APR1400
DESIGN CONTROL DOCUMENT TIER 2

CHAPTER 14
VERIFICATION PROGRAMS

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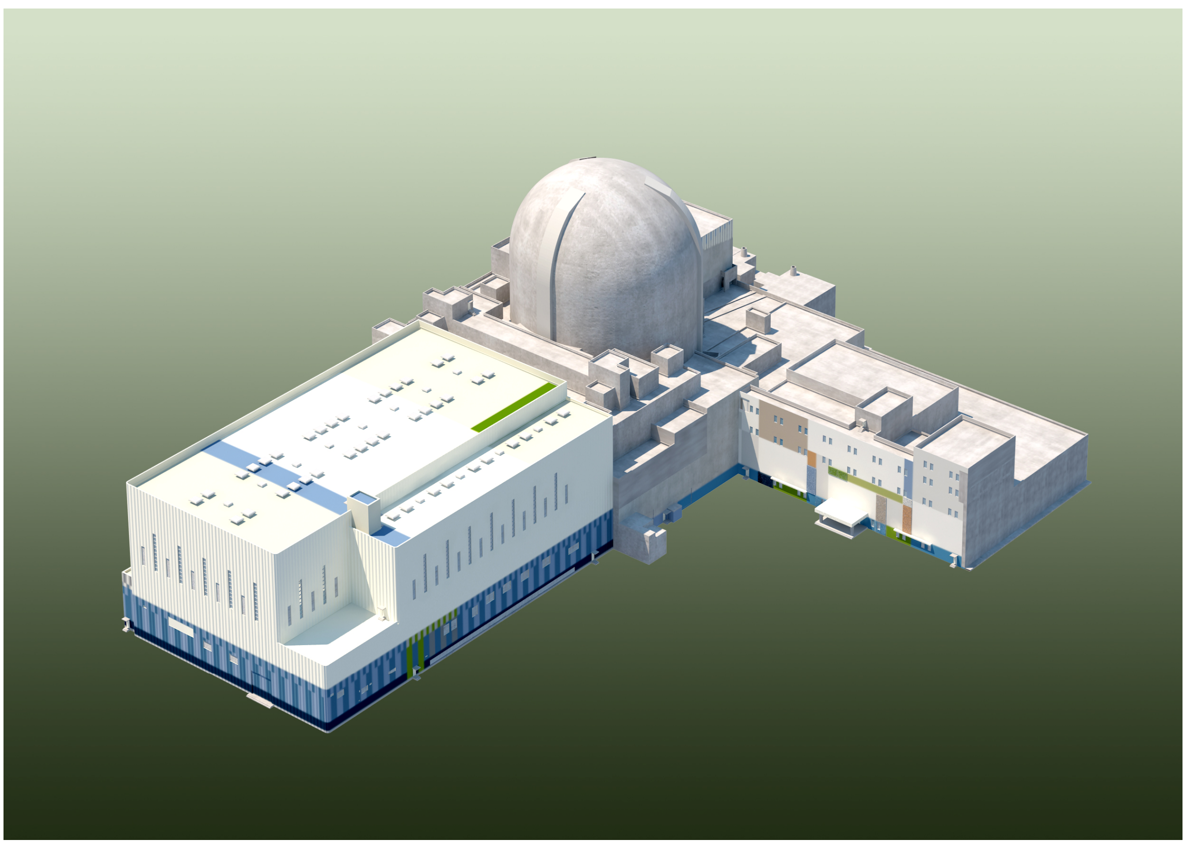

KOREA ELECTRIC POWER CORPORATION
KOREA HYDRO & NUCLEAR POWER CO., LTD

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
ASI	Axial Shape Index
ASME	American Society of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
BAST	Boric Acid Storage Tank
BOP	Balance Of Plant
BTP	Branch Technical Position
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
CFR	Code of Federal Regulations
CFS	Cavity Flooding System
CHCS	Containment Hydrogen Control System
CIAS	Containment Isolation Actuation Signal
COL	Combined License
COLA	Combined License Application
COLSS	Core Operating Limit Supervisory System
CPC	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
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
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 (or Signal)
ESF-CCS	Engineered Safety Features – Component Control System
ESW	Essential Service Water
ESWS	Essential Service Water System
FHEVAS	Fuel Handling Area Emergency Ventilation Actuation Signal
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 50, Appendix A)
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
HMS	Hydrogen Mitigation System
HRAS	High Radiation Actuation Signal
HVAC	Heating, Ventilation, and Air Conditioning

HVT	Holdup Volume Tank
HX	Heat Exchanger
I&C	Instrumentation And Control
IEEE	Institute of Electrical and Electronics Engineers
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
IVMS	Internal Vibration Monitoring System
LBB	Leak Before Break
LEL	Lower Electrical Limit
LOCA	Loss Of Coolant Accident
LOOP	Loss Of Offsite Power
LPMS	Loose Parts Monitoring System
LPZ	Low Population Zone
LTOP	Low Temperature Overpressure Protection
LWMS	Liquid Waste Management System
LWR	Light Water Reactor
MCR	Main Control Room
MFIV	Main Feedwater Isolation Valve
MG	Motor-Generator
MG Set	Motor-Generator Set
MOV	Motor-Operated Valve
MSADV	Main Steam Atmospheric Dump Valve
MSIS	Main Steam Isolation Signal
MSIV	Main Steam Isolation Valve
MSS	Main Steam System
MSSV	Main Steam Safety Valve
MT	Main Transformer
MTC	Moderator Temperature Coefficient

NEI	Nuclear Energy Institute
NPSH	Net Positive Suction Head
NSSS	Nuclear Steam Supply System
NUREG	U.S. Nuclear Regulatory Commission Regulation
OSC	Operational Support Center
PAR	Passive Autocatalytic Recombiner
PAT	Power Ascension Test
PERMSS	Process and Effluent Radiation Monitoring and Sampling System
PLCS	Pressurizer Level Control System
POSRV	Pilot Operated Safety Relief Valve
PPCS	Pressurizer Pressure Control System
PPS	Plant Protection System
PRA	Probabilistic Risk Assessment
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
RPS	Reactor Protection System
RRS	Required Response Spectra
RSC	Remote Shutdown Console
RSR	Remote Shutdown Room
RTD	Resistance Temperature Detector
RTP	Rated Thermal Power
RTSS	Reactor Trip Switchgear System
RV	Reactor Vessel
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
SGBDS	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 3&4	Shin-Kori Nuclear Power Plant Units 3&4
SRO	Senior Reactor Operator
SRP	Standard Review Plan
SSC	Structures, Systems, and Components
SSE	Safe Shutdown Earthquake
SWMS	Solid Waste Management System
T/G	Turbine-Generator
TGBCCW	Turbine Generator Building Closed Cooling Water
TGBOCWS	Turbine Generator Building Open Cooling Water System
TMI	Three Mile Island
TSC	Technical Support Center
TSP	Tri-sodium Phosphate
UHS	Ultimate Heat Sink
USNRC	United States Nuclear Regulatory Commission
VCT	Volume Control Tank

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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 50, Appendix B, Section XI, (Reference 3) as it relates to test programs demonstrating that structures, systems, and components (SSCs) perform satisfactorily

d. 10 CFR 50, Appendix J, Section III.A.4, (Reference 4) 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

e. 10 CFR 52.79(a)(28) (Reference 5) as it relates to preoperational testing and initial operations

f. 10 CFR 52, Subpart A, Subpart B, and Subpart C (Reference 6), as they relate to the inspections, tests, analysis, 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

l. Individual test descriptions

14.1.1 Combined License Information

No COL information is required with regard to Section 14.1.

14.1.2 References

1. Tests, "Rules of General Applicability to domestic Licensing of Byproduct Material," Energy, Title 10, Code of Federal Regulations, Part 30.53, U.S. Nuclear Regulatory Commission, Washington, DC.

2. Contents of Applications; Technical Information, "Domestic Licensing of Production and Utilization Facilities," Energy, Title 10, Code of Federal Regulations, Part 50.34, U.S. Nuclear Regulatory Commission, Washington, DC.

3. Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, " Domestic Licensing of Production and Utilization Facilities," Energy, Title 10,

Code of Federal Regulations, Part 50, Appendix B, U.S. Nuclear Regulatory Commission, Washington, DC.

4. Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors, "Domestic Licensing of Production and Utilization Facilities," Energy, Title 10, Code of Federal Regulations, Part 50, Appendix J, U.S. Nuclear Regulatory Commission, Washington, DC.

5. Contents of Applications; Technical Information, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Energy, Title 10, Code of Federal Regulations, Part 52.79, U.S. Nuclear Regulatory Commission, Washington, DC.

6. "Licenses, Certifications, and Approvals for Nuclear Power Plants," Energy, Title 10, Code of Federal Regulations, Part 52, U.S. Nuclear Regulatory Commission, Washington, DC.

14.2 Initial Plant Test Program

14.2.1 Summary of Test Program and Objectives

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 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

14.2.1.1 Phase I – Preoperational Testing

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, analysis, 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 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. Testing is performed at plateaus of approximately 20, 50, 80, and l00 percent power and is intended to demonstrate that the facility operates in accordance with its design during steady-state conditions and, to the extent practicable, during anticipated transients. 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.

14.2.2 Organization and Staffing

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.

14.2.3 Test Procedures

The plant operator provides reasonable assurance of the preparation and designate 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 initial test procedures and/or guidelines that are used for the conduct of the initial test program. 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 and provide preoperational and startup test summaries that contain testing objectives and acceptance criteria applicable for its scope of the plant design. The COL applicant is also to develop a startup administrative manual and supporting documents that delineate plant operational conditions at which tests are to be conducted, testing methodologies to be utilized, data to be collected, and data reduction techniques. The startup administrative manual and supporting documents are to be available for review during the COL application process. Testing performed at other than design operating conditions for systems are to be reconciled either through the test acceptance criteria or post-test data analysis. The COL applicant is to provide this information in conjunction with the development of the startup manual.

14.2.3.1 Test Procedure Preparation

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 Conduct of Test Program

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 Review, Evaluation, and Approval of Test Results

The COL applicant is to review and evaluate individual test results. 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 Test Records

A single copy of each test procedure is designated as the official copy to be used for testing. The official copy and information specifically called for in the test procedure, such as completed data sheets, instrumentation calibration data and chart recordings, are to be retained for the life of the plant by the COL applicant in accordance with NRC RG 1.28 (Reference 2) for record retention.

14.2.7 Conformance of Test Programs with NRC Regulatory Guides

Subsection 1.9.1 and Table 1.9-1 discuss compliance with the applicable NRC RGs. Table 14.2-7 provides the matrix of applicable guidance of 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.

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 Reference Appendix A, Section 1.k. (2)

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 Reference Appendix A, Section 1.n. (15)

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 Reference Appendix A, Section 4.s

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 Reference Appendix A, Section 5.a

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 Reference Section C, Regulatory Position 4

This section requires inclusion of acceptance criteria that account for uncertainties. The test summaries in Subsections 14.2.12.2.1 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"

Regulatory Position C.9 of NRC RG 1.68.3 (Reference 5) requires that testing demonstrate that the plant equipment designated by design to be supplied by the instrument air system is not being supplied by other compressed air supplies (such as the service air system), which may have less restrictive air quality requirements. The APR1400 instrument air system is supplied for control and instrument facilities, and 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 are 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.

The COL applicant is also to provide a summary description of preoperational and/or startup testing that is planned for each unique or first-of-a-kind principal design feature that may be included in the facility design. The summary test description is to include the test method, objective, and frequency (e.g., first-plant-only test, first-three-plant tests) necessary to validate design or analysis assumptions. The COL application also includes the justification for not including preoperational and/or startup testing for any unique or first-of-a-kind design features such as reactor internals vibration measurement, natural circulation test, pressurizer surge line thermal stratification test, reactor coolant pump seal test, and/or pseudo ejected CEA and dropped CEA test.

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.

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.

14.2.10 Initial Fuel Loading and Initial Criticality

14.2.10.1 Initial Fuel Loading

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 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 cavity 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 ex-core nuclear channel in the event that one of the temporary channels becomes inoperative. Both temporary and permanent channels are response checked 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 Safe Loading Criteria

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 Fuel Loading Procedure

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.

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.

14.2.10.2.1 Safe 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 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 Test Program Schedule

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 nine months for conducting preoperational testing and at least three 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 Testing Sequence

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 t 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 Individual Test Descriptions

14.2.12.1 Preoperational Tests

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 OBJECTIVE

1.1 To verify the proper operation of each reactor coolant pump motor

1.2 To collect base data for each RCP motor

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 component cooling water (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

5.0 ACCEPTANCE CRITERIA

5.1 The RCP motors, support systems, alarms, indications, and interlocks perform as described in Subsection 5.4.1.

14.2.12.1.2 Reactor Coolant System Test

1.0 OBJECTIVE

1.1 To perform the initial venting of the RCPs and the reactor coolant system (RCS)

1.2 To perform the initial operation of the RCPs

1.3 To verify RCP performance

1.4 To verify alarm setpoints

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 temperature, pressure, and flow signals from each RCP and verify alarm setpoints.

3.2 Simulate temperature signals from each RCS resistance temperature detector (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

5.0 ACCEPTANCE CRITERIA

5.1 RCS and RCP performance and alarms are as described in Subsections 5.4.1 and 5.4.3.

14.2.12.1.3 Pressurizer Pilot-operated Safety Relief Valve Test

1.0 OBJECTIVE

1.1 To verify the opening/closing pressure and opening time of the pressurizer pilot-operated safety relief valves (POSRVs)

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 time and opening time.

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 time and opening time

5.0 ACCEPTANCE CRITERIA

5.1 POSRVs perform as described in Subsection 5.4.14.

14.2.12.1.4 Pressurizer Pressure and Level Control Systems Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the pressurizer pressure control system (PPCS) and pressurizer level control system (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.

