.68	Subsection #	Individual Test
AFF. A		
1.p.5	14.2.12.1.91	Containment polar crane test
	14.2.12.1.92	Fuel handling area cranes test
1.p.6	14.2.12.1.91	Containment polar crane test
	14.2.12.1.92	Fuel handling area cranes test
1.p.7	14.2.12.1.91	Containment polar crane test
	14.2.12.1.92	Fuel handling area cranes test
2.a	14.2.12.2.1	Initial Fuel Loading
2.b	14.2.12.2.5	Post-core control element drive mechanism performance
2.c	14.2.12.1.24	Plant protection system test
	14.2.12.2.5	Post-core control element drive mechanism performance
2.d	14.2.12.2.8	Post-core reactor coolant system leak rate measurement
2.e	14.2.12.2.2	Post-core hot functional test controlling document
	14.2.12.2.6	Post-core reactor coolant and secondary water chemistry data
2.f	14.2.12.2.3	NSSS integrity monitoring system (post-core)
	14.2.12.2.4	Reactor coolant system flow measurements
	14.2.12.2.11	Post-core acoustic leak monitor system test
2.g	14.2.12.3.1	Initial Criticality
2.h	14.2.12.2.9	Post-core in-core instrumentation test
3	14.2.12.3.1	Initial Criticality
4.a	14.2.12.3.3	Isothermal temperature coefficient test
	14.2.12.3.6	Critical boron concentration test
4.b	14.2.12.3.4	Shutdown and regulating CEA group worth test
4.c	14.2.12.2.10	Post-core instrument correlation
	14.2.12.3.1	Initial Criticality
4.d	14.2.12.2.10	Post-core instrument correlation
	14.2.12.1.24	Plant protection system test
4.e	14.2.12.4.10	Steady-state core performance test
	14.2.12.4.17	Core operating limit supervisory system verification
	14.2.12.4.9	Biological shield survey test
4.f	14.2.12.1.106	Process and effluent radiological monitoring system test

Table 14.2-7 (14 of 18)

RG 1.68 APP. A	Subsection #	Individual Test	
4.g	14.2.12.4.4	Reactor coolant and secondary chemistry and radiochemistry test	1
4.h	14.2.12.4.9	Biological shield survey test	
4.i	14.2.12.1.27	Digital rod control system test	Ì
	14.2.12.1.54	Pre-core control element drive mechanism performance test	
	14.2.12.2.5	Post-core control element drive mechanism performance	
4.j	14.2.12.4.21	HVAC capability test	
4.k	14.2.12.1.34	Auxiliary feedwater system test	Ì
	14.2.12.1.62	Main turbine systems test	
4.1	14.2.12.1.64	Main steam isolation valves and MSIVBVs test	
4.m	-	Not applicable	
		This is not a design feature of the APR1400.	
4.n	14.2.12.4.3	Control systems checkout test	
	14.2.12.4.11	Intercomparison of plant protection system, core protection calculator, information processing system, and qualified information and alarm system inputs	
4.0	14.2.12.2.5	Post-core control element drive mechanism performance	
4.p	14.2.12.1.3	Pressurizer pilot-operated safety relief valve test	
	14.2.12.1.63	Main steam safety valve test	
4.q	14.2.12.1.5	Chemical and volume control system letdown subsystem test	
	14.2.12.1.7	Chemical and volume control system charging subsystem test	
4.r	14.2.12.1.20	Shutdown cooling system test	
	14.2.12.1.65	Main steam system test	
4.s	-	Exception	
		Reactor internal vibration test is excluded from the comprehensive vibration assessment program described in Subsection 3.9.2.4 since APR1400 is classified as non-prototype category I plant according to NRC RG 1.20 (Reference 9).	
4.u	14.2.12.4.3	Control systems checkout test	1
5.a	14.2.12.4.1	Variable Tavg (isothermal temperature coefficient and power coefficient) test	

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RG 1.68		
APP. A	Subsection #	Individual Test
5.b	14.2.12.4.10	Steady-state core performance test
	14.2.12.4.12	Verification of core protection calculator power distribution related constants test
5.c	-	Not applicable
		This is not a design feature of the APR1400.
5.d	14.2.12.4.2	Unit load transient test
	14.2.12.4.14	Core protection calculator verification
	14.2.12.4.17	Core operating limit supervisory system verification
5.e	14.2.12.4.25	Pseudo dropped CEA test
5.f	14.2.12.1.27	Digital rod control system test
	14.2.12.2.5	Post-core control element drive mechanism performance
5.g	14.2.12.2.5	Post-core control element drive mechanism performance
5.h	-	Not applicable
		This is not a design feature of the APR1400.
5.i	14.2.12.4.2	Unit load transient test
	14.2.12.4.6	Unit load rejection test
5.j	14.2.12.1.21	Safety injection system test
	14.2.12.1.22	Safety injection tank subsystem test
	14.2.12.1.59	Pre-core safety injection check valve test
5.k	14.2.12.4.7	Shutdown from outside the main control room test
	14.2.12.4.13	Feedwater and auxiliary feedwater system test
	14.2.12.4.15	Main steam atmospheric dump and turbine bypass valve test
5.1	14.2.12.2.4	Reactor coolant system flow measurements
5.m	14.2.12.4.18	NSSS integrity monitoring system
	14.2.12.4.26	Fatigue monitoring system test
5.n	14.2.12.2.11	Post-core acoustic leak monitor system test
5.0	-	Exception
		Reactor internal vibration test is excluded from the comprehensive vibration assessment program described in Subsection 3.9.2.4 since the APR1400 is classified as non-prototype category I plant according to NRC RG 1.20 (Reference 9).
5.p	-	Not applicable
		This is not a design feature of the APR1400.

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RG 1.68		
APP. A	Subsection #	Individual Test
5.q	14.2.12.4.3	Control systems checkout test
	14.2.12.4.14	Core protection calculator verification
	14.2.12.4.17	Core operating limit supervisory system verification
5.r	14.2.12.4.1	Variable Tavg (isothermal temperature coefficient and power coefficient) test
	14.2.12.4.3	Control systems checkout test
	14.2.12.4.8	Loss of offsite power test
	14.2.12.4.13	Feedwater and auxiliary feedwater system test
5.s	14.2.12.1.3	Pressurizer pilot-operated safety relief valve test
	14.2.12.1.63	Main steam safety valve test
	14.2.12.4.5	Turbine trip test
	14.2.12.4.15	Main steam atmospheric dump and turbine bypass valve test
5.t	14.2.12.4.15	Main steam atmospheric dump and turbine bypass valve test
5.u	-	Exception
		The turbine trip test from full power results in essentially similar dynamic plant response and should provide reasonable assurance that primary and secondary safety valves do not lift open during the test. For these reasons, the plant response to automatic closure of all MSIVs from full power is not demonstrated.
5.v	14.2.12.4.2	Unit load transient test
	14.2.12.4.5	Turbine trip test
	14.2.12.4.13	Feedwater and auxiliary feedwater system test
5.w	14.2.12.4.20	Penetration temperature survey test
5.x	14.2.12.4.21	HVAC capability test
5.y	14.2.12.4.3	Control systems checkout test
	14.2.12.4.11	Intercomparison of plant protection system, core protection calculator, information processing system, and qualified information and alarm system inputs
	14.2.12.4.12	Verification of CPC power distribution related constants test
	14.2.12.4.14	Core protection calculator verification
	14.2.12.4.16	In-core detector test
	14.2.12.4.17	Core operating limit supervisory system verification
	14.2.12.4.27	Ex-core neutron flux monitoring system calibration

Table 14.2-7 (17 of 18)

RG 1.68		
APP. A	Subsection #	Individual Test
5.z	14.2.12.1.18	Process radiation monitor subsystem test
	14.2.12.1.19	Gas stripper effluent radiation monitor subsystem test
5.aa	14.2.12.4.4	Reactor coolant and secondary chemistry and radiochemistry test
5.bb	14.2.12.4.9	Biological shield survey test
5.cc	14.2.12.4.22	Liquid waste management system test
	14.2.12.4.23	Gaseous waste management system test
5.dd	14.2.12.4.7	Shutdown from outside the main control room test
5.ee	14.2.12.4.21	HVAC capability test
5.ff	14.2.12.4.21	HVAC capability test
5.gg	14.2.12.1.49	Diverse protection system test
5.hh	14.2.12.4.2	Unit load transient test
5.ii	14.2.12.4.8	Loss of offsite power test
5.jj	14.2.12.4.8	Loss of offsite power test
5.kk	-	Exception
		Performance of the load rejection test and turbine trip test from full power provides sufficient information to verify design adequacy. Therefore, the plant response to reduction in feedwater temperatures is not demonstrated.
5.11	14.2.12.4.5	Turbine trip test
5.mm	-	Exception The turbine trip test from full power results in essentially similar dynamic plant response and should provide reasonable assurance that primary and secondary safety valves do not lift open during the test. For these reasons, the plant response to automatic closure of all MSIVs from full power is not demonstrated.
5.nn	14.2.12.4.6	Unit load rejection test
5.00	14.2.12.1.51	Pre-core reactor coolant system expansion measurements
	14.2.12.1.117	Balance-of-plant piping thermal expansion measurement test
	14.2.12.1.118	Balance-of-plant piping vibration measurement test
5.pp	-	Exception
		The COL applicant is to prepare the testing of ultimate heat sink cooling chains (COL 14.2(19))

Table 14.2-7 (18 of 18)

RG 1.68 APP. A	Subsection #	Individual Test
5.qq	-	Exception The COL applicant is to prepare the verification of ultimate heat sink cooling chains (COL 14.2(19))
5.rr	14.2.12.1.109 14.2.12.1.108	480 V class 1E auxiliary power system test 4,160 V class 1E auxiliary power system test
5.ss	14.2.12.4.6	Unit load rejection test

14.3 Inspections, Tests, Analyses, and Acceptance Criteria

The APR1400 Design Control Document (DCD) contains Tier 1 and Tier 2 information and generic Technical Specifications that are incorporated by reference into the Design Certification rules.

This section provides the bases, processes, and selection criteria used to develop Tier 1 information including a description of the Tier 1 chapters and their development.