14.2.12.1.5 Chemical and Volume Control System Letdown Subsystem Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the chemical and volume control system (CVCS) letdown subsystem during normal and emergency operation

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 safety injection actuation/containment isolation actuation signals (SIAS/CIAS) and observe isolation valve response.

3.3 Simulate letdown temperature and observe the response of control 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 control valves to simulated letdown temperature

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.

14.2.12.1.6 Volume Control Tank Subsystem Test

1.0 OBJECTIVE

1.1 To verify proper operation of the volume control tank (VCT) subsystem

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 alarm operation.

3.3 Vent the VCT and repressurize using the hydrogen pressurization system. (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 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.

14.2.12.1.7 Chemical and Volume Control System Charging Subsystem Test

1.0 OBJECTIVE

1.1 To verify the proper performance of the chemical and volume control system (CVCS) charging subsystem

2.0 PREREQUISITES

2.1 Construction activities on the reactor coolant charging subsystem have been completed.

2.2 The CVCS charging subsystem is operational to supply charging pump suction.

2.3 The volume control tank (VCT) subsystem is operational to supply charging pump suction.

2.4 The reactor vessel (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 Reactor coolant pumps (RCP) are operational.

2.7 Support systems required for operation of the reactor coolant 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 Simulate pressurizer level error signals and observe charging control valve response.

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.

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 simulated pressurizer level error signals

4.7 Setpoints at which alarms and interlocks occur

4.8 Seal injection flow rates

4.9 Auxiliary spray flow rates

4.10 Pump head vs. flow

5.0 ACCEPTANCE CRITERIA

5.1 The CVCS charging subsystem performs as described in Subsection 9.3.4.2.1.

14.2.12.1.8 Chemical Addition Subsystem Test

1.0 OBJECTIVE

1.1 To demonstrate that the chemical addition subsystem can inject water into the charging pump suction line

1.2 To verify a flow path from the chemical addition tank to the miscellaneous liquid waste management system

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 With a charging pump in operation, start the chemical addition metering pump and observe the chemical addition tank level.

3.2 Drain the chemical addition tank to the miscellaneous liquid waste management system and observe the chemical addition tank level.

4.0 DATA REQUIRED

4.1 Chemical addition tank levels

5.0 ACCEPTANCE CRITERIA

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 miscellaneous 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.

14.2.12.1.9 Reactor Drain Tank Subsystem Test

1.0 OBJECTIVE

1.1 To verify the proper performance of the reactor drain tank (RDT) subsystem

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 equipment drain tank 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 containment isolation actuation signal (CIAS) and observe isolation valve response.

3.3 Fill the RDT from any convenient source and observe level and pressure indications and alarms.

3.4 Using the N_2 system, pressurize the RDT and observe indications and alarms.

3.5 Line up the RDT and drain the RDT using each RDT pump. Observe level and pressure indicators, alarms, and interlocks.

3.6 Simulate RDT temperature and observe indicators and alarms.

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

5.0 ACCEPTANCE CRITERIA

5.1 The RDT subsystem performs as described in Subsections 9.3.4, 9.3.4.2.8.1, and 9.3.4.2.8.3

14.2.12.1.10 Equipment Drain Tank Subsystem Test

1.0 OBJECTIVE

1.1 To verify the proper performance of the equipment drain tank (EDT) subsystem

2.0 PREREQUISITES

2.1 Construction activities on the EDT subsystem have been completed.

2.2 EDT subsystem instrumentation has been calibrated.

2.3 Holdup tank subsystem is operational.

2.4 RDT subsystem is operational.

2.5 Reactor makeup subsystem 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 Fill the EDT from the reactor makeup water subsystem and observe indications, alarms, and interlocks.

3.3 Drain the EDT using a reactor drain tank pump and observe indications, alarms, and interlocks.

3.4 Simulate high EDT temperature and observe indications and alarms.

3.5 Simulate high EDT pressure and observe indications and alarms.

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 and 9.3.3.2.4.

14.2.12.1.11 Boric Acid Batching Tank Subsystem Test

1.0 OBJECTIVE

1.1 To verify proper operation of the boric acid batching tank subsystem

2.0 PREREQUISITES

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

2.2 The in-containment refueling water storage tank (IRWST) subsystem is operational.

2.3 Support systems required for operation of the boric acid batching tank are complete and operational.

2.4 The boric acid batching tank subsystem is operational.

3.0 TEST METHOD

3.1 Fill the boric acid batching tank with water from the RMW system. Energize heaters and measure the length of time required to heat the tank. Observe heater control setpoints.

3.2 Line up the boric acid batching tank to the boric acid storage tank. Start a boric acid makeup pump and observe the batching tank level.

3.3 Line up the boric acid batching tank to the IRWST. Start a boric acid makeup pump and observe the batching tank level to the IRWST.

3.4 Refill the boric acid batching tank, dissolve boric acid crystals, and start the batch tank mixer. Take samples as the tank is drained to the equipment drain tank 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

5.0 ACCEPTANCE CRITERIA

5.1 The boric acid batching tank subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.3.

14.2.12.1.12 Concentrated Boric Acid Subsystem Test

1.0 OBJECTIVE

1.1 To verify the proper performance of the concentrated boric acid subsystem

2.0 PREREQUISITES

2.1 Construction activities of the concentrated boric acid and boric acid storage tank (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 volume control tank (VCT) subsystem is complete and operational.

2.5 The boric acid batching tank 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 boric acid batching tank subsystem and observe level alarm setpoints.

3.3 Operate each boric acid makeup (BAMU) pump and observe pump performance.

3.4 Operate BAMU pumps using all interconnections between BAMU pumps and BAST.

3.5 Line up the BAMU to charging pump suction and verify ability of the BAMU pumps 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 high and low BAST temperature and observe indications, alarms, and controls.

3.9 Line up the BAMU pumps to the VCT and verify that the makeup system is capable of supplying BAMU 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 BAMU pumps.

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 BAMU pump 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

5.0 ACCEPTANCE CRITERIA

5.1 The concentrated boric acid subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.8.1.

14.2.12.1.13 Reactor Makeup Subsystem Test

1.0 OBJECTIVE

1.1 To verify the performance of the reactor makeup water (RMW) subsystem

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 reactor makeup water tank (RMWT) and observe level indications and alarms.

3.3 Simulate RMWT temperature and observe indications and alarms.

3.4 Drain the RMWT using each RMW pump. 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 RMW pump.

3.7 Verify makeup to volume control tank and boric acid storage tank through the RMW pumps.

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 RMW pump discharge pressure

4.5 RMWT filter differential pressure

4.6 Setpoints of alarms and interlocks

4.7 Pump head vs. flow

4.8 Volume control tank and boric acid storage tank levels

5.0 ACCEPTANCE CRITERIA

5.1 The RMW subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.8.1.

14.2.12.1.14 Holdup Subsystem Test

1.0 OBJECTIVE

1.1 To verify proper operation of the holdup subsystem

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 tank 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

5.0 ACCEPTANCE CRITERIA

5.1 The holdup subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.8.1.

14.2.12.1.15 <u>Boric Acid Concentrator Subsystem Test</u>

1.0 OBJECTIVE

1.1 To verify the performance of the boric acid concentrator subsystem

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

5.0 ACCEPTANCE CRITERIA

5.1 The boric acid concentrator subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.2.

14.2.12.1.16 <u>Gas Stripper Subsystem Test</u>

1.0 OBJECTIVE

1.1 To verify proper operation of the gas stripper subsystem

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

5.0 ACCEPTANCE CRITERIA

5.1 The gas stripper subsystem performs as described in Subsections 9.3.4 and 9.3.4.2.8.7.

14.2.12.1.17 Boronometer Subsystem Test

1.0 OBJECTIVE

1.1 To demonstrate proper operation of the boronometer

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.

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 7.7.1.1f.

14.2.12.1.18 Process Radiation Monitor Subsystem Test

1.0 OBJECTIVE

1.1 To demonstrate proper operation of the process radiation monitor

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.

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 9.3.4.5.6.

14.2.12.1.19 Gas Stripper Effluent Radiation Monitor Subsystem Test

1.0 OBJECTIVE

1.1 To demonstrate proper operation of the gas stripper effluent radiation monitor subsystem

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.

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 gas stripper effluent radiation monitor subsystem performs as described in Subsection 9.3.4.5.5.

14.2.12.1.20 Shutdown Cooling System Test

1.0 OBJECTIVE

1.1 To demonstrate proper operation of shutdown cooling system and the shutdown cooling pumps

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.

2.6 The low-temperature overpressure protection (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 shutdown cooling system (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 Subsection 5.4.7 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.

14.2.12.1.21 Safety Injection System Test

1.0 OBJECTIVE

1.1 To functionally test the operation and performance of the components within the safety injection system (SIS), including valve and pump performance

1.2 To verify proper SI response to a safety injection actuation signal (SIAS) using normal, alternate, and emergency power sources

1.3 To verify the flow paths through the direct vessel injection (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 in-containment refueling water storage tank (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.

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 Subsection 6.3.2 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 reactor coolant system (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 net positive suction head (NPSH) requirements when corrected for IRWST minimum level attainable during an SIAS and maximum IRWST fluid temperature. Operate each SI pump available for hot leg injection (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.

14.2.12.1.22 Safety Injection Tank Subsystem Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the safety injection tank (SIT) subsystem

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 direct vessel injection (DVI) nozzles.

2.6 SIT subsystem instrumentation has been checked 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 opens.

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

5.0 ACCEPTANCE CRITERIA

5.1 The SIT subsystem performs as described in Subsection 6.3.2.2.2.

14.2.12.1.23 Engineered Safety Features – Component Control System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the engineered safety features – component control system (ESF-CCS)

2.0 PREREQUISITES

2.1 Construction activities on the engineered safety feature actuation system (ESFAS) have been completed.

2.2 ESFAS instrumentation has been calibrated.

2.3 External test instrumentation is available and calibrated.

2.4 Support systems required for operation of the ESFAS are operational.

3.0 TEST METHOD

3.1 Energize power supplies and observe output voltages.

3.2 Simulate ground faults and observe operation of the ground fault detectors.

3.3 Individually de-energize each group relay and monitor contact operation.

3.4 Test manual trips and monitor relay operation.

3.5 De-energize all combinations of the two-out-of-four trip logic for each of the actuation systems (SIAS, CIAS, CSAS, MSIS, AFAS) and observe actuation of the appropriate trip circuit and associated alarms.

3.6 De-energize combinations of the one-out-of-two trip logic for each balance-of-plant (BOP) ESFAS (CREVAS, FHEVAS, CPIAS) and observe actuation of the appropriate trip circuit and associated alarms.

3.7 Simulate inputs to the appropriate circuits and observe trip initiations.

3.8 Exercise the manual control functions to the safety depressurization and shutdown cooling system to verify proper operation.

3.9 Exercise automatic and manual test functions to verify control functions of ESF-CCS.

3.10 Test control transfer function from the main control room (MCR) to the remote shutdown room (RSR) and observe the status of plant equipment.

4.0 DATA REQUIRED

4.1 Power supply voltages

4.2 Resistance for ground fault detector operation

4.3 Response to manual trips

4.4 Response to logic trips

4.5 Trip setpoints

4.6 Automatic and manual test function outputs and displays

4.7 Response to control transfer function

5.0 ACCEPTANCE CRITERIA

5.1 The ESF-CCS performs as described in Subsection 7.3.1.

14.2.12.1.24 Plant Protection System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the plant protection system (PPS)

1.2 To determine the reactor protection system (RPS) and the engineering safety features actuation system (ESFAS) response times

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 instrumentation has been calibrated.

2.3 External test instrumentation is available and calibrated.

2.4 Support systems required for operation of the trip circuit breakers, ESF-CCS, and PPS are operational.

3.0 TEST METHOD

3.1 Energize power supplies and verify output voltage.

3.2 Simulate ground faults and observe operation of the ground fault detectors.

3.3 Using simulated reactor trip signals, trip each reactor trip circuit breaker with the breaker in the test position. Observe circuit breaker operation.

3.4 Repeat Step 3.3 with the reactor trip circuit breakers in the operate position.

3.5 Exercise the bistable comparators using internal and external test circuitry and observe the setpoints and operation of the appropriate ESFAS logic.

3.6 Check the operation of trip channel bypass features including, where applicable, observation of the setpoints at which the trip bypasses are canceled automatically.

3.7 Test manual trips and observe relay operation.

3.8 Check that low pressurizer pressure and low steam generator pressure trip setpoints track the process variable at the prescribed rate and can be manually reset to the proper margin below the process variable.

3.9 Using the installed testing devices, observe test functions and verify proper local coincidence logic (LCL) operation.

3.10 Using manually initiated semi-automatic test functions to trip the reactor trip circuit breakers and ESF-CCS interfaces, observe interlock, alarm, and interface operation.

3.11 Verify proper operation of the core protection calculator system by input/output and internal function tests.

3.12 Inject signals into appropriate sensors or sensor terminals and measure the elapsed time to achieve tripping of the reactor trip circuit breakers or actuation of the ESFAS actuation relays. Trip or actuation paths may be tested in several segments.

4.0 DATA REQUIRED

4.1 Power supply voltages

4.2 Resistance for ground fault detector operation

4.3 Circuit breaker and indicator operation

4.4 Point of actuation of bistable comparators

4.5 Reset margin and rate of setpoint change of variable setpoints

4.6 Maximum and minimum values of variable setpoints

4.7 RPS and ESF trip and actuation path response times

4.8 LCL operation

5.0 ACCEPTANCE CRITERIA

5.1 The PPS performs 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.

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

1.0 OBJECTIVE

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

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.

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.

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 Subsection 7.7.1.1 h.

14.2.12.1.26 Fixed In-core Nuclear Signal Channel Test

1.0 OBJECTIVE

1.1 To measure cable insulation resistance

1.2 To verify proper amplifier operation

2.0 PREREQUISITES

2.1 Construction activities on the in-core nuclear instrumentation system are complete. (Detectors do not need to be installed.)

2.2 Fixed in-core nuclear signal channel instrumentation 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.

14.2.12.1.27 <u>Digital Rod Control System</u>

1.0 OBJECTIVE

1.1 To demonstrate proper input signals and proper sequencing of input signals to control element drive mechanism (CEDM) coils

1.2 To demonstrate proper operation of the digital rod control system (DRCS) in all modes

1.3 To verify proper operation of the DRCS interlocks and alarms

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 control element assembly (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 digital rod control system (DRCS) performs as described in Subsections 7.7.1.1 a, 4.6.1, and 4.6.2.

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

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the reactor regulating system (RRS)

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.

14.2.12.1.29 Steam Bypass Control System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the steam bypass control system (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.

Note: 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.

14.2.12.1.30 Feedwater Control System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the feedwater control system (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.

14.2.12.1.31 Core Operating Limit Supervisory System Test

1.0 OBJECTIVE

1.1 To verify proper operation of the core operating limit supervisory system (COLSS) application program contained in the information processing system (IPS)

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.

14.2.12.1.32 <u>Reactor Power Cutback System Test</u>

1.0 OBJECTIVE

1.1 To demonstrate proper operation of the reactor power cutback system (RPCS)

2.0 PREREQUISITES

2.1 Construction activities on the RPCS have been completed.

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.

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 Handling and Storage System Test

1.0 OBJECTIVE

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 assemblies, 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 bridge, checking bridge, trolley, hoist speeds, load limits, interlocks, and limit switches.

3.3 Using the X-Y coordinates and the spent fuel handling machine, trial fit each of the usable spent fuel storage rack positions using the dummy fuel assembly.

3.4 Verify the transfer system using both 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, trial fit the core locations and record coordinates.

3.8 Verify the proper operation of the CEA change platform and elevator, including operating speeds, interlocks, load limits, and limit switches.

3.9 Verify the following:

3.9.1 Using the full sequence of focusing, camera tilt and camera rotation, 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 area 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.

4.0 DATA REQUIRED

4.1 Applicable indexing coordinates

4.2 Monitoring instrumentation responses

5.0 ACCEPTANCE CRITERIA

5.1 The fuel handling and storage system performs as described in Section 9.1.

14.2.12.1.34 Auxiliary Feedwater System Test

1.0 OBJECTIVE

1.1 To demonstrate the ability of the auxiliary feedwater system (AFWS) to supply feedwater to the steam generators for design emergency conditions

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 turbine-driven 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 flow downstream of venturi meets design requirement.

3.6 Verify proper operation in response to signals from the plant protection system and the diverse protection system.

3.7 Verify, if appropriate, proper operation, stroking speed, and position indication of control valves.

3.8 Verify AFW discharge line isolation valves stroke properly with design basis differential pressure across them.

3.9 Verify proper operation of protective devices, controls, interlocks, instrumentation, and alarms using actual or simulated inputs.

3.10 Demonstrate proper pump performance during an endurance test.

3.11 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 auxiliary feedwater pumps to engineering safety features actuation system (ESFAS) signals

4.6 Pump start times

4.7 Position response of valves to loss of motive power

5.0 ACCEPTANCE CRITERIA

5.1 The AFWS performs as described in Subsections 7.3.1.9 e and 10.4.9.

14.2.12.1.35 Reactor Coolant System Hydrostatic Test

1.0 OBJECTIVE

1.1 To verify the integrity of the reactor coolant system (RCS) pressure boundary and associated safety Class 1 piping

2.0 PREREQUISITES

2.1 The RCS is filled and 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 or 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.

14.2.12.1.36 <u>Control Element Drive Mechanism Cooling System Test</u>

1.0 OBJECTIVE

1.1 To verify the proper operation of the control element drive mechanism cooling system (CEDMCS)

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 CEDMCS performs as described in Subsection 9.4.6.2.1.3.

14.2.12.1.37 Safety Depressurization and Vent System Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the reactor coolant gas vent function

1.2 To verify the flow paths for the rapid depressurization function of pilot-operated safety relief valves (POSRVs)

2.0 PREREQUISITES

2.1 Construction activities on the system to be tested are essentially 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.

3.0 TEST METHOD

3.1 Verify flow paths through the reactor coolant gas vent system from the pressurizer to the reactor drain tank and to the in-containment refueling water storage tank (IRWST).

3.2 Verify flow paths through the reactor coolant gas vent system from the reactor vessel to the reactor drain tank and to the IRWST.

3.3 Verify that the reactor coolant gas vent system (both the pressurizer vent and the reactor vessel upper head vent) meets design depressurization rates.

3.4 Verify flow paths through manually operated POSRVs from the pressurizer to the IRWST, using water or air.

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

5.0 ACCEPTANCE CRITERIA

5.1 The reactor coolant gas vent system allows venting of the pressurizer and reactor vessel through designed flow paths, as described in Subsection 5.4.12.

5.2 The reactor coolant gas vent system (both the pressurizer vent and the reactor vessel upper head vent) meets the design depressurization rates, as presented in Table 5.4.14-1.

5.3 The safety depressurization and vent system provides a depressurization path through designed flow paths, as described in Subsection 5.4.12.

14.2.12.1.38 Containment Spray System Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the containment spray system (CSS) and the containment spray pumps

1.2 To verify proper operation of the emergency containment spray backup system (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 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 emergency containment spray backup pumping device connectability to the containment spray tee connection. Verify pumping device performance, including head and flow characteristics.

3.10 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 system and containment spray pumps perform as described in Subsection 6.2.2.2.

5.2 The ECSBS performs as described in Subsection 6.2.2.2.

14.2.12.1.39 Integrated Engineered Safety Features / Loss of Power Test

1.0 OBJECTIVE

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.

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.

3.3 Demonstrate the proper diesel generator response to loss of power including bus energization, load sequencing, and load-carrying capability. Verify that full load is within the emergency diesel generator design capability.

3.4 Demonstrate proper response to actual or simulated engineered safety features actuation signals (ESFAS).

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 The ESFs respond as described in Chapters 6 and 9 and in Sections 7.3, 8.3, and 10.4.

5.2 Electrical redundancy, independence, and load group assignments are as designed.

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 OBJECTIVE

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)

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 HVT and reactor cavity.

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 pressure relief dampers.

3.8 Verify proper operation of spillways by visually observing flow path capability from the IRWST through the HVT spillway to the reactor cavity spillway.

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 Pressure relief damper opening pressure

5.0 ACCEPTANCE CRITERIA

5.1 The in-containment water storage system performs as described in Section 6.8.

14.2.12.1.41 Internals Vibration Monitoring System Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the internals vibration monitoring system (IVMS) of the nuclear steam supply system integrity monitoring system (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.

14.2.12.1.42 Loose Parts Monitoring System Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the loose parts monitoring system (LPMS) of the NSSS integrity monitoring system (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 baseline monitoring data for a cold, subcritical plant.

3.4 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.

5.2 The loose parts alarm setpoints have been adjusted for power operation.

14.2.12.1.43 Acoustic Leak Monitoring System Test

1.0 OBJECTIVE

1.1 To verify proper operation of the acoustic leak monitoring system (ALMS) of the NSSS integrity monitoring system (NIMS)

1.2 To adjust the alarm setpoints under operational conditions.

1.3 To verify automated calibration features

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.

2.5 Data analysis, storage, and trending software 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 baseline monitoring data under operating conditions for a cold, subcritical plant.

3.4 Verify the automated electronics calibration functions.

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.

5.2 The alarm setpoints have been established.

14.2.12.1.44 Information Processing System and Qualified Information and Alarm System Test

1.0 OBJECTIVE

1.1 To verify that the information processing system (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 qualified information and alarm system (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 Turbine Generator Building Open Cooling Water System Test

1.0 OBJECTIVE

1.1 To demonstrate the ability of turbine generator building open cooling water system (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 circulating water system (CWS) discharge header is available to receive flow.

3.0 TEST METHOD

3.1 Verify system flow from the CWS meets design.

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.

14.2.12.1.46 Pre-core Hot Functional Test Controlling Document

1.0 OBJECTIVE

To demonstrate the proper integrated operation of plant systems when in simulated or actual operating configurations. This shall include 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 are 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 pre-core hot functional test appendices.

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 reactor coolant system (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 Pre-core Instrument Correlation

1.0 OBJECTIVE

1.1 To demonstrate that the inputs and appropriate outputs between the plant protection system (PPS), process instrumentation, qualified

indication and alarm system (QIAS), and information processing system (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 wide-range process instrumentation QIAS and IPS readings as directed by the pre-core hot functional test.

3.2 Record narrow-range process instrumentation 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 narrow-range instrument readings agree within the accuracy of the instrumentation as described in Subsections 7.7.1.4 and 7.5.1.1.

5.2 All wide-range 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 Remote Shutdown Console Test

1.0 OBJECTIVE

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.

2.2 All remote shutdown console instrumentation has been calibrated.

2.3 The communication systems between the main control room (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 ability to cool down using remote shutdown instrumentation and controls has been demonstrated.

5.2 The remote shutdown console performs as described in Subsection 7.4.1.1 l.

14.2.12.1.49 Diverse Protection System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the diverse protection system (DPS)

2.0 PREREQUISITES

2.1 Construction activities on the reactor trip switch system (RTSS) and the DPS have been completed.

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 signals, trip each reactor trip circuit breaker with the breaker in the test position. Observe RTSS trip circuit breaker operation.

3.3 Using simulated input signals, observe alternate auxiliary feedwater actuation signals.

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 The DPS performs as described in Section 7.8.

14.2.12.1.50 Pre-core Test Data Record

1.0 OBJECTIVE

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 OBJECTIVE

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

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 vessels keys, and RCP columns.

2.3 Initial ambient dimensions for the steam generator, reactor vessel, and RCP supports have been recorded.

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, and RCP clearances.

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 at hydraulic snubbers

4.3 Clearance between the reactor vessel upper and lower supports and expansion plates

4.4 Reactor vessel support temperature

4.5 Clearances at the RCP snubbers, column joints, and piston setting for the hydraulic snubbers

4.6 Clearances at all test points after cooldown

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 Subsection 3.9.2

14.2.12.1.52 Pre-core Reactor Coolant and Secondary Water Chemistry Data

1.0 OBJECTIVE

1.1 To demonstrate that proper water chemistry for the RCS and steam generator can be maintained

2.0 PREREQUISITES

2.1 Primary and secondary sampling systems are operable.

2.2 Chemicals 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 Minimum sampling frequency for the steam generator and RCS is specified by the chemistry manual. The sampling frequency is modified as required to provide reasonable assurance of the proper RCS and steam generator water chemistry.

3.2 Perform RCS and steam generator 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 Steam generator chemistry analysis

4.3 RCS chemistry analysis

5.0 ACCEPTANCE CRITERIA

5.1 RCS and steam generator water chemistry can be maintained as described in Subsections 9.3.4 and 10.3.5.

14.2.12.1.53 Pre-core Pressurizer Performance Test

1.0 OBJECTIVE

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 flow control valves and charging pumps

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 a low-low pressurizer level 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 Pre-core Control Element Drive Mechanism Performance Test

1.0 OBJECTIVE

1.1 To determine the effectiveness of the control element drive mechanism cooling system (CEDMCS) 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 CEDMCS 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 CEDMCS cabinets and energize the CEDM. Measure and record the dc voltage across the upper gripper coil and across the shunt on the CEDMCS power switch assembly panel.

3.4 Operate the CEDM and observe count totalizer operation.

4.0 DATA REQUIRED

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

4.7 CEDM count totalizer readings

5.0 ACCEPTANCE CRITERIA

5.1 The CEDMCS performs as described in Subsection 7.7.1.1 a.

14.2.12.1.55 Pre-core Reactor Coolant System Flow Measurements

1.0 OBJECTIVE

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 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 and 7.2.1.1.

14.2.12.1.56 Pre-core Reactor Coolant System Heat Loss Measurement

1.0 OBJECTIVE

1.1 To measure reactor coolant system (RCS) heat loss under HZP conditions

1.2 To measure pressurizer heat loss under HZP conditions

2.0 PREREQUISITES

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(1) 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.

4.0 DATA REQUIRED

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

5.0 ACCEPTANCE CRITERIA

5.1 The measured heat loss is less than the capacity of the containment cooling subsystem to remove the heat loads as described in Subsection 9.4.6.

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(1) 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 14.2.12.2.6.

14.2.12.1.57 Pre-core Reactor Coolant System Leak Rate Measurement

1.0 OBJECTIVE

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.

4.0 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 Equipment drain tank level, temperature, and pressure

4.5 RCS temperature and pressure

4.6 Safety injection tank level and pressure

4.7 Time interval

5.0 ACCEPTANCE CRITERIA

5.1 Identified and unidentified leakage are within the limits described in the Technical Specification as described in Subsection 5.2.5.

14.2.12.1.58 Pre-core Chemical and Volume Control System Integrated Test

1.0 OBJECTIVE

1.1 To verify proper operation of the letdown subsystem and ion exchangers and charging subsystem

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 Measure and record the pressure drops across the ion exchanger, filter, and strainer.

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 The CVCS performs as described in Subsection 9.3.4.

14.2.12.1.59 Pre-core Safety Injection Check Valve Test

1.0 OBJECTIVE

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

2.0 PREREQUISITES

2.1 The RCS is at HZP conditions.

2.2 SITs are filled and pressurized to their normal operating conditions.

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).