Tier 1 contains the principal design characteristics; site parameters; interface requirements; and inspections, tests, analyses, and acceptance criteria (ITAAC) that are certified through a process established by the Atomic Energy Act (AEA) and U.S. Nuclear Regulatory Commission (NRC) regulations.

The type of information and level of detail in Tier 1 are based on a graded approach commensurate with the safety significance of the structures, systems, and components (SSCs) for the design. The top-level information selected for Tier 1 includes a description of the principal performance characteristics and safety functions of the SSCs, which are verified by the ITAAC.

The APR1400 design information in Tier 1 is derived from the more detailed design information in Tier 2. Tier 1 contains the significant design information and reflects the tiered approach to Design Certification that is to be endorsed by the NRC.

Tier 1 includes:

- a. Definitions of terms used in Tier 1 and general provisions
- b. Design descriptions
- c. ITAAC
- d. Significant site parameters
- e. Significant interface requirements

The information in this section (Section 14.3) is in accordance with the NRC guidance in NRC Regulatory Guide (RG) 1.206 (Reference 1) and NUREG-0800, Standard Review Plan (SRP), Section 14.3 (Reference 2).

Tier 1 is divided into three chapters, as follows:

- a. Chapter 1: Introduction
- b. Chapter 2: Design Descriptions and ITAAC
- c. Chapter 3: Interface Requirements

The guidance used to develop the Tier 1 chapters is provided in the following subsections.

14.3.1 <u>Tier 1, Chapter 1: Introduction</u>

Chapter 1 of Tier 1 (Introduction) includes definitions of terms, the general provisions that are applicable to all Tier 1 entries, and an explanation of how the ITAAC are presented.

This subsection explains the selection criteria and methodology used to develop the definitions, general provisions, and figure legend and abbreviations that are used to prepare Tier 1.

The item numbers in Tier 1 tables are not the part of certified design.

14.3.1.1 Definitions

Chapter 1 contains definitions of terms that are used in Tier 1.

Selection Criteria

Terms are selected if they had the potential to be interpreted differently, needed to have the context in which the term would be used, and are judged to merit a definition, with an emphasis on terms associated with the implementation of the ITAAC.

Selection Methodology

The terms defined in this subsection were selected based on the perceived need to state the context in which the term was to be used. The terms were identified during the preparation and review of Tier 1.

Example Entries

"as-built," "division," and "type test."

14.3.1.2 <u>General Provisions</u>

Chapter 1 contains the general provisions that apply to Tier 1.

Selection Criteria

Provisions that are selected on the basis of necessity to (a) define technical requirements applicable to the systems that are described in Tier 1 or (b) provide clarification and guidance for the implementation of Tier 1.

Selection Methodology

Entries that are developed during the preparation of Tier 1. Entries provide the general requirements, guidelines, or interpretations that are intended to be applied to Tier 1.

Example Entries

Guidance on the interpretation of figures in Tier 1 and the scope of system configuration checks that are specified in ITAAC entries.

14.3.1.3 Figure Legend and Abbreviation List

The figure legend and abbreviation list are provided as an aid to the Tier 1 reader.

14.3.2 <u>Tier 1, Chapter 2: Design Descriptions and ITAAC</u>

Chapter 2 of Tier 1 (Design Descriptions and ITAAC) contains the design description and ITAAC material for every system that is either fully or partially in the scope of the APR1400 design certification. The intent of this comprehensive list of the APR1400 systems is to define, at the Tier 1 level, the scope of the certified design.

This subsection provides the Chapter 2 organization, the selection criteria and methodology of design descriptions, and the ITAAC that are used to prepare Tier 1.

The guidance for developing the ITAAC in accordance with NRC RG 1.206 (Reference 1) and SRP 14.3 (Reference 2) is described in the following subsections.

The organization of Chapter 2 is the same as SRP 14.3 to facilitate NRC staff review, as follows:

Standard Review Plan			
Section	Title	Section	
14.3.1 (Reference 3)	Site Parameters	2.1	
14.3.2 (Reference 4)	Structural and Systems Engineering	2.2	
14.3.3 (Reference 5)	Piping Systems and Components	2.3	
14.3.4 (Reference 6)	Reactor Systems	2.4	
14.3.5 (Reference 7)	Instrumentation and Controls	2.5	
14.3.6 (Reference 8)	Electrical Systems	2.6	
14.3.7 (Reference 9)	Plant Systems	2.7	
14.3.8 (Reference 10)	Radiation Protection	2.8	
14.3.9 (Reference 11)	Human Factors Engineering	2.9	
14.3.10 (Reference 12)	Emergency Planning	2.10	
14.3.11 (Reference 13)	Containment Systems	2.11	
14.3.12 (Reference 14)	Physical Security Hardware	2.12	

Design Descriptions

The design description for the APR1400 systems addresses the most significant design features and the performance standards that pertain to the safety of the plant and include descriptive text and supporting figures. The intent of the Tier 1 design descriptions is to define the APR1400 design characteristics.

Selection Criteria

The following criteria were considered in determining which information warranted inclusion in the certified design descriptions:

- a. The information in the certified design descriptions is to be derived only from the technical information presented in Tier 2. This reflects the approach that Tier 1 contains the most significant design information.
- b. The certified design descriptions contain only information from Tier 1 that is most significant to safety; Tier 2 contains a wide spectrum of information on various aspects of the APR1400 design, and not all this information warrants inclusion in the certified design descriptions. In determining what information is most significant to safety, several factors are considered, including the following:

- Whether the feature or function in question is necessary to satisfy 10 CFR Part 20 (Reference 33), 50 (Reference 15), 52 (Reference 16), 73 (Reference 17), and 100 (Reference 18)
- 2) Whether the feature or function in question pertains to a safety-related structure, system, or component
- 3) Whether the feature or function in question is specified in the SRP as being necessary to perform a safety-significant function
- 4) Whether the feature or function in question represents an important assumption or insight from the probabilistic risk assessment (PRA)
- 5) Whether the feature or function in question is important in preventing or mitigating severe accidents
- 6) Whether the feature or function in question has had a significant impact on the safety or operation of existing nuclear power plants
- 7) Whether the feature or function in question is typically the subject of a provision in the Technical Specifications

The absence or existence of any 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, are taken into account in making this determination.

- c. In general, only the safety-related features and functions of SSCs are discussed in the certified design descriptions. SSCs that are not classified as safety-related are discussed in the certified 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 SSCs. This criterion follows from the principle that only features and functions that are safety-significant warrant treatment in the certified design. Non-safety-significant features and functions of safety-related SSCs are not generally discussed in the certified design descriptions.
- d. In general, the certified design descriptions for SSCs are limited to a statement of design features and functions. The design bases of SSCs, and explanations of

their importance to safety, are provided in Tier 2 and are not included in the certified design descriptions. The purpose of 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; however, the descriptions do not provide information that demonstrates these flow capacities are sufficient to maintain post-accident fuel clad temperatures.

- e. The certified design descriptions focus on the physical characteristics of the facility. The certified 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.
- f. The certified design descriptions in Tier 1 discuss the configuration and performance characteristics that the SSCs should have after construction is completed.

In general, the certified design descriptions do not discuss the processes that are used for designing and constructing a plant that references the APR1400 design certification. This is acceptable because the safety performance of an SSC is demonstrated by appropriate inspections, tests, and analyses of the as-built SSCs. Exceptions to this criterion are:

g. The welding, dynamic qualification (including seismic and other design bases dynamic loads), environmental qualification, and valve testing requirements.

In addition, the programmatic aspects of the design and construction processes (e.g., training, quality assurance, qualification of welders) are part of the licensee's programs and are subject to commitments made at the time of COL issuance. These issues are therefore not addressed in Tier 1.

h. In general, the certified 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 operation-related programs. Because 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, and control element assemblies (CEAs). These components are discussed in the certified 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 APR1400 certified design.

- The certified APR1400 design descriptions do not 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 types/manufacturers 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, when the type of component is of safety significance.
- j. The design descriptions do not contain any proprietary information.
- k. The design description is intended to be self-contained and does not make direct reference to Tier 2, industrial standards, regulatory requirements, or other documents. (The ASME Code is an exception and is referenced in some systems, including the reactor pressure vessel and containment). 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 confusion regarding how much of a referenced document is encompassed in and becomes part of Tier 1.
- 1. Selection of the technical terminology to be used in Tier 1 was guided by the principle that the technical 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 used to minimize misinterpretations of the intent of Tier 1 commitments.

The initial test program (ITP) defines testing activities that are conducted following completion of construction and construction-related inspections and tests. The ITP extends through to the start of commercial operation of the facility. The ITP is defined in Section 14.2 of Tier 2. The testing specified in ITAAC is a subset of the ITP.

The ITP has been included in Tier 1 because of the importance of the ITP in defining comprehensive testing in accordance with detailed procedures and administrative controls for the as-built facility to demonstrate conformance with the design certification.

No ITAAC entries are necessary in Tier 1 for the ITP. This is acceptable because:

- m. The ITP activities that involve testing with the reactor containing fuel or conducted at various power levels cannot be completed prior to fuel load.
- n. Testing activities specified as part of the ITAAC in Tier 1 must be performed prior to fuel loading. Because the ITAAC addresses the design features and characteristics of key safety significance, additional ITAAC assigned to ITP are not necessary to provide reasonable assurance that the as-built plant conforms to the certified design.

Selection Methodology

Using the criteria listed above, design description material is developed for each system by reviewing Tier 2 material relating to that system.

Of particular importance was the review of the sections of Tier 2 that document plant safety evaluations showing acceptable plant performance. Detailed reviews are conducted of the following: the flooding analyses in Chapter 5, analysis of overpressure protection in Chapter 5, containment analyses in Chapter 6, core cooling analyses in Chapters 6 and 15, analysis of fire protection in Chapter 9, safety analysis of transients and anticipated transients without scram (ATWS) in Chapter 15, radiological analyses in Chapter 15, resolution of unresolved or generic safety issues and Three Mile Island issues in Chapters 1 and 20, and the PRA and severe accident information in Chapter 19. These reviews are a key factor in identifying the important, safety-related system design information warranting discussion in the design descriptions.

Example Entries: Because the safety significance of the APR1400 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 types of APR1400 systems are listed below along with a summary of the consequences of this graded treatment:

System Type	Scope of Certified 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., turbine generator contribution to station blackout event sequence)	Brief discussion of design features and performance characteristics affecting the safety of the plant's response to the event(s)	
Non-safety-related systems potentially impacting safety (e.g., containment hydrogen control system)	Brief discussions of design features that prevent or mitigate the potential safety concern	
Non-safety-related systems that affect overall plant design (e.g., chemical and volume control 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., turbine building closed cooling water system)	Limited description of system features	

For safety-related systems, application of the selection criteria described above resulted in design description entries that include the following information, as applicable: name and scope of the system; purpose; safety-related modes of operation; system classification (i.e., safety-related, seismic category, and ASME Code Class); location; basic configuration of safety-significant components (usually shown by means of a figure); type of electrical power provided; the electrical independence and physical separation of divisions within the system; important instruments, controls, and alarms located in the main control room; identification of Class 1E electrical equipment qualified for its intended environment; motor-operated valves that have an active safety-related function; and other functions that are significant to safety.

The 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 has significance to safety. Since much of this information is not relevant to non-safety-related systems, the certified design descriptions for non-safety-related systems are generally substantially less extensive than the descriptions for safety-related systems.

Inspections, Tests, Analyses, and Acceptance Criteria

A table of ITAAC entries is generally provided for each system containing design description entries. The intent of these ITAAC is to define activities that are used to verify

that the as-built system conforms to the design features and characteristics defined in the corresponding Tier 1 design description for that system. A three-column table format is used to specify the design commitment; inspections, tests, and analyses; and acceptance criteria for each ITAAC. Each design commitment in the left-hand column of the ITAAC has one or more associated inspection, test, or analysis (ITA) requirements specified in the middle column. The acceptance criteria for the ITA are defined in the right column.

Selection Criteria

The following criteria are considered when determining which information warranted inclusion in the ITAAC entries:

- a. The scope and content of the ITAAC correspond to the scope and content of the certified design descriptions. There are no ITAAC for those aspects of the design that are 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 design descriptions.
- b. With only a few special-case exceptions (e.g., initial test program), the APR1400 system has a design description text and an ITAAC table with one or more entries. This reflects the assessment that, in general, design features meriting a Tier 1 description also merit an ITAAC entry to verify that the feature has been included in the as-built facility.
- c. One inspection, test, or analysis may verify one or more provisions in the certified design description. In particular, an ITAAC that calls for a system functional test or an inspection of basic configuration may verify a number of provisions in a certified design description. Therefore, there is not necessarily a one-to-one correspondence between the ITAAC and the certified design descriptions. Each COL applicant is responsible for demonstrating that the as-built facility conforms with the ITAAC. However, in certain circumstances, documentation that verifies conformance of an inspection, test, or analysis at one plant may be used as a basis to demonstrate conformance at one or all subsequent plants without repeating that inspection, test, or analysis, for example, type testing of valves if the requirements for the valves have not changed.

- d. As required by 10 CFR 52.103(g) (Reference 19), the inspections, tests, and analyses must be completed and the acceptance criteria satisfied prior to fuel loading. Therefore, the ITAAC do not include inspections, tests, or analyses that are dependent upon conditions that only exist after fuel load.
- e. In general, the ITAAC verify the as-built configuration and performance characteristics of SSCs as identified in Tier 1 design descriptions. With limited exceptions (e.g., welding), the ITAAC do not address typical construction processes for the reasons discussed in item (f) of Subsection 14.3.2.

Selection Methodology

Using the preceding selection criteria, ITAAC table entries are developed for each system. This was achieved by evaluating the design features and performance characteristics defined in the Tier 1 design description and preparing an ITAAC table entry for each design description entry that satisfied the selection criteria. As a result of this process, there is a close correlation 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 (a test, an inspection, or an analysis [ITA] or a combination of inspection, test, and analysis) and the acceptance criteria (AC) against which the as-built feature or functional performance is measured.

The emphasis when selecting an ITAAC verification method is placed on using in-situ testing in the as-built facility when possible. Selection of the verification method was dependent upon the plant feature to be verified but was guided by the following:

- 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 SSC condition to one or more design description commitments.
- Test To be used when verification can be accomplished in a practical manner by the actuation or operation, or establishment of specified conditions, to evaluate the performance or integrity of the as-built SSCs. 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 SSCs. (In this case, engineering or technical evaluations could include, but are not limited to, comparisons with operating experience or design of similar SSCs.)

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, Chapter 14 test abstracts contain specific testing descriptions related to ITAAC. This information is not referenced in Tier 1 and is not part of Tier 1; it is considered to provide 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 based upon Tier 1 design description. For many of the 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 minimizes 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 parameters from Tier 2 that are not specifically identified in Tier 1 design descriptions.

Also, in some cases, 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. This material is not considered as part of Tier 1 but does provide one of potentially several methods for satisfying the ITAAC. Ranges, limits, and/or tolerances are included for numerical AC. This is necessary and acceptable because:

a. Specification of a single-value AC is impractical because minute/trivial deviations would represent nonconformance.

- b. Tolerances recognize that as-built variations can occur that do not affect function or performance.
- c. Minor variations within the tolerance bounds have no impact on plant safety.

14.3.2.1 ITAAC for Site Parameters

Section 2.1 of Tier 1 provides the site parameters that are used as a basis for the design defined in the APR1400 design certification application in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 2.0 (Reference 3). The proposed plant must be designed and built based on this parametric information. Furthermore, it is intended that applicants referencing the APR1400 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.

Although the site parameters for certified designs are included in Tier 1, no ITAAC are developed for the site parameters.

14.3.2.2 ITAAC for Structural and Systems Engineering

Section 2.2 of Tier 1 involves building structures and structural aspects of major components, such as the reactor pressure vessel (RPV), pressurizer, and steam generator.

ITAAC are developed for structures and systems and group them by systems and building structures in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP Subsection 14.3.2 (Reference 4).

The scope of structural design covers the major structural systems in the APR1400 standard design facility, including the RPV; Class 1, 2, and 3 piping systems defined by the ASME Code; and major building structures of the APR1400 standard design. Using the General Design Criteria (GDC) specified in Appendix A to 10 CFR Part 50 (Reference 20), the ITAAC verify the following design attributes for the major structures and systems in the APR1400 standard design facility:

a. Pressure boundary integrity (GDC 14, GDC 16, and GDC 50)

- b. Normal loads (GDC 2)
- c. Seismic loads (GDC 2)
- d. Suppression pool hydrodynamic loads (GDC 4)
- e. Flood, wind, and tornado (GDC 2)
- f. Rain and snow (GDC 2)
- g. Pipe ruptures (GDC 4)
- h. Codes and standards (GDC 1)
- i. Site proximity missiles and externally generated missiles
- j. Aircraft hazards

14.3.2.3 ITAAC for Piping Systems and Components

Section 2.3 of Tier 1 involves piping system and components and includes piping stress analysis, analysis of protection against the dynamic effects of pipe rupture, evaluations of leak-before-break(LBB), and analysis of component stress in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.3 (Reference 5).

The scope of piping systems and components covers piping design criteria, structural integrity, and functional capability of ASME code Class 1,2 and 3 piping systems included in the APR1400 design. A graded approach is taken to the scope of piping systems and components design. More of the ASME code Class 1 piping systems and components are designed than Class 2 and 3 due to their high safety significance. The ASME Code Class 1 piping systems include RCS main loops, pressurizer surge line and thirteen piping subsystems of RCS branch piping which include four DVI lines, two SC lines, and four RCS drain lines (letdown, charging, RG and spray lines). The scope of design for ASME code Class 1 piping, i.e., the direct vessel injection line (12 inch) and shutdown cooling line (16 inch). The other branch line over 2.5 inches includes pressurizer spray line (4 inch). This line is smaller in size and has no significant impact to RCS integrity. Out of the four direct vessel injection lines, only one line for each system is analyzed as a representative case.

scope of design for ASME code Class 2 and 3 piping includes main steam and main feedwater piping located inside the containment building. Main steam and main feedwater piping is the largest ASME Class 2 and 3 piping connected to the steam generators and has the highest structural load. The other major Class 2 and 3 piping of concern is SG blowdown piping (4 inch). However, this piping is connected to the SG at around the same elevation as the main feedwater piping (economizer line, 14 inch) and has much less impact to the SG. The scope of design for main steam and main feedwater piping outside the containment building covers piping from the containment penetration anchors to the main steam valve house (MSVH) penetration anchors beyond the isolation valves, which are located in the break exclusion area in the auxiliary building. In addition, the scope includes analysis methods, modeling techniques, pipe stress analysis criteria, pipe support design criteria, high-energy line break criteria, and the leak-before-break (LBB) approach, as applicable to the APR1400 design. Graded approach is also taken to the scope of piping hazards analysis and LBB analysis. Piping hazards analysis includes main steam and main feedwater piping inside the containment building since it is most safety significant in terms of pipe break hazard as well as impact on the RCS structural analysis. LBB analysis includes pressurizer surge line as a representative case in consideration of the thermal stratification expected during the normal operation.

RG 1.207 provides two distinct methods for incorporating LWR environmental effects into the fatigue analysis of ASME Class 1 piping systems and components. The first method involves developing new fatigue curves that are applicable to LWR environments. Given that the fatigue life of ASME Class 1 piping systems and components in LWR environments is a function of several parameters, this method necessitates the development of several fatigue curves to address potential parameter variations. Alternatively, a single bounding fatigue curve could be developed. This second method involves using an environmental correction factor (F_{en}) to account for LWR environments by correcting the fatigue usage calculated with the ASME "air" curves. The second method is used to meet this requirement.