4.0 DATA REQUIRED

4.1 SIT level and pressure

4.2 SI discharge header pressure

5.0 ACCEPTANCE CRITERIA

5.1 Verification that the loop check valves and SIT discharge check valves pass flow with the RCS at HZP conditions as described in Section 6.3.

14.2.12.1.60 Pre-core Boration / Dilution Measurements

1.0 OBJECTIVE

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) is filled with borated water.

2.2 The boron addition 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 Line up the boric acid makeup (BAMU) pumps to take suction from the BAST and discharge to the charging pump suction and to the RCS, and observe operation of the boron addition system.

3.2 Perform a boration and dilution operation of the RCS by operating the boric acid makeup control system in its various modes of operation.

3.3 Sample the RCS during boration and dilution operations and observe operation of the boronometer.

4.0 DATA REQUIRED

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 The boration subsystem performs as described in Subsection 9.3.4.2.

14.2.12.1.61 Downcomer Feedwater System Water Hammer Test

1.0 OBJECTIVE

1.1 To demonstrate the absence of any significant water hammer during steam generator water level recovery following the exposure of the downcomer feedwater sparger to a steam environment

2.0 PREREQUISITES

2.1 Construction activities on the auxiliary feedwater system (AFWS) and those sections of the feedwater system (FWS) that are affected have been completed.

2.2 Feedwater control system (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 (HZP) conditions (hot standby).

3.0 TEST METHOD

3.1 Lower the steam generator water level below the feedwater sparger but within the narrow-range (NR) 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 [2] 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 [3] have not been violated.

14.2.12.1.62 Main Turbine Systems Test

1.0 OBJECTIVE

1.1 To verify the functional performance of the main turbine controls

1.2 To verify the functional performance of the main turbine support system

1.3 To perform initial operation of the main turbine system (HFT and PAT)

1.4 To verify the main turbine generator trips in response to a simulated reactor trip signal and to a simulated loss of condenser vacuum signal

2.0 PREREQUISITES

2.1 Construction activities on the main turbine system are complete.

2.2 Main turbine system instrumentation has been calibrated.

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

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

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 (EHC) 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.

4.0 DATA REQUIRED

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.

14.2.12.1.63 Main Steam Safety Valve Test

1.0 OBJECTIVE

1.1 To verify the popping pressure of the main steam safety valves (MSSVs) during hot functional testing (HFT)

2.0 PREREQUISITES

2.1 Construction activities on the MSSVs have been completed.

2.2 Main steam system (MSS) 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.

4.0 DATA REQUIRED

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.

14.2.12.1.64 Main Steam Isolation Valves and MSIV Bypass Valves Test

1.0 OBJECTIVE

1.1 To demonstrate the functional performance of the main steam isolation valves (MSIVs) and MSIV bypass valve controls

1.2 To demonstrate the proper operation of the MSIVs at normal operating temperatures (HFT) and during normal and emergency operating conditions

2.0 PREREQUISITES

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 is calibrated.

2.5 MSIV accumulators are charged and associated hydraulic systems are operational.

3.0 TEST METHOD

3.1 Operate the MSIVs and MSIV bypass valves 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 MSIV bypass valves fail to the position indicated in Figure 10.3.2-1 on loss of motive power.

3.3 Verify MSIV and MSIV bypass valve controls, alarms, and interlocks.

3.4 Verify MSIV and MSIV bypass valve response to main steam isolation signal.

3.5 Verify MSIV and MSIV bypass valve seat leakage.

3.6 Perform MSIV drift test.

4.0 DATA REQUIRED

4.1 MSIV and MSIV bypass valve 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 MSIV bypass valve seat leakage

4.6 MSIV and MSIV bypass valve response to MSIS

4.7 MSIV drift data

5.0 ACCEPTANCE CRITERIA

5.1 The MSIVs and MSIV bypass valves operate as described in Subsections 10.3.2.2.2.

5.2 The MSIVs and MSIV bypass valves meet the test acceptance criteria described in Subsection 10.3.4.

14.2.12.1.65 Main Steam System Test

1.0 OBJECTIVE

1.1 To demonstrate the operation of the main steam system (MSS)

2.0 PREREQUISITES

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 is calibrated.

2.5 The main condenser is available to receive steam during hot functional test (HFT) condition.

3.0 TEST METHOD

3.1 Demonstrate automatic drain valve operation.

3.2 Demonstrate 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 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.

14.2.12.1.66 Steam Generator Blowdown System Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the steam generator blowdown system (SGBDS)

2.0 PREREQUISITES

2.1 Construction activities on the SGBDS have been completed.

2.2 SGBDS instrumentation has been calibrated.

2.3 Support systems required for operation of the SGBDS are complete and operational.

2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Verify the 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 ability to regenerate resin.

3.7 Verify the proper operation of all protective devices, controls, interlocks, and alarms, using actual or simulated inputs.

3.8 Verify the proper system response to containment isolation actuation signal (CIAS), main steam isolation signal (MSIS), and auxiliary feedwater actuation signal (AFAS).

3.9 Verify steam generator wet layup system operation.

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 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 SGBDS operates as described in Subsection 10.4.8.

14.2.12.1.67 Main Condenser and Condenser Vacuum Systems Test

1.0 OBJECTIVE

1.1 To demonstrate the ability of the main condenser and condenser vacuum systems to provide a continuous heat sink for normal operation as well as a sink for the turbine bypass system under certain conditions

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 Turbine is on turning gear.

2.7 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.

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.

14.2.12.1.68 Feedwater System Test

1.0 OBJECTIVE

1.1 To demonstrate that the feedwater system (including startup feedwater) is capable of supplying feedwater to the steam generators for normal operation

2.0 PREREQUISITES

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 pump.

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 main feedwater isolation valves (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 main steam isolation signal (MSIS).

4.0 DATA REQUIRED

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.

14.2.12.1.69 Condensate System Test

1.0 OBJECTIVE

1.1 To demonstrate that the condensate system is capable of supplying an adequate flow of water at the design pressure to support the remainder of the power conversion system

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 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 deareator.

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.

14.2.12.1.70 Turbine Steam Seal System Test

1.0 OBJECTIVE

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 closed cooling water (TGBCCW) 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 turbine load has increased and the system has 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.

14.2.12.1.71 Circulating Water System Test

1.0 OBJECTIVE

1.1 To demonstrate the ability of the circulating water system (CWS) to provide a continuous supply of cooling water to the main condensers and the turbine generator building closed cooling water (TGBCCW) heat exchanger and reject the waste heat from main condensers to the circulating water

2.0 PREREQUISITES

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 turbine generator building closed cooling water (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.

14.2.12.1.72 Steam Generator Hydrostatic Test

1.0 OBJECTIVE

1.1 To hydrostatically test the secondary side of the steam generators (SGs) and associated portions of the main steam, feedwater, blowdown, and auxiliary feedwater systems

2.0 PREREQUISITES

2.1 Construction activities on the SG secondary side are complete.

2.2 The reactor coolant system (RCS) is available to be pressurized and the reactor coolant pumps (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 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).

14.2.12.1.73 Heater Drains System Test

1.0 OBJECTIVE

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.

14.2.12.1.74 Chilled Water System Test

1.0 OBJECTIVE

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.

3.0 TEST METHOD

3.1 Demonstrate that each essential chilled water system division can be operated from its local and remote manual control station.

3.2 Demonstrate that each essential chilled water system division starts automatically in response to the appropriate signal.

3.3 Verify that the chillers supply chilled water at the rated flow and design conditions.

3.4 Verify chilled water flow to supplied components.

3.5 Verify alarms, interlocks, indicating instruments, and status lights are functional.

3.6 Verify head-versus-flow characteristics for the chilled water system pumps.

3.7 Verify system baseline performance during hot functional testing (HFT).

3.8 Simulate containment isolation actuation signal (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

5.0 ACCEPTANCE CRITERIA

5.1 The chilled water system operates as described in Subsection 9.2.7.

14.2.12.1.75 Essential Service Water System Test

1.0 OBJECTIVE

1.1 To demonstrate the ability of the essential service water system (ESWS) to supply cooling water as designed under normal and emergency conditions

1.2 To demonstrate the operating characteristics of the essential service water pumps and verify that the associated instrumentation functions properly, including system response to safety signals

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.

2.5 Circulating water discharge conduits are available.

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

5.0 ACCEPTANCE CRITERIA

5.1 The ESWS operates as described in Subsection 9.2.1.

14.2.12.1.76 Component Cooling Water System Test

1.0 OBJECTIVE

1.1 To demonstrate the capability of the component cooling water system (CCWS) to provide cooling water during normal unit operation, during unit cooldown, during refueling, and during an emergency situation; and

to demonstrate proper system response to a simulated engineered safety features actuation signal

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.

3.0 TEST METHOD

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 Perform a pump head-versus-flow verification for all four pumps.

3.4 Verify the nonessential portions of the system are isolated on a safety injection actuation signal (SIAS). Verify the containment spray heat exchanger isolation valves open on a containment spray actuation signal (CSAS).

3.5 Verify all non-safety-related portions of the corresponding train 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 each 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 specified in Subsection 9.2.2 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

5.0 ACCEPTANCE CRITERIA

5.1 The CCWS operates as described in Subsection 9.2.2.

14.2.12.1.77 Spent Fuel Pool Cooling and Cleanup System Test

1.0 OBJECTIVE

1.1 To demonstrate the capability of the spent fuel pool cooling/cleanup system (SFPCCS) to provide the proper flow paths and flow rates required to remove decay heat from the spent fuel pool. The purification capability of the system is verified by demonstrating the proper purification flow paths and flow rates.

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 reactor vessel cavity 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 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 and filtration capacity.

3.8 Verify power-operated valves fail to the position specified in Subsection 9.1.3 upon loss of motive power.

3.9 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 Position response of valves to loss of motive power

4.6 Control valve operation and position

5.0 ACCEPTANCE CRITERIA

5.1 The SFPCCS operates as described in Subsection 9.1.3.

14.2.12.1.78 Turbine Generator Building Closed Cooling Water System Test

1.0 OBJECTIVE

1.1 To verify proper operation of the turbine generator building closed cooling water (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.

3.0 TEST METHOD

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

5.0 ACCEPTANCE CRITERIA

5.1 The TGBCCW system performs as described in Subsection 9.2.8.

14.2.12.1.79 Condensate Storage System Test

1.0 OBJECTIVE

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.

3.0 TEST METHOD

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 the condensate storage tank is maintained at acceptable water oxygen concentration.

3.7 Verify 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.

14.2.12.1.80 <u>Normal Lighting System Test</u>

1.0 OBJECTIVE

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 have been completed.

2.2 Test instruments are properly calibrated and available.

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 operates as described in Subsection 9.5.3.

14.2.12.1.81 Emergency Lighting System Test

1.0 OBJECTIVE

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 have been completed.

2.2 Test instruments are properly calibrated and available.

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 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 operates as described in Subsection 9.5.3.

14.2.12.1.82 Compressed Air and Gas Systems Test

1.0 OBJECTIVE

1.1 To demonstrate that the compressed air and gas systems (instrument air, service air, breathing air, nitrogen, hydrogen, carbon dioxide) provide a safe and reliable source of compressed air for the operation of plant equipment

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.

3.0 TEST METHOD

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 Subsection 9.3.1 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 prefilters and afterfilters).

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

5.0 ACCEPTANCE CRITERIA

5.1 The compressed air systems operate in accordance with Subsection 9.3.1.

14.2.12.1.83 <u>Process and Primary Sampling System Test</u>

1.0 OBJECTIVE

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

2.0 PREREQUISITES

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

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 has been calibrated.

3.0 TEST METHOD

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 Calculate the holdup times using the piping volume and measured flow rate for reactor coolant system (RCS) and pressurizer samples.

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 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 opening and closing times, where required

4.5 Valve position indication

4.6 Holdup time for RCS and pressurizer samples

5.0 ACCEPTANCE CRITERIA

5.1 The process sampling system performs as described in Subsection 9.3.2.

14.2.12.1.84 Heat Tracing System Test

1.0 OBJECTIVE

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 have been completed.

2.2 Heat tracing system instrumentation has been 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

14.2.12.1.85 Fire Protection System Test

1.0 OBJECTIVE

1.1 To demonstrate the ability of the fire protection system (FPS) to provide water at acceptable flows and pressures to protected areas

2.0 PREREQUISITES

2.1 Construction activities on the FPS have been 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 the proper operation of the fire detection system.

3.2 Demonstrate the head and flow characteristics of the fire water pumps, and the operation of all auxiliaries.

3.3 Verify control logic.

3.4 Verify flow rates in the various flow paths of the fire protection water distribution system.

3.5 Verify sprinkler and deluge spray patterns where possible.

3.6 Verify alarms, indicating instruments, and status lights are functional.

3.7 Verify proper operation of smoke control and fire dampers under the design air flow conditions.

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.

14.2.12.1.86 <u>Emergency Diesel Generator Mechanical System Test</u>

1.0 OBJECTIVE

1.1 To demonstrate the emergency diesel generator (EDG) mechanical system operates reliably

2.0 PREREQUISITES

2.1 Construction activities on the diesel generator system have been completed.

2.2 EDG system instrumentation has been calibrated.

2.3 Support systems required for operation of the EDG system are complete and operational.

2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Demonstrate that each EDG can be started from the control room and its local panel in automatic and manual.

3.2 Demonstrate that the following mechanical and electrical trips are operable and function as described in Subsection 8.3.1 (includes protective trips bypass tests).