As-built ITAAC are developed to verify the following:

a. A report that documents the results of an as-built reconciliation confirming that the piping systems have been constructed in accordance with ASME Section III requirements

- b. The welding quality of as-built pressure boundary welds for ASME Class 1, 2, and 3 SSCs
- c. The pressure integrity of ASME Code Class 1, 2, and 3 SSCs by specifying hydrostatic testing
- d. The dynamic qualification records (e.g., seismic, loss-of-coolant accident [LOCA], and pilot-operated safety relief valve [POSRV] discharge loads) of seismic Category I mechanical and electrical equipment (including connected instrumentation and control [I&C]) and associated equipment anchorages
- e. The vendor test records that demonstrate the ability of pumps, valves, and dynamic restraints to function under design conditions
- f. In-situ testing and functional design and qualification records that installed pumps, valves, and dynamic restraints have the capability to perform their intended functions under expected ranges of fluid flow, differential pressure, electrical conditions, and temperature conditions up to and including design basis conditions
- g. An LBB evaluation report that demonstrates that the as-built piping and piping materials comply with the LBB acceptance criteria

These as-built ITAAC are covered in each system ITAAC such as Sections 2.4, 2.6, 2.7, and 2.11 of Tier 1.

14.3.2.4 ITAAC for Reactor Systems

Section 2.4 of Tier 1 includes RCS, In-containment Water Storage System, SIS, SCS, RCGVS, CVCS and leak detection system in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), SRP 14.3.4 (Reference 6), and the ITAAC for reactor systems that have been developed to verify the following:

- a. Important input parameters used in the transient and accident analyses for the facility design
- b. Net positive suction head for key pumps
- c. Design pressures of the piping systems that interface with the reactor coolant boundary to validate intersystem LOCA analyses

- d. The following top-level design aspects of the reactor systems:
 - 1) Functional arrangement
 - 2) Seismic and ASME Code classification
 - 3) Weld quality and pressure boundary integrity
 - 4) Valve qualification and operation
 - 5) Controls, alarms, and displays
 - 6) Logic and interlocks
 - 7) Equipment qualification for harsh environments
 - 8) Interface requirements with other systems
 - 9) Numeric performance values
 - 10) Class 1E electrical power sources and divisions, if applicable
 - 11) System operation in various modes

14.3.2.5 ITAAC for Instrumentation and Controls

Section 2.5 of Tier 1 addresses I&C involving reactor protection and control, engineered safety features actuation, reactivity control systems, other miscellaneous I&C systems, digital computers in I&C systems, and selected interface requirements related to I&C issues in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.5 (Reference 7). ITAAC for I&C are developed to address conformance with 10 CFR 50.55a(h) (Reference 22) and applicable sections of Institute of Electrical and Electronics Engineers (IEEE) Standard 603-1991 (Reference 23), as they pertain to safety systems. These ITAAC also address conformance with the following GDC set forth in 10 CFR Part 50 Appendix A (Reference 20):

- a. GDC 1 as it pertains to quality standards for design, fabrication, erection, and testing
- b. GDC 2 as it pertains to protection against natural phenomena

- c. GDC 4 as it pertains to environmental and dynamic effects
- d. GDC 13 as it pertains to I&C requirements
- e. GDC 19 as it pertains to control room requirements
- f. GDC 20 as it pertains to protection system design requirements
- g. GDC 21 as it pertains to protection system reliability and testability requirements
- h. GDC 22 as it pertains to protection system independence requirements
- i. GDC 23 as it pertains to protection system failure modes requirements
- j. GDC 24 as it pertains to separation of protection systems from control systems
- k. GDC 25 as it pertains to protection system requirements for reactivity control malfunctions
- 1. GDC 29 as it pertains to protection against anticipated operational occurrences (AOOs)

For documentation of a high-quality software design process, the I&C ITAAC also address the planning documentation, implementation documents, and software life-cycle process design output documents, as shown in Branch Technical Position BTP 7-14 (Reference 24) in SRP Chapter 7 (Reference 25).

14.3.2.6 <u>ITAAC for Electrical Systems</u>

Section 2.6 of Tier 1 involves the entire station electrical system, including Class 1E portions of the system, equipment qualification, major portions of the non-Class 1E system, and portions of the plant lightning, grounding, and lighting systems in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.6 (Reference 8).

ITAAC for electrical systems and equipment are developed to verify the following:

a. Equipment qualification for seismic and harsh environments

- 1) To verify that Class 1E equipment is seismic Category I and that equipment located in a harsh environment is qualified.
- b. Redundancy and independence
 - 1) To verify the Class 1E divisional assignments and independence of electric power by both inspections and tests
 - 2) To verify by analysis that the transients or failures occurring in the non-Class 1E electrical equipment will not cause failure of the Class 1E loads.
- c. Capacity and capability
 - 1) To verify adequate sizing of the electrical system equipment and its ability to respond to postulated events (e.g., automatically in the times needed to support the accident analyses)
 - 2) To verify by analysis the ability of the as-built electrical system and installed equipment (e.g., diesel generators, transformers, switchgear, direct current systems, and batteries) to power the loads, including tests to demonstrate the operation of equipment
 - 3) To verify the initiation of the Class 1E equipment necessary to mitigate postulated events for which the equipment is credited (e.g., loss-of-coolant accident [LOCA], loss of offsite power [LOOP], and degraded voltage conditions)
 - 4) To verify by analysis how the as-built electrical power system responds to a LOCA, LOOP, combinations of LOCA and LOOP (including LOCA with delayed LOOP as well as LOOP with delayed LOCA), and degraded voltage, including tests to demonstrate the actuation of the electrical equipment in response to postulated events
- d. Electrical protection features
 - 1) To analyze the ability of the as-built electrical system equipment to withstand and clear electrical faults.

- 2) To analyze the protection feature coordination and verify its ability to limit the loss of equipment attributable to postulated faults.
- e. Displays, controls, and alarms
 - 1) To verify, by inspection, the ability to retrieve information (displays and alarms) and to control the electrical power system in the main control room and/or at locations provided for remote shutdown.
- f. Offsite power
 - To verify by inspection the direct connection of offsite power sources to the Class 1E divisions as well as the adequacy of voltage, capacity, and independence/separation of the offsite sources
 - 2) To verify by inspection appropriate lightning protection and grounding features
- g. Containment electrical penetrations
 - 1) To verify that all electrical containment penetrations are protected against postulated currents greater than their continuous current rating
- h. Alternate ac (AAC) power source
 - To verify, through inspection and testing, the AAC power source and its auxiliaries to provide reasonable assurance of the availability of the AAC power source for station blackout (SBO) events as well as its independence from other ac sources
- i. Lighting
 - 1) To verify the continuity of power sources for plant lighting systems to provide reasonable assurance that a portion of the plant lighting remains available during accident scenarios and power failures
- j. Electrical power for non-safety plant systems

- 1) To verify the functional arrangement of electrical power systems provided to support non-safety systems to the extent that those systems perform a significant safety function.
- k. Physical separation and independence
 - 1) To verify the separation and independence of redundant electrical equipment, circuits, and cabling for post-fire safe shutdown.

14.3.2.7 ITAAC for Plant Systems

Section 2.7 of Tier 1 involves most of the fluid systems that are not part of the reactor systems and also includes new and spent fuel handling systems; power generation systems; air systems; cooling water systems; radioactive waste systems; heating, ventilation, and air conditioning (HVAC) systems; and fire protection systems in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.7 (Reference 9).

ITAAC for these systems are developed to require or verify the following:

- a. As-built plant reports for reconciliation with flood analyses to provide reasonable assurance of consistency with design requirements of SSCs for flood protection and mitigation
- b. As-built plant reports for reconciliation with post-fire safe shutdown analyses to provide reasonable assurance of consistency with design requirements of SSCs for fire protection and mitigation
- c. Heat removal capabilities for design basis accidents (DBAs) as well as tornado/hurricane and missile protection
- d. Net positive suction head for key pumps
- e. Physical separation for appropriate systems
- f. The minimum inventory of alarms, controls, and indications-as derived from emergency procedure guidelines, NRC RG 1.97 (Reference 26), and PRA insights-is provided for the main control room and remote shutdown stations.

- g. The following design attributes for plant systems commensurate with the importance of the design attribute to safety:
 - 1) Functional arrangement
 - 2) Key design features of systems
 - 3) Seismic and ASME Code classifications
 - 4) Weld quality and pressure boundary integrity, as necessary
 - 5) Valve qualification and operation
 - 6) Controls, alarms, and displays
 - 7) Logic and interlocks
 - 8) Equipment qualification for harsh environments
 - 9) Required interfaces with other systems
 - 10) Numeric performance values
- h. Performance of the liquid waste management system, expressed as removal efficiencies or decontamination factors
- i. Performance of the gaseous waste management system, expressed as removal efficiencies, decontamination factors, and holdup or decay times
- j. Performance of the solid waste management systems
- k. Performance of the process and effluent radiological monitoring instrumentation and sampling systems

The COL applicant is to provide the site-specific ITAAC for the plant systems specified in Subsection 14.3.3 (COL 14.3(1)).

14.3.2.8 ITAAC for Radiation Protection

Section 2.8 of Tier 1 involves those SSCs that provide radiation shielding, confinement or containment of radioactivity, ventilation of airborne contamination, or monitoring of

radiation (or radioactivity concentration) for normal operations and during accidents in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.8 (Reference 10).

ITAAC for those SSCs are developed to verify the following:

- a. Adequacy of as-built walls, structures, and buildings as radiation shields, as applicable and for walls surrounding very high-radiation areas and significantly high-radiation areas
- b. Plant airborne concentrations of radioactive materials through adequate design of ventilation and airborne monitoring systems
- c. Radiation and airborne radioactivity levels in plant rooms and areas to provide reasonable assurance of adequacy of plant shielding and ventilation system designs
- d. Radiation levels that are commensurate with area access requirements and with as low as reasonably achievable (ALARA) principles during normal plant operations and maintenance
- e. Adequate shielding that is provided to provide reasonable assurance that radiation levels in plant areas are within the limits necessary for operator actions to aid in mitigating or recovering from an accident

14.3.2.9 ITAAC for Human Factors Engineering

Section 2.9 of Tier 1 involves human factors engineering (HFE) as it pertains to main control room (MCR), remote shutdown room (RSR), local control panels, the technical support center, and the emergency operations facility in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.9 (Reference 11). In addition, it addresses the minimum inventory of alarms, controls, and indications appropriate for the main control room (MCR) and the remote shutdown room (RSR).

ITAAC are developed to verify the following essential HFE elements:

a. An integrated system validation test that demonstrates the final HSI design conforms to the accepted HFE design principles

b. The as-built HSI design that conforms to the verified and validated design resulting from the HFE design process

Design ITAAC is applied to the HFE verification and validation (V&V) for the APR1400. The COL applicant is to provide a design ITAAC closure schedule for implementing the V&V design ITAAC (COL 14.3(2)). Design ITAAC will be closed in accordance with the guidance in RG 1.215 (Reference 31) and Section 10.1 of NEI 08-01 (Reference 32) as described in Subsection 14.3.5.

14.3.2.10 ITAAC for Emergency Planning

Section 2.10 of Tier 1, which covers emergency planning, is prepared in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.10 (Reference 12). ITAAC for emergency planning are provided in accordance with the requirements of 10 CFR 52.80(b) (Reference 27). These ITAAC are consistent with the applicable generic ITAAC in Table C.II.1-B1 of Appendix C.II.1-B to NRC RG 1.206 (Reference 1) and provide for verifying the following:

- a. Location and size of the TSC
- b. Habitability of the TSC
- c. Means of communication among the MCR, TSC, and EOF
- d. A data communications system to provide plant data exchange among the MCR, TSC, and EOF
- e. The emergency response data system
- f. Location of the operation support center (OSC)
- g. Means of communications among the MCR, TSC, and OSC

The COL applicant is to provide the proposed ITAAC for the facility's emergency planning not addressed in the DCD in accordance with NRC RG 1.206 (Reference 1) as appropriate (COL 14.3(3)).

14.3.2.11 ITAAC for Containment Systems

Section 2.11 of Tier 1 involves containment design and associated issues, such as containment isolation provisions, containment leakage testing, hydrogen generation and control, containment heat removal, and subcompartment analysis, in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 14.3.11 (Reference 13).

ITAAC for containment system are developed to verify the following:

- a. Key parameters and insights from containment safety analyses, such as loss-ofcoolant accident (LOCA), main steam line break, main feed line break, and subcompartment analyses
- b. Existence of severe accident prevention and mitigation design features
- c. Functional arrangements of containment isolation provisions
- d. Design qualification of containment isolation valves
- e. Containment isolation functions of motor-operated valves (MOVs) and check valves by in-situ testing
- f. Containment isolation signal generation, valve closure times, and valve leakage

14.3.2.12 ITAAC for Physical Security Hardware

Section 2.12 of Tier 1, which addresses standard plant physical security hardware, is based on the generic set of physical security hardware ITAAC (developed by the NRC in coordination with the Nuclear Energy Institute) provided in SRP 14.3.12 (Reference 14). The standard plant physical security ITAAC are consistent with the guidance provided in SRP 14.3 (Reference 2) and the applicable generic ITAAC in SRP 14.3.12 (Reference 14). They provide for verifying that:

- a. Location of vital equipment
- b. Access to vital equipment
- c. Equipment to permit observation of abnormal presence or activity of persons or vehicles

- d. Vehicle barrier system to protect against the design basis threat vehicle bombs
- e. Vital areas with active intrusion detection systems
- f. Security alarm annunciation and video assessment information
- g. Location and equipment of the central and secondary alarm stations
- h. Secondary security power supply system
- i. Intrusion detection and assessment systems
- j. Equipment and emergency exits

The COL applicant is to provide the proposed ITAAC for the facility's physical security hardware not addressed in the DCD in accordance with NRC RG 1.206 (Reference 1) as appropriate (COL 14.3(4)).

14.3.2.13 ITAAC for the Design Reliability Assurance Program

Section 2.13 of Tier 1, which addresses the design reliability assurance program, was prepared in accordance with the guidance in NRC RG 1.206 (Reference 1), SRP 14.3 (Reference 2), and SRP 17.4 (Reference 28).

Section 17.4 describes the design reliability assurance program, which is developed in accordance with guidance in NUREG-0800, and SRP 17.4 (Reference 28). The purposes of this program are to provide reasonable assurance of the following:

- a. A plant is designed, constructed, and operated in a manner that is consistent with the risk insights and key assumptions (e.g., SSC design, reliability, availability) from the probabilistic, deterministic, and other methods of analysis used to identify and quantify risk.
- b. The RAP SSCs do not degrade to an unacceptable level of reliability, availability, or condition during plant operations.
- c. The frequency of transients that challenge these SSCs are minimized.
- d. These SSCs are to function reliably when challenged.

Table 17.4-1 identifies risk-significant SSCs for the APR1400 design.

The risk-significant SSCs are identified by introducing site-specific information to the list shown in Table 17.4-1. A single ITAAC is provided to verify that the design reliability assurance program provides reasonable assurance that the designs of these SSCs are consistent with the assumptions used in the associated risk analyses.

14.3.2.14 ITAAC for the Initial Test Program

Section 2.14 of Tier 1 involves the initial test program for the APR1400 plant, which is developed in accordance with NRC RG 1.68 (Reference 29), NRC RG 1.206 (Reference 1), SRP 14.2 (Reference 30), and SRP 14.3 (Reference 2).

It provides a brief explanation about how the preoperational and startup tests, as part of the initial test program, are to be conducted and controlled based on Section 14.2 of Tier 2. This section does not include ITAAC.

14.3.3 <u>Tier 1, Chapter 3: Interface Requirements</u>

Chapter 3 of Tier 1 provides interface requirements for those SSCs of a complete power generating facility that are either totally or partially not within the scope of the APR1400 standard plant design as defined in the certification application. For the APR1400 standard plant, these systems are identified in Section 1.8. Generally, SSCs that are part of, or within, the nuclear island structure and emergency diesel generator building are in the APR1400 standard plant scope. Those portions of the plant outside these buildings are not generally in the APR1400 standard plant scope.

This scope split occurs because design of the plant features located outside the main buildings is dependent upon site-specific characteristics that are not specified at the time of certification (e.g., source of plant cooling water, characteristics of the electrical grid to which the plant is connected).

Chapter 3 of Tier 1 also identifies the scope of the design to be certified by specifying the systems that are completely or partially out of scope of the certified design. Thus, interface requirements are defined for (a) systems that are outside the scope of the design, and (b) the out-of-scope portions of the systems that are only partially within the scope of the APR1400 standard design.

14.3.4 <u>Elements of Design Material Incorporated into Tier 1</u>

The design material included in Tier 1 was selected based on risk insights regarding the safety significance of the SSCs, their importance in safety analyses, and their functions with respect to defense-in-depth considerations.

Tables 14.3.4-1 through 14.3.4-6 summarize the design information particularly significant to selection of design material for Tier 1, as follows:

- a. Table 14.3.4-1: Design Bases Accident Analysis Key Design Features
- b. Table 14.3.4-2: PRA Key Design Features
- c. Table 14.3.4-3: Flooding Analysis Key Design Features
- d. Table 14.3.4-4: Fire Protection Analysis Key Design Features
- e. Table 14.3.4-5: ATWS Analysis Key Design Features
- f. Table 14.3.4-6: Radiological Analysis Key Design Features

The risk insights from the PRA are used to identify and support ITAAC as summarized in Table 14.3.4-2.

The referenced Tier 2 sections in these tables, however, may contain more information than is encompassed by the subject areas. Each table may also include design information (certified or noncertified) that is not directly related to the particular subject area. Further, the tables are not intended to include all system-specific information that is provided in the Tier 2 system descriptions.

14.3.5 Design ITAAC Closure Process

APR1400 standard design uses "design ITAAC" to specify the limits, parameters, procedures, and attributes associated with HFE (V&V). These design ITAAC are identified in DCD Tier 1 and provided with an as-built ITAAC to verify their completion prior to initial fuel load.

Design ITAAC will be closed using the process described in this subsection. Following closure of the design ITAAC, ITAAC for related as-built SSCs will be closed to verify that their respective principal performance characteristics and safety functions conform to the

certified design. RG 1.206 (Reference 1), "Combined License Applications for Nuclear Power Plants (LWR Edition)," Section C.III.5 provides design ITAAC closure guidance.

14.3.5.1 Design ITAAC Closure Options

There are three options available to close a design ITAAC. Design information used to close design ITAAC represents a level of detail similar to that which would have been provided during design certification review if a design ITAAC had not been used. The three options for design ITAAC closure are:

a. Closure through an amendment of the design certification rule

A design certification rule amendment request is submitted to the NRC to provide the design and analysis information needed to close the design ITAAC and the design ITAAC are deleted from the DCD. ITAAC for as-built SSCs will remain or be modified, as appropriate, to demonstrate that the as-built facility conforms to the final design and analysis information.

b. Closure through the COLA review process

A COL application contains the required design and analysis information needed to close the design ITAAC. ITAAC for as-built SSCs will remain or be modified, as appropriate, to demonstrate that the as-built facility conforms to the final design and analysis information.

c. Closure after COL issuance

The NRC issues a COL with design ITAAC still open and inspects design ITAAC closure as part of the construction inspection process. Design ITAAC closure is accomplished using the normal ITAAC closure process.

Regarding the first option, this method resolves design with finality for all COL applicants that subsequently reference the amended standard design.

The second or third option may be applied only by the first licensee following completion of the required design and analysis information needed to close design ITAAC. Subsequent licensees may use the standard plant design and analysis information approved for closure of design ITAAC by the first licensee. This does not include design ITAAC that are dependent upon site-specific parameters. As discussed by RG 1.206

Section C.III.5 (Reference 1), the licensee and NRC may use the design centered review approach to close design ITAAC for subsequent licensees.

Topical reports may be submitted to the NRC to support design ITAAC closure using any of the three options. The NRC may issue a safety evaluation in conjunction with a closure letter or inspection report conclusion that design ITAAC acceptance criteria have been satisfied. This allows subsequent COL applicants or licensees to reference NRC closure documents to close design ITAAC.

14.3.5.2 <u>Human Factors Engineering Design ITAAC</u>

Human factors engineering design ITAAC verifies final design at a level of detail adequate for procurement and construction. The final design can be validated by V&V since V&V covers all of the other elements. An integrated system validation test will be performed in accordance with the HF V&V implementation plan to validate final HSI design. The design ITAAC for V&V are listed in Tier1 Table 2.9-1.