3.2.1 Engine overspeed

3.2.2 Generator differential protection

3.2.3 Low-low lube oil pressure

3.2.4 Generator voltage-controlled overcurrent

3.2.5 Low-pressure lube oil

3.2.6 High-pressure crankcase

3.2.7 High-temperature bearings

3.2.8 High-temperature lube oil out

3.2.9 High-high temperature jacket water

3.2.10 High vibration

3.3 Demonstrate that the following parameters are correctly monitored in the control room and at the local panel:

3.3.1 Lube oil temperature and pressures

3.3.2 Bearing temperatures

3.3.3 Cooling water temperatures and pressures

3.3.4 Speed

3.3.5 Starting air pressure

3.4 Demonstrate the operation of the following status indications:

3.4.1 Cooling water not available

3.4.2 Emergency diesel generator breaker racked out

3.4.3 Emergency diesel generator overspeed

3.4.4 Loss of control power

3.4.5 Generator fault

3.4.6 Low air and oil pressure

3.4.7 Maintenance mode

3.5 Demonstrate the capability for 35 consecutive starts.

3.6 Demonstrate full load capability.

3.7 Demonstrate EDG speed control.

4.0 DATA REQUIRED

4.1 EDG engine operating parameters

4.2 EDG engine consecutive starts data

4.3 Setpoints of EDG trips

4.4 EDG governor operating data

4.5 Setpoints at which alarms and interlocks occur

5.0 ACCEPTANCE CRITERIA

5.1 The EDG mechanical system performs as described in Subsection 8.3.1.1.3.

14.2.12.1.87 Emergency Diesel Generator Electrical System Test

1.0 OBJECTIVE

1.1 To verify the emergency diesel generators (EDGs) can supply power at the rated load, voltage, and frequency under all design conditions

2.0 PREREQUISITES

2.1 Construction activities on the EDG system have been completed.

2.2 EDG mechanical system test is completed.

2.3 EDG system instrumentation has been calibrated.

2.4 Support systems required for operation of the EDG system are complete and operational.

2.5 Test instrumentation is available and calibrated.

2.6 Electrical testing is complete as needed to allow the buses to be energized.

2.7 DG electrical voltage tests are complete.

2.8 Engineered safety features (ESF) loads are available to be loaded onto the bus.

3.0 TEST METHOD

3.1 Demonstrate all control logic and controls including the EDG sequencer and response to ESF actuation signals.

3.2 Demonstrate the continuous rating of the EDG for an interval of not less than 1 hour and until temperature equilibrium has been attained.

3.3 Demonstrate that the EDG unit starts from standby conditions, reaches required voltage and frequency within acceptable limits and time as defined in the plant Technical Specifications.

3.4 Demonstrate by simulating a loss of offsite power that:

a. The emergency buses are de-energized and the loads are shed from the emergency buses.

b. The EDG starts on the auto-start signal from its standby conditions, attains the required voltage and frequency within acceptable limits and time, and energizes the auto-connected shutdown loads through the load sequencer.

3.5 Demonstrate that on a safety injection actuation signal (SIAS), the EDG starts on the auto-start signal from its standby conditions, and attains the required voltage and frequency within acceptable limits and time.

3.6 Demonstrate the EDG's capability to reject a loss of the largest single load, and verify that the voltage and frequency requirements are met and that the EDG unit does not trip on overspeed.

3.7 EDG endurance and margin test: demonstrate full-load carrying capability for an interval of not less than 24 hours. Verify that voltage and frequency requirements are maintained. Verify that mechanical systems such as fuel, lubrication, and cooling function within design limits.

3.8 Demonstrate hot restart functional capability at full-load temperature conditions (after it has operated for 2 hours at full load) by verifying that the EDG starts on a manual or autostart signal, and attains the required voltage and frequency within acceptable limits and time. This testing is to occur immediately after the full-load carrying capability demonstration.

3.9 Demonstrate the ability to:

a. Synchronize the diesel generator unit with offsite power while the unit is connected to the emergency load

b. Transfer this load to the offsite power

c. Isolate the diesel generator unit

d. Restore it to standby status

3.10 Demonstrate that with the EDG operating in a test mode while connected to its bus, a simulated SIAS overrides the test mode by:

a. Returning the EDG to standby operation

b. Automatically energizing the emergency loads from offsite power

3.11 Demonstrate that, by starting and running both redundant EDG units simultaneously, potential common failure modes that may be undetected in single EDG unit tests do not occur.

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 EDG electrical system performs as described in Subsection 8.3.1.1.3.

14.2.12.1.88 Emergency Diesel Generator Auxiliary Systems Test

1.0 OBJECTIVE

1.1 To demonstrate that the emergency diesel generator (EDG) fuel oil system provides a reliable and adequate supply to each EDG

1.2 To demonstrate the operation of the EDG engine cooling water system

1.3 To demonstrate that the EDG engine starting air system provides an adequate amount of air for 5 consecutive starts of its EDG without makeup air

1.4 To demonstrate the operation of the EDG engine lube oil system

2.0 PREREQUISITES

2.1 Construction activities on the EDG auxiliary systems have been completed.

2.2 EDG auxiliary systems instrumentation has been calibrated.

2.3 Support systems required for operation of the EDG auxiliary systems are complete and operational.

2.4 Test instrumentation is available and calibrated.

2.5 The EDGs are available for a loaded run to measure fuel consumption and to perform consecutive starts.

3.0 TEST METHOD

3.1 Demonstrate the operation of the fuel oil automatic transfer feature from the storage tanks to the day tank.

3.2 Demonstrate the operation of the fuel oil and day tank level alarms.

3.3 Demonstrate that the day tank can be filled manually.

3.4 Demonstrate the operation of the fuel oil transfer pump.

3.5 Demonstrate the operation of the fuel oil recirculation system.

3.6 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 72 minutes of EDG operation with the EDG supplying the power requirements of the most limiting design basis accident.

3.7 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.

3.8 Demonstrate the operation of the EDG cooling water system to keep the pump warm.

3.9 Demonstrate the operation of EDG cooling system heaters.

3.10 Demonstrate the operation of the EDG cooling system alarms.

3.11 Demonstrate the operation of EDG starting air compressors.

3.12 Demonstrate that each EDG starting air system has sufficient volume available to perform five consecutive starts of its EDGs.

3.13 Demonstrate the EDG starting air system operates the EDG pneumatic controls as designed.

3.14 Demonstrate the EDG starting air alarm interlocks and automatic operation.

3.15 Demonstrate the operation of the EDG lube oil prelube pump.

3.16 Demonstrate the operation of EDG lube oil heaters.

3.17 Demonstrate the operation of EDG lube oil alarms.

3.18 Demonstrate the operation of the EDG lube oil transfer pump.

4.0 DATA REQUIRED

4.1 EDG fuel oil consumption rate

4.2 Setpoints of alarms, interlocks, and controls

4.3 Operating data for pumps and compressors

4.4 Operating data for the heaters

4.5 EDG starting air volume parameters after consecutive starts

5.0 ACCEPTANCE CRITERIA

5.1 The EDG engine fuel oil system operates as described in Subsection 9.5.4.

5.2 The EDG engine cooling water system operates as described in Subsection 9.5.5.

5.3 The EDG engine starting air system operates as described in Subsection 9.5.6.

5.4 The EDG engine lubrication system operates as described in Subsection 9.5.7.

14.2.12.1.89 Alternate AC Source System Test

1.0 OBJECTIVE

1.1 To verify the proper operation of the alternate ac (AAC) source system

2.0 PREREQUISITES

2.1 Construction activities on the AAC source system have been completed.

2.2 Support systems, including the AAC support systems and the 4160 V distribution system required for the operation of the AAC source system, are complete and operational.

2.3 AAC source system instrumentation has been calibrated.

2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Verify the system alarms, instrumentation, interlocks, and controls.

3.2 Verify the AAC source system provides rated power at the proper voltage and frequency.

3.3 Verify operation of the AAC source system from all its control stations.

3.4 Demonstrate the AAC source system can be connected in the design configuration to each 4160 V bus combination.

3.5 Verify AAC can carry design loads.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms and interlocks occur

4.2 AAC source system operating data at designated loads including time to start and connect to each assigned 4,160 V bus combination

5.0 ACCEPTANCE CRITERIA

5.1 The AAC source system operates as described in Subsection 8.4.1.

14.2.12.1.90 Alternate AC Source Support Systems Test

1.0 OBJECTIVE

1.1 Demonstrate the proper operation of the AAC source system fuel, starting, cooling, and lubrication subsystems

2.0 PREREQUISITES

2.1 Construction activities on the AAC source support systems have been completed.

2.2 AAC source support system instrumentation has been calibrated.

2.3 Support systems required for operation of the AAC source support systems are complete and operational.

2.4 The AAC source system is available to be run.

3.0 TEST METHOD

3.1 Demonstrate the adequacy and operation of the AAC source fuel systems.

3.2 Demonstrate the operation of the AAC source starting system 3 consecutive times.

3.3 Demonstrate the operation of the AAC source lube oil system.

3.4 Demonstrate alarms, interlocks, and controls on the AAC source fuel systems, starting system, lube oil, and cooling system.

3.5 With the AAC source system in operation, verify the AAC source cooling system maintains design temperatures.

4.0 DATA REQUIRED

4.1 Setpoints of alarms, interlocks, and controls

4.2 Verification of starts from each AAC source starting system

4.3 AAC source cooling system temperature

4.4 Fuel consumption rate for required configurations

5.0 ACCEPTANCE CRITERIA

5.1 The AAC source support systems operate as described in Subsection 8.3.1.

14.2.12.1.91 Containment Polar Crane Test

1.0 OBJECTIVE

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.

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 as described in Subsection 9.1.5.2.2.

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

1.0 OBJECTIVE

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.

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 OBJECTIVE

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

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 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 Perform air balance as appropriate for each subsystem.

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 Reactor Containment Purge System Test

1.0 OBJECTIVE

1.1 To demonstrate the capability of the containment purge system to maintain the containment air temperature and cleanliness at the required value during inspection, testing, maintenance, and refueling operations, and to demonstrate the capability of backup function in case of low-volume purge system failure or containment hydrogen control system failure

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 containment purge system have been completed.

2.3 Containment purge system instrumentation has been calibrated.

2.4 Support systems required for operation of the containment purge system are complete and operational.

2.5 Test instrumentation is available and calibrated.

2.6 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 design airflows for high-volume purge, low-volume purge subsystems.

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 Subsection 9.4.6 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 N510 (Testing of Nuclear Air-Treatment Systems).

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

5.0 ACCEPTANCE CRITERIA

5.1 Reactor containment purge system performs as described in Subsection 9.4.6.

5.2 Reactor containment purge system radiation monitors perform as described in Table 11.5-1.

14.2.12.1.95 Control Room Area HVAC System Test

1.0 OBJECTIVE

1.1 To verify the functional operation of the control room area 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 area HVAC system are described in Subsection 14.2.12.1.100.

2.0 PREREQUISITES

2.1 Construction activities in the control room area have been completed and all penetrations sealed.

2.2 Construction activities on the control room area HVAC system have been completed.

2.3 Control room area HVAC system instrumentation has been calibrated.

2.4 Support systems required for operation of the control room area 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.

3.0 TEST METHOD

3.1 Verify all control logic.

3.2 Verify the proper operation, stroking speed, and position indication of all dampers.

3.3 In manual operating mode, verify proper operation of the units, system rated airflow, and air balance.

3.4 In automatic mode, demonstrate the transfer to emergency operations as a result of radiation detection, smoke detection, and safety injection actuation signals.

3.5 Verify the filter particle removal efficiency, carbon adsorber efficiency, and filter bank airflow capacity.

3.6 Verify the proper operation of all protective devices, controls, interlocks, instrumentation, and alarms, using actual or simulated inputs.

3.7 Verify that the system maintains the control room and control room envelope (CRE) at positive pressure relative to the outside atmosphere during system operation in the pressurized mode as required by the Technical Specifications.

3.8 Demonstrate the operation of the kitchen/toilet exhaust fan and smoke removal fan.

3.9 Verify the proper operation of control room area 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 510 (Testing of Nuclear Air-Treatment Systems).

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 area HVAC system radiation monitor performance data

5.0 ACCEPTANCE CRITERIA

5.1 The control room area HVAC system operates as described in Subsection 9.4.1.

5.2 The control room area HVAC system radiation monitors perform as described in Table 11.5-1.

5.3 The control room area HVAC system maintains CRE integrity.

14.2.12.1.96 Turbine Generator Building HVAC System Test

1.0 OBJECTIVE

1.1 To demonstrate that the turbine building HVAC system provides a suitable operating environment for equipment and personnel during normal operations

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.

3.0 TEST METHOD

3.1 Verify all control logic.

3.2 Verify the proper operation of inlet air-operated dampers and damper controls.

3.3 Verify the proper operation of the AHU, fans, and cubicle coolers.

3.4 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

5.0 ACCEPTANCE CRITERIA

5.1 The turbine building HVAC system operates as described in Subsection 9.4.4.

5.2 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 OBJECTIVE

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 design airflow with each emergency diesel generator area HVAC system in operation.

3.3 Verify design temperature can be maintained in each emergency diesel generator area.

3.4 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 building HVAC system operates as described in Subsection 9.4.5.

14.2.12.1.98 Fuel Handling Area HVAC System Test

1.0 OBJECTIVE

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.

3.0 TEST METHOD

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 units (AHUs) 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 systems' rated airflow and air balance.

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 and system response to a high radiation signal.

3.10 Verify that the ACUs perform in accordance with RG 1.140 (Reference 10), RG 1.52 (Reference 11) and ASME N510 (Testing of Nuclear Air –Treatment Systems).

3.11 Verify isolation of safety-related dampers installed upstream of normal supply AHU and downstream of normal ACU on a simulated fuel handling area emergency ventilation action signal (FHEVAS).

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 fuel handling area HVAC system radiation monitor performs as described in Table 11.5-1.

14.2.12.1.99 Compound Building HVAC System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the compound building HVAC system to maintain design condition

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.

3.0 TEST METHOD

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 systems rated airflow and air balance.

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 system response to a high radiation signal.