14.3.6 <u>Combined License Information</u>

- COL 14.3(1) The COL applicant is to provide the ITAAC for the site-specific portion of the plant systems specified in Subsection 14.3.3.
- COL 14.3(2) The COL applicant is to provide a design ITAAC closure schedule for implementing the V&V design ITAAC as addressed in Subsection 14.3.2.9.
- COL 14.3(3) The COL applicant is to provide the proposed ITAAC for the facility's emergency planning not addressed in the DCD in accordance with RG 1.206
- COL 14.3(4) The COL applicant is to provide the proposed ITAAC for the facility's physical security hardware not addressed in the DCD in accordance with RG 1.206.
- 14.3.7 <u>References</u>
- 1. Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," U.S. Nuclear Regulatory Commission, June 2007.

- 2. NUREG-0800, Standard Review Plan, Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," "Initial Test Program and ITAAC Design Certification," U.S. Nuclear Regulatory Commission, March 2007.
- 3. NUREG-0800, Standard Review Plan, Section 2.0, "Site Characteristics and Site Parameters," Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, March 2007.
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Table 14.3.4-1 (1 of 4)

Design Basis Accident Analysis Key Design Features

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
1-1	2.4.2 ITAAC # 9.a	The pressurizer pilot operated safety relief valves (POSRVs) provide overpressure protection in ASME Section III. The pressurizer POSRVs pass sufficient pressurizer steam to limit the reactor coolant system pressure to 110 % of design pressure (193.3 kg/cm ² A [2,750 psia]) following a loss of load with a delayed reactor trip which is assumed to be initiated by the secondly generated safety grade signal from the reactor protection system. The minimum valve capacity is 540,000 lb/hr (244.9 ton/hr) steam.	5.2.2 5.4.14.2 Table 5.4.14-1
1-2	2.4.2 ITAAC # 9.a	The POSRV set pressure equals $173.7 \pm 1.3 \text{ kg/cm}^2\text{A}$ (2470 ± 18 psia).	5.4.14.2 Table 5.4.14-1
1-3	2.4.2 ITAAC # 9.c	Each RCP has rotating inertia to slow the pump flow coast down when electrical power is disconnected.	5.4.1.1
1-4	2.4.2-4 ITAAC # 9.d	The RCPs circulate coolant at a rate that removes heat generated in the reactor core.	5.4.1.4.1 Table 5.4.1-1
1-5	2.4.5 ITACC #9.a	Each as-built SCP is sized to deliver 18,927 L/min (5,000 gpm) at a discharge head of 140.2 m (460 ft) excluding flow through mini-flow heat exchanger.	Table 5.4.7-1
1-6	2.11.1 ITAAC #4	Containment Design Pressure: 4.22 kg/cm ² g (60 psig)	6.2.1.1.1.1 Table 6.2.1-3
1-7	2.11.1 Table 2.11.1-1	Containment Free Volume: Minimum $8.8576 \times 10^4 \text{ m}^3$ (3.128 × 10 ⁶ ft ³)	6.2.1.1.3.1 Table 6.2.1-3
1-8	2.4.4 ITACC#1 #9.c, #9.e	The safety injection system consists of four independent and dedicated SI pump trains. The SI pump trains are automatically initiated by a safety injection actuation signal, and supply borated water from the IRWST to the reactor vessel via direct vessel injection line.	6.3.1 Table 6.3.2-1 Fig.6.3.2-1

Table 14.3.4-1 (2 of 4)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
1-9	2.4.4 ITACC #9.a.iii	Each as-built safety injection pump has a pump differential pressure of no less than 123.8 kg/cm ² d (1,761 psid) at the minimum flow, and injects no less than 4,115 L/min (1,087 gpm) and no more than 4,198 L/min (1,109 gpm) of IRWST water into the reactor vessel at atmospheric pressure.	6.3.2.2 Table 6.3.2-1
1-10	2.4.4 ITACC #1 #9.a.i/iv	Four (4) safety injection tanks store borated water under pressure and automatically inject it into the RCS if the reactor coolant pressure decreases below the SIT pressure. The total water volume injected from each as-built SIT into the reactor vessel is \geq 50.7 m ³ (1790 ft ³). The water volume injected from each SIT into reactor vessel at large flow rate (prior to flow switching to small flow rate) is \geq 22.7 m ³ (800 ft ³). The volume per the as-built SIT is greater than or equal to 68.1 m ³ (2,406 ft ³)	6.3.2.2.2 Table 6.3.2-1
1-11	2.4.5 ITACC #9.a	The SCS cools the reactor by removing decay heat, and other residual heat from the reactor core and the RCS during the normal plant shutdown and cool down conditions. The product of the overall heat transfer coefficient and the effective heat transfer area of each SDCHX is no less than 1.4×10^6 kcal/hr-°C (3.2×10^6 Btu/hr-°F).	5.4.7.2.1 Table 5.4.7-1
1-12	2.4.5 ITACC #1, #6.b	The shutdown cooling system consists of two subsystems, each of which receives electrical power from one of two safety buses. Each subsystem includes one SC pump and one SC heat exchanger, one SCP mini-flow heat exchanger.	5.4.7.2.1 Fig. 5.4.7-3
1-13	2.4.5 ITACC #9.b	The LTOP relief valve has a capacity of about 29,337 L/min (7,750 gpm) and a set pressure of less than equal to 37.3 kg/cm ² (530 psig) to provide LTOP for the RCS.	Table 5.2-3
1-14	2.4.7 ITAAC #9.a	Each CVCS charging pump delivers a flow rate greater than or equal to 586.7 L/min (155 gpm).	9.3.4.1.1 Table 9.3.4-2

Table 14.3.4-1 (3 of 4)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
1-15	2.4.7 ITAAC #9.b	Each CVCS charging pump provides seal injection flow greater than or equal to 99.9 L/min (26.4 gpm) to four RCPs.	9.3.4.1.2, Tables 9.3.4- 2/3
1-16	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on variable overpower.	Table 7.2-4
1-17	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on high logarithmic power level.	Table 7.2-4
1-18	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on high local power density from CPCS.	Table 7.2-4
1-19	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on low departure from nucleate boiling ratio from CPCS.	Table 7.2-4
1-20	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on high pressurizer pressure.	Table 7.2-4
1-21	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on low pressurizer pressure.	Table 7.2-4
1-22	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on high steam generator level.	Table 7.2-4
1-23	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on low steam generator level.	Table 7.2-4
1-24	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on low steam generator pressure.	Table 7.2-4

Table 14.3.4-1 (4 of 4)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
1-25	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on high containment pressure.	Table 7.2-4
1-26	2.5.1 Table 2.5.1-2, ITACC #4.a	A reactor trip occurs on low reactor coolant flow.	Table 7.2-4
1-27	2.5.1 Table 2.5.1-3, ITACC #4.a	The safety injection actuation signal is initiated on low pressurizer pressure or high containment pressure.	Table 7.3-5A
1-28	2.5.1 Table 2.5.1-3, ITACC #4.a	The containment isolation actuation signal is initiated on high containment pressure or low pressurizer pressure.	Table 7.3-5A
1-29	2.5.1 Table 2.5.1-3, ITACC #4.a	The containment spray actuation signal is initiated on high high containment pressure.	Table 7.3-5A
1-30	2.5.1 Table 2.5.1-3, ITACC #4.a	The main steam isolation signal is initiated on low steam generator pressure, high containment pressure or high steam generator level.	Table 7.3-5A
1-31	2.5.1 Table 2.5.1-3, ITACC #4.a	The auxiliary feedwater actuation signal-1 is initiated on low steam generator 1 level.	Table 7.3-5A
1-32	2.5.1 Table 2.5.1-3, ITACC #4.a	The auxiliary feedwater actuation signal-2 is initiated on low steam generator 2 level.	Table 7.3-5A
1-33	2.4.6 ITAAC #9.d	The as-built charging restricting orifices limit the charging flow rate to less than or equal to the following at atmospheric pressure of RCS: 567.8 L/min (150 gpm) with two charging flow restricting valves closed and 681.4 L/min (180 gpm) with one charging flow restricting valve closed.	Table 15.4.6-1
1-34	2.4.6 ITAAC #9.e	A report exists and concludes that the as-built calculated NPSH available exceeds each CVCS pump's NPSH required.	Table 9.3.4-1

Table 14.3.4-2 (1 of 7)

PRA Key Design Features

T . 11	Tier 1		Tier 2
Item #	Reference	Design Features	Reference
2-1	2.2.1 ITAAC #2.c	The containment and its penetrations retain their pressure boundary integrity associated with the design pressure. The containment pressure boundary is evaluated to provide reasonable assurance the maintenance of its role as a reliable leak-tight barrier under severe accident conditions.	3.8.1 3.8.2 19.1.3 19.2.4
2-2	2.4.1 ITAAC #8.b	All controls required by the design exist in the RSR to start and stop the reactor coolant pumps and to open and close MOVs and AOVs listed in Table 2.4.1-2.	5.4.1 19.1.4.1
2-3	2.4.1 ITAAC #9.a	The pressurizer POSRVs provide overpressure protection for reactor coolant pressure boundary components in the RCS.	5.2.2 19.1.3 19.2.3
2-4	2.4.2 ITAAC #1	The IRWST provides borated water for the safety injection system (SIS) and the containment spray system (CSS). It is the primary heat sink for discharges from the safety depressurization and vent system. It is the source of water for the CFS, and for filling the refueling pool via the shutdown cooling system (SCS).	6.8.1 19.1.3 19.2.3
2-5	2.4.2 ITAAC #9.c	The IRWST sump for each SIS/CSS division has a strainer.	6.8.2.2 19.1.3
2-6	2.4.3 ITAAC #1a, #9a	The safety injection system (SIS) injects borated water into the reactor vessel to provide core cooling and reactivity control in response to design basis accidents. The SIS also provides core cooling during feed and bleed operation, in conjunction with the pilot operated safety relief valves (POSRVs). The major components of the SIS are four identical safety injection pumps (SIPs), an in-containment refueling water storage tank (IRWST), four identical safety injection tanks (SITs), and associated valves.	6.3.1 19.1.3
2-7	2.4.3 ITAAC #9.f	The SIS can be manually realigned for simultaneous hot leg injection and direct vessel injection (DVI).	6.3.1 19.1.3
2-8	2.4.4 ITAAC #1, #9.a, #9d	The SCS is designed such that the shutdown cooling pumps (SCPs) are identical and functionally interchangeable with containment spray pumps (CSPs) for containment spray system (CSS). Provisions are made to control the valves used in the SCS/CSS interconnection. The SCS contains two heat exchangers and two pumps. One SCS pump is capable of meeting the safety-grade cooldown criteria and two SCS pumps are required to meet the normal cooldown design criteria.	5.4.7 19.1.3