3.11 Verify that the ACUs perform in accordance with RG 1.140 (Reference 10) and ASME N510 (Testing of Nuclear Air –Treatment Systems).

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

5.0 ACCEPTANCE CRITERIA

5.1 The compound building HVAC system operates as described in Subsection 9.4.7.

5.2 The compound building HVAC system radiation monitor performs as described in Table 11.5-1.

14.2.12.1.100 Balance of Control Room Area HVAC System Test

1.0 OBJECTIVE

1.1 To demonstrate that the control room area HVAC system airflow is balanced for all modes of operation

1.1.1 Control room area HVAC system

1.1.2 Control room area smoke removal subsystem

2.0 PREREQUISITES

2.1 Construction activities in the control room area are complete with all penetrations sealed in place.

2.2 Construction activities on the control room area HVAC system have been completed.

2.3 Control room area HVAC system instrumentation has been calibrated.

2.4 Support systems required for operation of the control room area HVAC system are complete and operational.

2.5 Test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Verify control logic.

3.2 Verify the operation of control room area supply AHUs.

3.3 Verify operation of the kitchen/toilet exhaust fan and smoke removal fan.

3.4 Verify alarms, indicating lights, and status lights are functional.

3.5 Perform airflow balancing of the control room area HVAC.

3.6 Verify the proper operation of dampers.

3.7 Verify the proper operation of the control room area emergency makeup ACUs.

4.0 DATA REQUIRED

4.1 Fan operating data for each of the air handling units, air cleaning units, and kitchen/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 area HVAC subsystems

5.0 ACCEPTANCE CRITERIA

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

14.2.12.1.101 Hydrogen Mitigation System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the hydrogen mitigation system (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.

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 OBJECTIVE

1.1 To demonstrate that the hydrogen recombiners can be properly installed and are operable

2.0 PREREQUISITES

2.1 Construction activities on the containment hydrogen recombiner system (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 OBJECTIVE

1.1 To demonstrate the operability of the liquid waste management system (LWMS) for collection, processing and recycling of liquid wastes, and for preparation of liquid waste for release to the environment

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.

3.0 TEST METHOD

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.

3.4 Verify the proper operation of high differential pressure alarms for the process vessel.

3.5 Verify the proper operation of the tank mixers.

3.6 Verify the proper operation of the filtration unit.

3.7 Demonstrate that discharge isolation features and other system controls function properly. Simulate a high-radiation signal to the LWMS discharge radiation monitor.

3.8 Verify alarms, indicating instruments, and status lights are functional. Simulate a high-radiation signal to the LWMS discharge radiation monitor and verify alarm actuation.

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

5.0 ACCEPTANCE CRITERIA

5.1 The LWMS operates as described in Section 11.2.

5.2 The LWMS discharge radiation monitor operates as described in Table 11.5-2.

14.2.12.1.104 Solid Waste Management System Test

1.0 OBJECTIVE

1.1 To demonstrate the operability of the solid waste management system (SWMS) to collect and package solid wastes for shipment

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.

3.0 TEST METHOD

3.1 Verify the operation of the sluice pump.

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 operation of the screw compactor.

3.5 Verify spent resin beds from the liquid waste management system can be sluiced to the solid radwaste system high-integrity container (HIC).

3.6 Verify the operation of the HIC fill/dewatering head.

3.7 Verify the proper operation of alarms, controls, and interlocks.

3.8 Verify system design flow paths.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms and interlocks occur

4.2 HIC fill/dewatering head level instrument data

4.3 Sluice pump operating data

4.4 Compound building crane data

4.5 System flow path data

5.0 ACCEPTANCE CRITERIA

5.1 The SWMS operates as described in Section 11.4.

14.2.12.1.105 Gaseous Waste Management System Test

1.0 OBJECTIVE

1.1 To demonstrate the ability of the gaseous waste management system (GWMS) to collect and process radioactive gases vented from plant equipment

2.0 PREREQUISITES

2.1 Construction activities on the GWMS have been completed.

2.2 GWMS instrumentation has been calibrated.

2.3 Support systems required for operation of the GWMS are completed and operational.

2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Verify flow paths.

3.2 Demonstrate that discharge isolation features and other system controls function properly. Simulate a high-radiation signal to the GWMS discharge radiation monitor.

3.3 Verify alarms, indicating instruments, and status lights are functional. Simulate a high-radiation signal to the GWMS discharge radiation monitor and verify alarm actuation in the main control room.

3.4 Demonstrate the operation of the gas drying equipment.

3.5 Demonstrate proper holdup time of gas through the charcoal adsorbers.

3.6 Demonstrate the operation of the system gas analyzers.

3.7 Operate control valves from all appropriate control positions. Observe valve operation and position indication. Measure opening and closing times, where required.

4.0 DATA REQUIRED

4.1 Setpoints of alarms, interlocks, and controls

4.2 Gas dryer operating data

4.3 Gas analyzer operating data

4.4 Gas transport times

5.0 ACCEPTANCE CRITERIA

5.1 The GWMS operates as described in Section 11.3.

5.2 The GWMS discharge radiation monitor operates as described in Table 11.5-1.

14.2.12.1.106 Process and Effluent Radiological Monitoring System Test

1.0 OBJECTIVE

1.1 To verify that the process and effluent radiological monitoring system (PERMS) can detect and record specific radiation levels, and to verify all alarms and interlocks

2.0 PREREQUISITES

2.1 Construction activities on the process and effluent radiological monitoring system have been completed.

2.2 Process and effluent radiological monitoring system instrumentation has been calibrated.

2.3 Support systems 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.

3.0 TEST METHOD

3.1 Using the check source 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 check source

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

5.0 ACCEPTANCE CRITERIA

5.1 The process and effluent radiological monitoring system operates as described in Section 11.5.

14.2.12.1.107 Area Radiation Monitoring System Test

1.0 OBJECTIVE

1.1 To verify the functional performance of the area radiation monitoring system

2.0 PREREQUISITES

2.1 Construction activities on the area radiation monitoring system have been completed.

2.2 Area radiation monitoring system instrumentation has been calibrated.

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 check source 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 check source

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

5.0 ACCEPTANCE CRITERIA

5.1 The area radiation monitors perform as described in Section 11.5 and Subsection 12.3.4.

14.2.12.1.108 4,160 V Class 1E Auxiliary Power System Test

1.0 OBJECTIVE

1.1 To demonstrate the operation of 4,160 V Class 1E systems

2.0 PREREQUISITES

2.1 Construction activities on the 4,160 V Class 1E auxiliary power system have been completed.

2.2 4,160 V Class 1E auxiliary power system instrumentation has been calibrated.

2.3 Support systems required for operation of the 4,160 V Class 1E auxiliary power system are completed and operational.

2.4 Test instrumentation is available and calibrated.

2.5 All 4.16 kV feeders and buses voltage tested with acceptable results.

2.6 4.16 kV power is available from the normal and alternate engineered safety feature (ESF) transformer sources.

2.7 Switchgear 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 sources are available.

3.0 TEST METHOD

3.1 Demonstrate the operability of the feeder and cross-tie protective circuit breakers locally and 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 Load the systems to the extent practicable and verify that the full-load voltage is within system design parameters. Verify the capability of bus loads to start and operate properly when connected to the 4,160 V Class 1E buses.

3.5 Verify the 4,160 V and 480 V safety-related systems load shed as designed on undervoltage.

3.6 Verify the 4,160 V Class 1E buses can be energized from power sources including the unit auxiliary transformer, respective standby auxiliary transformer, emergency diesel generators, and the alternate ac source.

4.0 DATA REQUIRED

4.1 Full-load bus voltage data

4.2 Setpoints at which alarms, interlocks, and protective relays activate

4.3 System response to low bus voltage

5.0 ACCEPTANCE CRITERIA

5.1 The 4160 V Class 1E auxiliary power system operates as described in Subsection 8.3.1.1.2.

14.2.12.1.109 <u>480 V Class 1E Auxiliary Power System Test</u>

1.0 OBJECTIVE

1.1 To demonstrate the operation of the 480 V Class 1E auxiliary power system

2.0 PREREQUISITES

2.1 Construction activities on the 480 V Class 1E auxiliary power system have been completed.

2.2 480 V Class 1E auxiliary power system instrumentation has been calibrated.

2.3 Support systems required for operation of the 480 V Class 1E auxiliary power system are completed and operational.

2.4 Test instrumentation is available and calibrated.

2.5 Buses and equipment have been meggered with acceptable results.

2.6 Applicable equipment has been visually inspected.

3.0 TEST METHOD

3.1 Demonstrate the operability of the 480 Vac source and feeder circuit breakers locally and 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 480 V 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 480 V Class 1E auxiliary power system operates as described in Subsection 8.3.1.1.2.

14.2.12.1.110 Unit Main Power System Test

1.0 OBJECTIVE

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 on the unit main power system have been completed.

2.2 The offsite power distributions system is available.

2.3 Buses and equipment have been voltage tested with acceptable results.

2.4 Equipment has been visually inspected.

2.5 Control power is available.

2.6 Plant conditions are such that the main generator can be operated.

3.0 TEST METHOD

3.1 Demonstrate the ability of the main transformers to supply power to the unit auxiliary transformers from the offsite power source.

3.2 Demonstrate the ability of the main transformers to transmit power from the main generator to the offsite power transmission system at rated voltage and load.

3.3 Demonstrate the ability of the main generator to generate designed voltage and load.

3.4 Demonstrate the ability of the unit auxiliary transformers to supply station loads.

3.5 Verify the operation of the generator circuit breaker.

3.6 Verify the operation of interlocks, alarms, and protective relays.

3.7 Verify the operation of the main generator auxiliary systems.

4.0 DATA REQUIRED

4.1 Main generator operating data at load

4.2 Main transformer operating data

4.3 Unit auxiliary transformer operating data

4.4 Setpoints of alarms, interlocks, and controls

5.0 ACCEPTANCE CRITERIA

5.1 The unit main power system operates as described in Subsection 8.3.1.1.

14.2.12.1.111 13,800 V Normal Auxiliary Power System Test

1.0 OBJECTIVE

1.1 To demonstrate the operation of the 13,800 V normal auxiliary power system

2.0 PREREQUISITES

2.1 Construction activities on the 13,800 V normal auxiliary power system have been completed.

2.2 13,800 V normal auxiliary power system instrumentation has been calibrated.

2.3 Support systems required for operation of the 13,800 V normal auxiliary power system are completed and operational.

2.4 Test instrumentation is available and calibrated.

2.5 Unit auxiliary transformers available.

2.6 All 13.8 kV feeders and buses have been voltage tested with acceptable results.

2.7 Switchgear 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 13.8 kV feeder circuit breakers locally and remotely.

3.2 Demonstrate the operability of the bus interlocks, alarms, and protective relays.

3.3 Verify the operation of meters and annunciators.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms, interlocks, and protective relays activate.

5.0 ACCEPTANCE CRITERIA

5.1 The 13,800 V normal auxiliary power system operates as described in Subsection 8.3.1.1.1.1.

14.2.12.1.112 4160 V Normal Auxiliary Power System Test

1.0 OBJECTIVE

1.1 To demonstrate the operation of the 4,160 V normal auxiliary power system

2.0 PREREQUISITE

2.1 Construction activities on the 4,160 V normal auxiliary power system have been completed.

2.2 4,160 V normal auxiliary power system instrumentation has been calibrated.

2.3 Support systems required for operation of the 4,160 V normal auxiliary power system are completed and operational.

2.4 Test instrumentation is available and calibrated.

2.5 All 4.16 kV feeders and buses have been voltage tested with acceptable results.

2.6 4.16 kV power is available from the unit auxiliary transformer, standby auxiliary transformer, and alternate ac source.

2.7 Switchgear assembly, breakers, control and protective equipment/circuit have been inspected and tested and are capable of being placed into service.

3.0 TEST METHOD

3.1 Demonstrate the operability of the feeder protective circuit breakers from the permanent non-safety buses to the safety loads buses.

3.2 Demonstrate the operability of the feeder protective circuit breakers from the unit auxiliary transformer to the non-safety loads locally and remotely.

3.3 Demonstrate the operability of the feeder and cross-tie protective circuit breakers for the permanent non-safety loads locally and remotely.

3.4 Demonstrate the operability of the bus interlocks, alarms, and protective relays.

3.5 Verify the operation of meters and annunciators.

3.6 Verify the permanent non-safety buses can be energized from the unit auxiliary transformer, standby auxiliary transformers, and alternate ac source.

3.7 Demonstrate the operation of the bus transfer for the permanent non-safety buses (Preferred 1 [normal] supply power to Preferred 2 [alternate] supply power).

4.0 DATA REQUIRED

4.1 Setpoints at which alarms, interlocks, and protective relays activate

4.2 System response to transfer of Preferred 1 (normal) supply power to Preferred 2 (alternate) supply power

5.0 ACCEPTANCE CRITERIA

5.1 The 4,160 V normal auxiliary power system supplies the loads as described in Subsection 8.3.1.1.1.2.

14.2.12.1.113 <u>480 V Normal Auxiliary Power System Test</u>

1.0 OBJECTIVE

1.1 To demonstrate the operation of the 480 V normal auxiliary power system

2.0 PREREQUISITES

2.1 Construction activities on the 480 V normal auxiliary power system have been completed.

2.2 480 V normal auxiliary power system instrumentation has been calibrated.

2.3 Support systems required for operation of the 480 V normal auxiliary power system are completed and operational.

2.4 Test instrumentation is available and calibrated.

2.5 Buses and equipment have been meggered with acceptable results.

2.6 Equipment has been visually inspected.

2.7 4,160 V normal auxiliary power is available.

3.0 TEST METHOD

3.1 Demonstrate the operability of the 480Vac source and feeder circuit breakers locally and 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 480 V normal 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 480 V normal auxiliary power system operates as described in Subsection 8.3.1.1.1.3.

14.2.12.1.114 <u>Non-Class 1E DC Power Systems Test</u>

1.0 OBJECTIVE

1.1 To demonstrate the operation of the following systems:

1.1.1 125 Vdc power system

1.1.2 120 Vac instrument and control power system

1.1.3 250 Vdc power system

1.1.4 AAC source 125 Vdc power system

2.0 PREREQUISITES

2.1 Construction activities 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 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 Operation of all breakers and cables is verified.

2.8 Ventilation systems are in operation as needed.

3.0 TEST METHOD

3.1 Demonstrate that the batteries and battery chargers of the 125 Vdc power system meet design capacities by performing discharge and charging tests.

3.2 Demonstrate that the batteries and battery charges of the 250 Vdc power system meet design capacities by performing discharge and charging tests.

3.3 Demonstrate that the battery and charger of the alternate ac source 125 Vdc power system meet design capacity by performing a discharge and charging test.

3.4 Verify that minimum bank and individual cell limits are not exceeded during battery discharge tests.

3.5 Verify the proper operation of the inverters, manual transfer switches, frequency synchronization, and blocking diodes.

3.6 Verify that the inverters automatically transfer the input to the regulating transformer upon loss of preferred power.

3.7 Place the battery chargers on equalize and verify the dc equalizing voltage does not result in driving the inverter, relieving the rectifier from carrying the inverter load.

3.8 Verify proper operation of all protective devices, controls, interlocks, alarms, computer inputs, and ground detection.

3.9 Verify the operation of bus transfer devices.

4.0 DATA REQUIRED

4.1 Battery voltage and load current without charger

4.2 Charger float voltage and current

4.3 Test discharge recording of voltage, current, temperature, capacity in ampere-hours, and individual cell voltages

4.4 Charger voltage and current as battery eliminator

4.5 Inverter voltage, frequency, and current from preferred source

4.6 Inverter voltage, frequency, and current from battery source

4.7 Setpoints at which alarms, interlocks, and controls activate

5.0 ACCEPTANCE CRITERIA

5.1 The non-Class 1E dc power system supplies the loads as described in Subsection 8.3.2.1.1.

14.2.12.1.115 Class 1E DC Power System Test

1.0 OBJECTIVE

1.1 To demonstrate that the Class 1E dc power system is capable of supplying power as designed in the different operating modes

2.0 PREREQUISITES

2.1 Construction activities 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 Operation of breakers and cables has been verified.

2.8 Ventilation systems are in operation as needed.

3.0 TEST METHOD

3.1 Demonstrate that the batteries and battery chargers meet design capacities by performing discharge and charging tests.

3.2 Verify that minimum bank and individual cell limits are not exceeded during battery discharge test.

3.3 Verify the proper operation of the inverters, frequency synchronization, and blocking diodes.

3.4 Verify that the inverters automatically transfer input to the regulating transformer upon loss of preferred power.

3.5 Place the battery chargers on equalize and verify dc equalizing voltage does not result in driving the inverter, relieving the rectifier from carrying the inverter load.

3.6 Verify proper operation of protective devices, controls, interlocks, alarms, computer inputs, and ground detection.

3.7 Verify the proper operation of the vital instrumentation and control power status information subsystem.

3.8 Verify proper operation of bus transfer devices.

4.0 DATA REQUIRED

4.1 Battery voltage and load current without charger

4.2 Charger float voltage and current

4.3 Test discharge recordings of voltage, current, temperature, capacity in ampere-hours, and individual cell voltages

4.4 Charger voltage and current as battery eliminator

4.5 Inverter voltage, frequency, and current from preferred source

4.6 Inverter voltage, frequency, and current from battery source

4.7 Setpoints at which alarms, interlocks, and controls activate

4.8 System status information subsystem indications

5.0 ACCEPTANCE CRITERIA

5.1 The Class 1E dc power system supplies the loads as described in Subsection 8.3.2.1.2.

14.2.12.1.116 Offsite Power System Test

1.0 OBJECTIVE

1.1 To verify that the offsite power system is capable of supplying the power as designed to the unit through the two preferred power circuits

1.2 To verify the power generated by the turbine generator can be fed to grid through the offsite power system

2.0 PREREQUISITES

2.1 Construction activities on the offsite power system have been completed.

2.2 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 operation of the switchyard protective relaying system.

3.2 Verify operation of switchyard power circuit breakers and motor-operated disconnects from main control room, switchyard relay house, and its local control cabinet.

3.3 Verify operation of interlock between the two separate offsite power connections.

3.4 Verify operation of the switchyard 125 Vdc power system and its associated controls, alarms, and batteries.

3.5 Verify the operation of the switchyard 480 Vac auxiliary power system and its associated controls, alarms, and annunciators.

4.0 DATA REQUIRED

4.1 Setpoints at which alarms and interlocks occur

4.2 Setpoints of the protective relays

5.0 ACCEPTANCE CRITERIA

5.1 The offsite power system operates as described in Subsection 8.2.1.

14.2.12.1.117 Balance-of-Plant Piping Thermal Expansion Measurement Test

1.0 OBJECTIVE

1.1 To demonstrate that the balance-of-plant (BOP) 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

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 pipe moves freely, except at locations where supports/restraints are designed to restrain pipe thermal movement as described in Section 3.12.

5.2 Thermal movement of pipe at the locations of spring hangers and snubbers are within the allowable travel range as described in Section 3.12.

5.3 The thermal movement of the pipe at restricted measurement locations are within the acceptable limits or the discrepant response is reconciled using acceptable reconciliation methods as described in Section 3.12.

14.2.12.1.118 Balance-of-Plant Piping Vibration Measurement Test

1.0 OBJECTIVE

1.1 To verify that piping layout and support/restraints are adequate to withstand normal transients without damage in the designated piping systems

1.2 To demonstrate that flow-induced vibration is sufficiently small to cause no fatigue or stress failures in the designated piping systems

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 Steady-state vibration testing as described in Section 3.9.

5.1.1 Acceptance criteria are based on conservatively estimated stresses, which are derived from measured velocities and conservatively assumed mode shapes.

5.2 Transient vibration testing as described in Section 3.9.

5.2.1 No permanent deformation or damage in any system, structure, or component important to nuclear safety is observed.

5.2.2 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 OBJECTIVE

1.1 To verify the structural integrity of the containment

1.2 To verify that the integrated leak rate from the containment does not exceed the maximum allowable leakage

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 Standard 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 Code Section III, Division 2, and ANSI/ANS 56.8-1994 (Reference 7).

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

5.0 ACCEPTANCE CRITERIA

5.1 Structural integrity test

5.1.1 Yielding of conventional reinforcement does not develop as determined from analysis of crack width and displacement data.

5.1.2 Visible signs of permanent damage to either the concrete structure or the steel liner are not detected.

5.1.3 Residual displacements at the points of maximum predicted radial and vertical displacement at the completion of depressurizing or up to 24 hours later does not exceed 20 percent of measured or predicted displacement at maximum test pressure, whichever is greater, plus 0.254 mm (0.01 in) plus measurement tolerance.

5.1.4 The measured displacements at test pressure at points of predicted maximum radial and vertical displacements do not exceed predicted values by more than 30 percent plus measurement tolerance. This requirement may be waived if the residual displacements within 24 hours are not greater than 10 percent.

5.2 Integrated leak rate test

5.2.1 The upper confidence limit, plus any local leakage rate additions, is less than 75 percent of the maximum allowed leakage rate.

5.2.2 The verification test by removal of a quantity of air is acceptable if the mass calculated from the test instrumentation is 75 to 125 percent of the metered mass change.

5.3 The containment performs as described in Subsections 6.2.6, 6.2.4, and 3.8.2.

14.2.12.1.120 Fuel Transfer Tube Functional Test and Leak Test

1.0 OBJECTIVE

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 operation of the fuel transfer tube quick-closure hatch

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 fuel transfer tube quick-closure hatch in accordance with manufacturer's instructions. Verify the hatch can be opened and closed within the stated amount of time.

3.2 Place the hatch 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 hatch

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 fuel transfer tube quick-closure hatch operates in accordance with manufacturer's instructions.

5.3 The fuel transfer tube penetration and quick-closure hatch perform as described in Subsections 3.8.1 and 6.2.4.

14.2.12.1.121 Equipment Hatch Functional Test and Leak Test

1.0 OBJECTIVE

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.

2.0 PREREQUISITES

2.1 Construction activities on the equipment hatch and shield wall have been completed.

2.2 Temporary pressurization equipment is installed and instrumentation 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

5.0 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 ANSI/ANS 56.8-1994 (Reference 8).

5.2 The equipment hatch and movable shield wall assembly operate in accordance with manufacturer’s instructions.

5.3 The equipment hatch performs as described in Subsections 3.8.1 and 6.2.4.

14.2.12.1.122 <u>Containment Personnel Airlock Functional Test and Leak Test</u>

1.0 OBJECTIVE

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 each containment personnel airlock operates as designed

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

5.0 ACCEPTANCE CRITERIA

5.1 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).

5.2 The containment personnel airlocks operate as designed.

5.3 The containment personnel airlocks perform as described in Subsections 6.2.6 and 3.8.2.

14.2.12.1.123 Containment Electrical Penetration Assemblies Test

1.0 OBJECTIVE

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

5.0 ACCEPTANCE CRITERIA

5.1 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).

5.2 Containment electrical penetration assemblies perform as described in Subsection 8.3.1.1.9.

14.2.12.1.124 Containment Isolation Valves Leakage Rate Test

1.0 OBJECTIVE

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 is installed and instrumentation is 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

5.0 ACCEPTANCE CRITERIA

5.1 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).

5.2 The containment isolation valves operate as described in Subsection 6.2.4.

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.

3.0 TEST METHOD

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 Mid-Loop Operations Verification Test

1.0 OBJECTIVE

1.1 To verify that installed instrumentation for operations at reduced reactor coolant system (RCS) inventory is accurate and reliable

1.2 To verify the shutdown cooling system (SCS) pumps can be operated at reduced RCS level without cavitation

2.0 PREREQUISITES

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.

14.2.12.1.127 Seismic Monitoring Instrumentation System Test

1.0 OBJECTIVE

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.

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 described in Subsection 3.7.4.

14.2.12.1.128 Auxiliary Steam System Test

1.0 OBJECTIVE

1.1 To demonstrate the auxiliary steam system provides the steam to various plant components at designed pressures and flow

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 boiler meets manufacturers design performance.

14.2.12.1.129 Containment Isolation Valves Test

1.0 OBJECTIVE

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.

3.0 TEST METHOD

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.

14.2.12.1.130 Post-Accident Monitoring Instrumentation Test

1.0 OBJECTIVE

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.

3.0 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 permanent data records

5.0 ACCEPTANCE CRITERIA

5.1 The post-accident monitor instrumentation performs as described in Subsection 7.5.1.1.

14.2.12.1.131 Electrical and I&C Equipment Room Area HVAC System Test

1.0 OBJECTIVE

1.1 To demonstrate proper operation of the electrical and I&C equipment room area heating, ventilation, and air conditioning (HVAC) systems.

2.0 PREREQUISITES

2.1 Construction activities on the electrical and I&C equipment room HVAC systems have been completed.

2.2 Electrical and I&C equipment room area HVAC system instrumentation has been calibrated.

2.3 Support systems required for operation of the electrical and I&C equipment room area HVAC systems 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 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 room area HVAC system operates as described in Subsection 9.4.5.1.2

5.2 Battery room exhaust fan limits the hydrogen accumulation to less than 1 percent of the total volume of the battery room.

14.2.12.1.132 Auxiliary Building Controlled Area HVAC System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the auxiliary building controlled area HVAC system to maintain design condition

2.0 PREREQUISITES

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.

3.0 TEST METHOD

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) and fans.

3.5 Verify the proper operation of the air cleaning units (ACUs) and fans.

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 N510 (Testing of Nuclear Air –Treatment 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 action signal (SIAS).

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 described in Subsection 9.4.5.1.3.

5.2 The auxiliary building controlled area HVAC system radiation monitors perform as described in Table 11.5-1.

14.2.12.1.133 Auxiliary Building Clean Area HVAC System Test

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of the auxiliary building clean area HVAC system to maintain design condition

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.

3.0 TEST METHOD

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 systems are at rated airflow and are 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 auxiliary building clean area HVAC system operates as described in Section 9.4.3.

14.2.12.1.134 Leakage Detection System Test

1.0 OBJECTIVE

1.1 To demonstrate the operation of the various leakage detection system installed inside and outside reactor containment

2.0 PREREQUISITES

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 Section 5.2.6.1.

14.2.12.2 Post-core Hot Functional Tests

14.2.12.2.1 Post-core Hot Functional Test Controlling Document

1.0 OBJECTIVE

1.1 To demonstrate the proper integrated operation of plant primary, secondary, and auxiliary systems with fuel loaded in the core

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 appendices.

4.0 DATA REQUIRED

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

5.0 ACCEPTANCE CRITERIA

5.1 Integrated operation of the primary, secondary, and related auxiliary systems is in accordance with the system descriptions.

14.2.12.2.2 Loose Parts Monitoring System

1.0 OBJECTIVE

1.1 To obtain baseline data on the loose parts monitoring system (LPMS)

1.2 To adjust LPMS alarm setpoints as necessary

2.0 PREREQUISITES

2.1 Preoperational tests of the LPMS have been completed.

2.2 All LPMS instrumentation has been calibrated and is operable.

3.0 TEST METHOD

3.1 Collect baseline data using the LPMS during plant heatup and at normal operating conditions.

3.2 Analyze baseline data and, if necessary, adjust alarm setpoints.

4.0 DATA REQUIRED

4.1 Baseline data using LPMS

4.2 LPMS alarm setpoints

4.3 RCS temperature and pressure

5.0 ACCEPTANCE CRITERIA

5.1 LPMS performs as described in Subsection 7.7.1.5.

5.2 The LPMS alarm setpoints have been adjusted as necessary.

14.2.12.2.3 Post-core Reactor Coolant System Flow Measurements

1.0 OBJECTIVE

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 make adjustments to the 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 differential pressure

4.4 RCS temperature and pressure

4.5 Pump configuration

4.6 Coastdown time

5.0 ACCEPTANCE CRITERIA

5.1 Measured RCS flow exceeds the flow rates used in the safety analysis in Subsection 15.6.5, but is less than the design maximum flow rate as described in Subsections 4.4.1.3 and 7.2.1.1.