Table 14.3.4-2 (2 of 7)

	Tier 1		Tier 2
Item #	Reference	Design Features	Reference
2-9	2.4.4 ITAAC #9.a	The SCS cools the reactor by removing decay heat, and other residual heat from the reactor core and the RCS during the normal plant shutdown and cool down conditions.	5.4.7 19.1.3
2-10	2.4.6 ITAAC #9.c	The CVCS provides backup spray water to the pressurizer, provides cooling water to the RCP seals, and provides water to the spent fuel pool and in-containment refueling water storage tank (IRWST).	9.3.4 19.1.3
2-11	2.4.6 ITAAC #9.b	The CVCS supplies seal water to the RCP seals.	9.3.4.2.4 19.1.3
2-12	2.5.1 Design Description	The plant protection system (PPS) consists of four channels of PPS cabinets and core protection calculator system (CPCS) cabinets.	7.2.1 19.1.3
2-13	2.5.1 ITAAC #4.c	Manual initiation switches are provided for reactor trip in the MCR and the RSR.	7.2.1.53 19.1.3
2-14	2.5.1 ITAAC #8	Each PPS channel is controlled from either the MCR or the RSR as selected from master transfer switches.	7.7.1.2 19.1.3
2-15	2.5.1 ITAAC #13	The RT logic of the PPS is designed to fail to a safe state such that loss of electrical power to a channel of PPS results in a trip but does not result in ESF actuation.	7.2.1.3 19.1.3
2-16	2.5.2 ITAAC #1, #2, #3	The diverse protection system (DPS) is non-safety system which provides a diverse mechanism to decrease risk from the anticipated transient without scram (ATWS) events, and assist the mitigation of the effects of a postulated common cause failure (CCF) of the digital computer logic within the plant protection system (PPS) and the engineered safety features-component control system (ESF-CCS).	7.8.1.1 7.8.1.2 7.8.1.3 Table 7.8-1 Table 7.8-2 19.1.3
2-17	2.5.2 ITAAC #2, #4	The DPS is physically separate, electrically independent, and diverse from the PPS and ESF-CCS including a diverse method for the interruption of power to the control element drive mechanism (CEDM), the turbine trip, the auxiliary feedwater actuation and safety injection actuation.	7.8.1.1 19.1.3
2-18	2.5.4 ITAAC #8	Each ESF-CCS channel is controlled from either the MCR or RSR, as selected from master transfer switches.	7.3.1 19.1.5

Table 14.3.4-2 (3 of 7)

	Tier 1		Tier 2
Item #	Reference	Design Features	Reference
2-19	2.5.4 ITAAC #7	Upon detecting loss of power to Class 1E division the ESF-CCS initiates startup of the diesel generators, shedding of electrical load, transfer of Class 1E bus connections to the diesel generators, and sequencing to the reloading of safety-related loads to the Class 1E bus.	7.3.1.8 19.1.3
2-20	2.5.2 ITAAC #7 2.5.4 ITAAC #1	Diverse manual ESF actuation (DMA) switches are provided in the MCR as an alternate means for manual actuation of ESF components in four channels of the ESF-CCS.	7.3.2.4 19.1.3
2-21	2.6.1 ITAAC #1	The ac electric power distribution system consists of the transmission system, the plant switchyard, main transformer (MT), two unit auxiliary transformers (UATs), two standby auxiliary transformers (SATs), a main generator (MG), a generator circuit breaker (GCB), isolated phase buses, switchgears, load centers (LCs), and motor control centers (MCCs). The electric power distribution system also includes the power, control, instrumentation cables and raceways, and electrical protection devices, such as circuit breakers and fuses.	8.1.1, 8.1.2 19.1.3
2-22	2.6.1 ITAAC #8	If normal offsite power supply is not available, 4.16 kV Class 1E medium voltage buses are automatically transferred to alternate offsite power supply.	8.3.1.1 19.1.3 19.2.2
2-23	2.6.1 ITAAC #10.a	Independence is provided between each of the four trains of Class 1E distribution equipment and circuits.	8.3.1.1.2.3 19.1.3
2-24	2.6.1 ITAAC #21	The post-fire safe-shutdown circuit analysis provides reasonable assurance that one success path of shutdown SSCs remains free of fire damage.	Table 9.5.1- 1 19.1.5
2-25	2.6.2 ITAAC #1	Four EDGs provide Class 1E power to the four independent Class 1E trains, respectively, during a LOOP or a LOOP concurrent with DBA. EDGs are normally in standby mode.	8.3.1.1 19.1.3

Table 14.3.4-2 (4 of 7)

	Tier 1		Tier 2
Item #	Reference	Design Features	Reference
2-26	2.6.2 ITAAC #15	A loss of power to a Class 1E medium voltage safety bus automatically starts its respective EDG and load sheds the Class 1E bus within the affected train. Following attainment of required voltage and frequency, the EDG automatically connects to its respective train bus. After the EDG connects to its respective bus, the non-accident loads are automatically sequenced onto the bus.	8.3.1.1.3.6 19.1.3
2-27	2.6.2 ITAAC #16	The Class 1E auxiliary power for EDG support systems is supplied power from the same train respectively.	8.3.1.1.3 19.1.3
2-28	2.6.2 ITAAC #17	For a loss of power to a Class 1E medium voltage safety bus concurrent with a design basis event condition (SIAS/CSAS/ AFAS), each EDG automatically starts and load shedding of the Class 1E bus within the affected train occurs. Following attainment of required voltage and frequency, the EDG automatically connects to its respective bus and the accident loads are sequenced onto the bus.	8.3.1.1.3 19.1.3
2-29	2.6.2 ITAAC #9	Each EDG has fuel storage capacity to provide fuel to its EDG for a period of seven days with the EDG supplying the power requirements for the most limiting design basis event.	9.5.4 19.1.3
2-30	2.6.2 ITAAC #11	One transfer pump in each train automatically supply diesel fuel oil from the storage tank to the day tank prior to actuation of low level alarm and stops automatically on a fuel oil day tank high- level signal.	9.5.4 19.1.3
2-31	2.6.3 ITAAC #1	The Class 1E 125 Vdc system consists of four independent subsystems, train A, B, C, and D, each corresponding to one of the four reactor protection instrumentation channels A, B, C, and D. The non-Class 1E dc power system is also comprised of two separate subsystems, divisions I and II. Each Class 1E and non- Class 1E dc power system is provided with its own battery, two battery chargers (normal and standby), a dc control center, and dc distribution panels. The Class 1E dc power system supplies reliable continuous power to the plant safety system dc loads and the Class 1E I&C system.	8.3.2.1.2.1 19.1.3
2-32	2.6.3 ITAAC #4	The Class 1E dc power system cables are routed in raceway systems within their respective trains.	8.3.2.1.2 19.1.5

Table 14.3.4-2 (5 of 7)

	Tier 1		Tier 2
Item #	Reference	Design Features	Reference
2-33	2.6.4 ITAAC #1	The Class 1E 120 Vac I&C power system is separated into four subsystems, trains A, B, C, and D that supply power to the plant protection system channels A, B, C, and D. The Class 1E I&C power system includes four separate and independent 120 Vac power distribution panel, and each system is powered from a 125 Vdc control center via a 125 Vdc/120 Vac static inverter.	8.3.2.1.2.2 19.1.3
2-34	2.6.4 ITAAC #4	When dc input power to the Class 1E inverter power supply unit is lost, input to the Class 1E inverter power supply unit is provided by the regulating transformer without interruption of power supply to the loads.	8.3.2 19.1.3
2-35	2.6.6 ITAAC #1	The alternate ac (AAC) power source supplies power to safety- related loads to maintain the plant in a safe shutdown condition during station blackout (SBO). The AAC power source also provides power to the permanent non-safety (PNS) buses during a loss of offsite power (LOOP) condition. The AAC power source is a gas turbine generator (GTG) that is independent from the EDGs and the offsite power sources.	8.4.1.2 8.4.1.3 19.1.3
2-36	2.6.6 ITAAC #3	The AAC source is connected to the Class 1E train A or train B bus through two in series (one Class 1E circuit breaker at the Class 1E bus and the other non-Class 1E circuit breaker at the non-Class 1E AAC bus) circuit breakers during SBO condition.	8.3.1.1.1 19.1.3
2-37	2.6.6 ITAAC #4	The AAC source can be started, brought up to the required voltage and frequency, and connected manually to the Class 1E train A or train B bus within 10 minutes in the event of SBO.	8.4.1.3 19.1.3
2-38	2.6.6 ITAAC #6	The GTG has fuel oil storage capacity enough to supply power to the required loads for 24 hours.	9.5.9 19.1.3
2-39	2.7.1.5 ITAAC #1, #11.a	The AFWS is designed to be either manually actuated or automatically actuated by an auxiliary feedwater actuation signal (AFAS) from the engineered safety feature actuation system (ESFAS) or diverse protection system (DPS).	10.4.9 19.1.3
2-40	2.7.1.5 ITAAC #10.b	Each AFWST has sufficient capacity for 8 hours of operation at hot standby condition and subsequent cooldown of the reactor coolant system within 6 hours to condition that permit operation of the shutdown cooling system.	10.4.9 19.1.3

Table 14.3.4-2 (6 of 7)

	Tier 1		Tier 2]
Item #	Reference	Design Features	Reference	
2-41	2.7.1.5 ITAAC #11.b	The ESF-CCS includes logic to close the AFW isolation valves when SG water level has risen above a high-level setpoint, and to reopen AFW isolation valves when SG water level drops below a low-level setpoint.	10.4.9 19.1.3	
2-42	2.7.2.1 ITAAC #1	The ESWS consists of two independent, redundant, once-through, safety-related divisions. Each division cools one of two divisions of the CCWS, which cools 100 percent of the safety-related loads. Each division of the ESWS consists of two pumps, three CCW heat exchangers, three debris filters, and associated piping, valves, controls, and instrumentation.	9.2.1 19.1.3	
2-43	2.7.2.1 ITAAC #9	The two mechanical divisions of the ESWS are physically separated.	9.2.1 19.1.3	
2-44	2.7.2.2 ITAAC #1	The CCWS consists of two separate, independent, redundant, closed loop, and safety-related divisions. Either division of the CCWS is capable of supporting 100 percent of the cooling functions required for a safe reactor shutdown. Each division of the CCWS includes three heat exchangers, a surge tank, two CCW pumps, a chemical addition tank, a CCW radiation monitor, piping, valves, controls, and instrumentation.	9.2.2 19.1.3	
2-45	2.7.2.2 ITAAC #9	The two mechanical divisions of the CCWS are physically separated.	9.2.2 19.1.3	
2-46	2.7.2.3 ITAAC #1, #9	The ECWS consists of two divisions. Each division includes two chillers, two chilled water pumps, a compression tank, an essential chilled water makeup pump, an air separator, piping, valves, controls, and instrumentation. The ECWS is located in the auxiliary building.	9.2.7.1.1 19.1.3	
2-47	2.11.2 Design Description	The containment spray system (CSS) is a safety-related system. It removes heat and reduces the concentration of radionuclides released from the containment atmosphere and transfers the heat to the component cooling water system following events that increase the containment temperature and pressure. The CSS can also remove heat from the in-containment refueling water storage tank (IRWST).	6.2.2 19.1.3 19.2.2	

Table 14.3.4-2 (7 of 7)

	Tier 1		Tier 2
Item #	Reference	Design Features	Reference
2-48	2.11.4 ITAAC #1	The containment hydrogen control system (CHCS) is non-safety- related system. The CHCS is used to maintain hydrogen gas concentration in containment at a level that precludes an uncontrolled hydrogen and oxygen recombination within containment following beyond-design-basis accidents. The CHCS consists of the passive autocatalytic recombiners (PARs) and hydrogen igniters (HIs). The PARs and HIs are designed to control and allow adiabatic controlled burning of hydrogen at fairly low concentration in containment and in- containment refueling water storage tank (IRWST) from exceeding 10 volume percent during a degraded core accident with 100 percent fuel clad metal-water reaction.	6.2.5 19.1.3 19.2.3
2-49	2.11.4 ITAAC #3	The CHCS provides PARs complemented by HIs to control the containment hydrogen concentration for beyond-design-basis accidents.	6.2.5 19.1.3 19.2.3
2-50	2.11.4 ITAAC #3	At least 30 PARs and 8 hydrogen igniters are provided inside containment.	6.2.5 19.2.3
2-51	3.2 a.	The UHS provides the capability to reject the heat under normal and accident conditions (safe shutdown or post-accident) assuming a single active failure concurrent with a loss of offsite power.	9.2.5 19.1.3
2-52	2.4.1 ITAAC #15	The decay heat removal function of the SCS will not be impaired by gas entrainment during mid-loop operation	19.1.4 5.4.7.2
2-53	2.11.4 ITAAC #3.b	A report exists and concludes that the hydrogen depletion rates for each installed PAR and HI will maintain containment hydrogen concentration of less than or equal to 10 percent by volume.	6.2.5 19.2.3

Table 14.3.4-3

Flooding Analysis Key Design Features

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
3-1	2.2.5 ITACC #2	Divisional walls provide separation and serve as flood barriers to prevent spreading of flood water to adjacent divisions.	3.4.1.5
3-2	2.2.5 ITACC #2	Watertight doors provide separation and serve as flood barriers to prevent flood propagation.	3.4.1.3
3-3	2.2.5 ITACC #2	Penetrations through flood barriers are sealed up to internal design flood levels.	3.4.1.3
3-4	2.2.5 ITACC #2	The safety-related systems and components are located above the design flood levels.	3.4.1.3

Table 14.3.4-4

Fire Protection Analysis Key Design Features

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
4-1	2.2.5 ITAAC #3	The redundant trains of safe shutdown systems, components and cabling except for the control room complex and inside containment are separated from each other by a fire barrier having a 3-hour rating.	Table 9.5.1-2 9.5A
4-2	2.2.5 ITAAC #3	Openings and penetrations through fire barriers are protected by components, (e.g., fire doors, fire dampers, penetration seals having fire resistance equivalent to those of the barriers).	9.5.1.2.1
4-3	2.2.5 ITAAC #3	Both the MCR complex and RSR are separated by 3-hour-rated fire barriers.	9.5A
4-4	2.7.5.2 ITAAC #7	Manual pull stations or individual fire detectors provide fire detection capability and can be used to initiate fire alarms.	9.5.1.2.6
4-5	2.7.5.2 ITAAC #3.a	Fire protection water supply system is designed to meet the largest design demand of any sprinkler, pre- action or deluge system plus 1,900 L/min (500 gpm) for manual hoses.	9.5.1.2.2
4-6	2.7.5.2 ITAAC #2.a	Fire protection water supply tank: The water supply tank is based on the largest demand of any sprinkler, pre-action or deluge system plus 1,900 L/min (500 gpm) for manual hoses operating for at least 2 hours. Minimum volume = 1.136×10^6 L (300,000 gal)	9.5.1.2.2
4-7	2.7.5.2 ITAAC #6	The fuel tank for the diesel-driven fire pump is capable of holding at least equal to 5.07 L per kW (1 gal per hp) plus 10 % volume.	9.5.1.2.2
4-8	2.7.5.2 ITAAC #5	The standpipe systems in the auxiliary building, along with their backup water supply, are classified as seismic Category I.	9.5.1.2
4-9	2.7.5.2 ITAAC #2.b	Seismic fire water supply tank: capacity = 6.813×10^4 L (18,000 gal)	9.5.1.2.4

Table 14.3.4-5

ATWS Analysis Key Design Features

	Tier 1		Tier 2
Item #	Reference	Design Features	Reference
5-1	2.5.2 Design Description	The diverse protection system (DPS) is non-safety system that provides a diverse mechanism to decrease risk from the anticipated transient without scram (ATWS) events and assist the mitigation of the effects of a postulated common-cause failure (CCF) of the digital computer logic within the plant protection system (PPS) and the engineered safety features – component control system (ESF-CCS).	7.8.1.1, 7.8.1.2, 7.8.1.3 Table 7.8-1, Table 7.8-2
5-2	2.5.2 ITACC #2	The DPS is physically separate, electrically independent, and diverse from the reactor protection system (RPS) including a diverse method for the reactor trip.	7.8.2, Figure 7.8-2
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Table 14.3.4-6 (1 of 2)

Radiological Analysis Key Design Features

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
6-1	2.2.1 ITAAC #2.d	The leakage rate through containment is 0.1 v/o/day during 0-24 hr.	6.2.6 Table 6.5-3 15.6.5.5 Table 15.6.5-13
6-2	2.4.3 ITAAC #9.c	The long-term pH of the in-containment refueling water storage tank (IRWST) water after postulated accidents is maintained above 7.0 to prevent the re- evaporation of radioactive iodine dissolved from IRWST water into the containment atmosphere. The volume of trisodium phosphate (TSP) required to establish a minimum pH of 7.0 is 26,976 kg.	6.5.2.3.2 Chapter 16 Bases 3.5.5
6-3	2.7.3.1 ITAAC #9, #10	The minimum time required to divert from the MCR normal makeup air supply to the emergency operation mode is 5 minutes.	9.4.1.2 Table 15.1.5-12 Table 15.2.8-3 Table 15.3.3-3 Table 15.4.8-4 Table 15.6.2-4 Table 15.6.3-5
6-4	2.7.3.1 Design Description ITAAC #8	The control room is maintained at positive pressure with respect to the surrounding areas.	9.4.1.2
6-5	2.7.3.1 ITAAC #8.a	The efficiencies of the MCR emergency ventilation HEPA and charcoal filters used in radiological consequence analysis are 99 %.	Table 15.1.5-12 Table 15.2.8-3 Table 15.3.3-3
6-6	2.7.3.1 ITAAC #8.b	The main control room (MCR) emergency recirculation flow (filtered) is 122 m ³ /min (4,300 cfm). The MCR emergency makeup flow (filtered) is 105 m ³ /min (3,700 cfm).	Table 15.4.8-4 Table 15.6.2-4 Table 15.6.3-5 Table 15.6.5-13

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Item #	Tier 1 Reference	Design Features	Tier 2 Reference
6-7	2.7.3.1 ITAAC #8.b, #12	Prior to the emergency operation mode, the MCR unfiltered inleakage rate is 105 m ³ /min (3,700 cfm) and, after that, is 8.50 m ³ /min (300 cfm).	Table 15.1.5-12Table 15.2.8-3Table 15.3.3-3Table 15.4.8-4Table 15.6.2-4Table 15.6.3-5Table 15.6.3-13
6-8	2.7.4.2 ITTAC #1	The spent fuel pool water level shall be 7 m (23 ft) over the top of irradiated fuel assemblies seated in the storage.	9.1.2 16.3.7.14
6-9	2.11.3.1 ITAAC #9	Closure time of containment low-volume purge isolation valve is 5 seconds.	15.6.5.5.1 Table 15.6.3-5
6-10	2.2.1 Table 2.2.1-1 2.8.1 ITAAC #1, #4	The plant shielding is designed to meet the radiation zone requirements for post-accident conditions.	12.3.2.3 Table 12.3-1
6-11	2.1 Table 2.1-1	Atmospheric dispersion (χ /Qs) values at EAB and LPZ used in radiological consequence analysis of DBAs	Tables 2.3-2 through 2.3-11