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 and for those portions of the coastdowns that occur prior to CPC initiation of a trip.

14.2.12.2.4 <u>Post-core Control Element Drive Mechanism Performance</u>

1.0 OBJECTIVE

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 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

5.0 ACCEPTANCE CRITERIA

5.1 The CEDM/CEAs and their associated position indications operate as described in Subsection 7.7.1.1 a.

5.2 CEA drop times are in agreement with the Technical Specifications.

5.3 CEA insertion and withdrawal times meet design requirements.

14.2.12.2.5 Post-core Reactor Coolant and Secondary Water Chemistry Data

1.0 OBJECTIVE

1.1 To maintain the proper water chemistry for the RCS and steam generators during post-core hot functional testing

2.0 PREREQUISITES

2.1 Primary and secondary sampling systems are operable.

2.2 Chemicals 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 Minimum sampling frequency for the steam generator and RCS is as specified by the chemistry manual. The sampling frequency is modified as required to provide reasonable assurance of the proper RCS and steam generator water chemistry.

3.2 Perform RCS and steam generator 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 Steam generator chemistry analysis

4.3 RCS chemistry analysis

5.0 ACCEPTANCE CRITERIA

5.1 RCS and steam generator water chemistry can be maintained as described in Subsections 9.3.4 and 10.3.5.

5.2 Baseline data for the steam generators and RCS is established.

14.2.12.2.6 <u>Post-core Pressurizer Spray Valve and Control Adjustments</u>

1.0 OBJECTIVE

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

14.2.12.2.7 Post-core Reactor Coolant System Leak Rate Measurement

1.0 OBJECTIVE

1.1 To measure the post-core load 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.

14.2.12.2.8 Post-core In-core Neutron Flux Detector Test

1.0 OBJECTIVE

1.1 To measure the leakage resistance of the fixed in-core detectors

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

5.0 ACCEPTANCE CRITERIA

5.1 Insulation resistance of the in-core neutron flux detectors is as described in manufacturer's recommendations.

14.2.12.2.9 Post-core Instrument Correlation

1.0 OBJECTIVE

1.1 To demonstrate the proper operation of 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 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

5.0 ACCEPTANCE CRITERIA

5.1 The IPS, QIAS, PPS, and CPCs perform as described in Sections 7.2 and 7.7.

14.2.12.2.10 Post-core Acoustic Leak Monitoring System

1.0 OBJECTIVE

1.1 To obtain baseline data on the acoustic leak monitoring system (ALMS)

1.2 To adjust ALMS alarm setpoints as necessary

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 ALMS performs as described in Subsection 7.7.1.5.

5.2 The ALMS alarm setpoints have been adjusted as necessary.

14.2.12.2.11 Post-core Ex-core Neutron Flux Monitoring System Test

1.0 OBJECTIVE

1.1 To verify the proper functional performance of the ex-core neutron flux monitoring system

1.2 To verify the proper performance of the audio and visual indicators

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 the operation of the ex-core neutron flux monitoring system are operational.

2.5 Check source is available.

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 Using a check source, verify calibration of the startup, safety, and control channels.

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

4.3 Channel response to the check source

5.0 ACCEPTANCE CRITERIA

5.1 The ex-core neutron flux monitoring system performs as described in Subsections 7.7.1.1 h.

14.2.12.3 Low-power Physics Test

14.2.12.3.1 Low-power Biological Shield Survey Test

1.0 OBJECTIVE

1.1 To measure radiation in accessible locations of the plant outside the biological shield

1.2 To obtain baseline levels for comparison with future measurements of level buildup with operation

2.0 PREREQUISITES

2.1 Radiation survey instruments are calibrated.

2.2 Background radiation levels have been measured in designated locations prior to initial criticality.

3.0 TEST METHOD

3.1 Measure gamma and neutron dose rates during low-power (<5 percent rated thermal power [RTP]) operation.

4.0 DATA REQUIRED

4.1 Power level

4.2 Gamma and neutron dose rates at each specified location

5.0 ACCEPTANCE CRITERIA

5.1 Baseline neutron and gamma surveys have been completed.

5.2 The biological shield performs as described in Subsection 12.3.2.2.

14.2.12.3.2 Isothermal Temperature Coefficient Test

1.0 OBJECTIVE

1.1 To measure the isothermal temperature coefficients (ITCs) for various reactor coolant system (RCS) temperatures, pressures, and control element assembly (CEA) configurations

1.2 To determine the moderator temperature coefficient (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 Reactivity and power swings are limited by compensation with the CEA motion when necessary.

4.0 DATA REQUIRED

4.1 Conditions of the measurement:

4.1.1 Pressurizer pressure

4.1.2 CEA configuration

4.1.3 Boron concentration

4.2 Time-dependent information:

4.2.1 Reactivity

4.2.2 CEA position

4.2.3 Temperature

5.0 ACCEPTANCE CRITERIA

5.1 The measured ITCs agree with the predicted values within the acceptance criteria specified in Table 14.2-6.

5.2 The MTCs derived from the measured ITC are in compliance with the Technical Specifications.

14.2.12.3.3 Shutdown and Regulating Control Element Assembly Group Worth Test

1.0 OBJECTIVE

1.1 To determine regulating and shutdown CEA group worths necessary to demonstrate adequate 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 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 and/or by use of alternate CEA configurations.

4.0 DATA REQUIRED

4.1 Conditions of the measurement:

4.1.1 RCS temperature

4.1.2 Pressurizer pressure

4.1.3 CEA configuration

4.1.4 Boron concentration

4.2 Time-dependent information:

4.2.1 Reactivity variation

4.2.2 CEA positions

5.0 ACCEPTANCE CRITERIA

5.1 The measured CEA group worths agree with predictions within the acceptance criteria specified in Table 14.2-6.

5.2 Evaluation of the measurements verifies shutdown margin.

14.2.12.3.4 Differential Boron Worth Test

1.0 OBJECTIVE

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 Conditions of the measurement at state points:

4.1.1 RCS temperature

4.1.2 Pressurizer pressure

4.1.3 CEA configuration

4.1.4 Boron concentration

4.2 Integral reactivity changes between state points

5.0 ACCEPTANCE CRITERIA

5.1 The measured boron worths agree with the predicted values within the acceptance criteria specified in Table 14.2-6.

14.2.12.3.5 Critical Boron Concentration Test

1.0 OBJECTIVE

1.1 To measure critical boron concentrations 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 it is established that an equilibrium state has been 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 agree with the predictions within the acceptance criteria specified in Table 14.2-6.

14.2.12.3.6 Control Element Assembly Symmetry Test

1.0 OBJECTIVE

1.1 To demonstrate that no loading or fabrication errors that result in measurable CEA worth asymmetries have occurred. This objective can be satisfied by performing CEA group worth measurement and by performing low-power (≤ 20 percent power) distribution measurements.

2.0 PREREQUISITES

2.1 The reactivity computer is in operation.

2.2 The reactor is critical at the desired conditions with the controlling CEA group partially inserted and in manual control.

3.0 TEST METHOD

3.1 Conduct CEA symmetry test (at hot zero-power [HZP] conditions).

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 the symmetric group has been determined.

3.1.4Repeat steps 3.1.1, 3.1.2, and 3.1.3 for the remainder of the groups.

4.0 DATA REQUIRED

4.1 Conditions of the measurement:

4.1.1 RCS temperature

4.1.2 Pressurizer pressure

4.1.3 CEA configuration

4.1.4 Boron concentration

4.2 Time-dependent information:

4.2.1 Reactivity variation

4.2.2 CEA positions

5.0 ACCEPTANCE CRITERIA

5.1 The relative worths of symmetric CEAs are within the acceptance criteria specified in Table 14.2-6.

14.2.12.4 Power Ascension Tests

14.2.12.4.1 Variable T_{avg} (Isothermal Temperature Coefficient and Power Coefficient) Test

1.0 OBJECTIVE

1.1 To measure the isothermal temperature coefficient (ITC) and power coefficient of reactivity at selected power levels

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 using CEA movement to maintain the power essentially constant and/or by balancing temperature against power changes.

3.2 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 Conditions of the measurement:

4.1.1 Reactor thermal power

4.1.2 CEA configuration

4.1.3 Boron concentration

4.1.4 Core burnup

4.2 Time-dependent data:

4.2.1 Power level

4.2.2 RCS temperature

4.2.3 CEA positions

5.0 ACCEPTANCE CRITERIA

5.1 Measured values agree with predictions within the acceptance criteria specified in Table 14.2-6 and conform to the Technical Specifications.

14.2.12.4.2 Unit Load Transient Test

1.0 OBJECTIVE

1.1 To demonstrate that load changes can be made at the desired rates

2.0 PREREQUISITES

2.1 The reactor is operating at the desired power level.

2.2 The reactor regulating system (RRS), feedwater control system (FWCS), steam bypass control system (SBCS), reactor power cutback system (RPCS), turbine control system (TCS), and the pressurizer level and pressure control systems are in automatic operation.

3.0 TEST METHOD

3.1 Load increases and decreases (steps and ramps) are performed in accordance with the NSSS supplier's fuel preconditioning guidelines,

and as allowed by the TCS and RRS, at power levels in the 80 to 95 percent range and in the 35 to 50 percent range.

4.0 DATA REQUIRED

4.1 Time-dependent data:

4.1.1 Pressurizer level and pressure

4.1.2 RCS temperatures

4.1.3 CEA position

4.1.4 Power level and demand

4.1.5 Steam generator levels and pressures

4.1.6 Feedwater and steam flow

4.1.7 Feedwater temperature

5.0 ACCEPTANCE CRITERIA

5.1 The step and ramp transients demonstrate that the plant performs load changes allowed by the NSSS supplier's fuel preconditioning guidelines and data have been recorded that demonstrate the plant's ability to meet unit load swing design transients as described in Subsections 3.9.1.1, 4.4.3.4, and 7.7.1.1.

5.2 No audible noise or significant vibration is observed in the economizer or in the rest of the feedwater and auxiliary feedwater systems due to water hammer.[4]

(4) Acceptance criteria can be satisfied by performing system walkdown when conditions permit entry to containment.

14.2.12.4.3 Control Systems Checkout Test

1.0 OBJECTIVE

1.1 To demonstrate that the automatic control systems operate satisfactorily during steady-state and transient conditions

2.0 PREREQUISITES

2.1 The reactor is operating at the desired conditions.

2.2 The reactor regulating system (RRS), feedwater control system (FWCS), steam bypass control system (SBCS), reactor power cutback system (RPCS), and the pressurizer level and pressure controls are in automatic operation.

2.3 The control element drive mechanism control system (CEDMCS) is operational.

3.0 TEST METHOD

3.1 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 Time-dependent data:

4.1.1 Pressurizer level and pressure

4.1.2 RCS temperatures

4.1.3 CEA position

4.1.4 Power level and demand

4.1.5 Steam generator levels and pressures

4.1.6 Feedwater and steam flow

4.1.7 Feedwater temperature

5.0 ACCEPTANCE CRITERIA

5.1 The control systems maintain the reactor power, RCS temperature, pressurizer pressure and level, and steam generator levels and pressures 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 as described in Subsection 7.7.1.1.

14.2.12.4.4 Reactor Coolant and Secondary Chemistry and Radiochemistry Test

1.0 OBJECTIVE

1.1 To conduct chemistry tests at various power levels to gather corrosion data and determine activity buildup

1.2 To verify the proper operation of the process radiation monitor

1.3 To verify the adequacy of sampling and analysis procedures

2.0 PREREQUISITES

2.1 The reactor is stable at the desired power level.

2.2 Sampling systems for the reactor coolant system (RCS) and chemical and volume control system (CVCS) 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

5.0 ACCEPTANCE CRITERIA

5.1 Measured activity levels are within their limits.

5.2 The process radiation monitors agree with the laboratory analyses within measurement uncertainties as described in Subsection 9.3.2.

5.3 Samples of the reactor coolant and secondary fluids can be obtained from the locations described in Subsection 9.3.2 and identified in Tables 9.3.2-1 through 9.3.2-4, and procedures for sample collection and analysis are verified as described in Subsection 9.3.2.

14.2.12.4.5 Turbine Trip Test

1.0 OBJECTIVE

1.1 To demonstrate that the plant responds and is controlled as designed following a 100 percent turbine trip without the reactor power cutback system (RPCS) in service

2.0 PREREQUISITES

2.1 The reactor is operating above 95 percent power.

2.2 The SBCS, FWCS, RRS, and pressurizer pressure and level control systems are in automatic operation.

2.3 The RPCS is in “Auto Actuate 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 RRS, SBCS, FWCS, and pressurizer pressure and level control systems maintain the NSSS within operating limits.

4.0 DATA REQUIRED

4.1 Plant condition prior to trip

4.2 The following acceptance criteria parameters are monitored prior to and throughout the transient:

4.2.1 Pressurizer pressure and level

4.2.2 RCS hot leg temperatures

4.2.3 Steam generator (SG) pressures

4.2.4 CEA drop times

4.3 Additional key plant parameters are monitored for baseline data.

5.0 ACCEPTANCE CRITERIA

5.1 The measured values of the acceptance criteria parameters in step 4.2 (above) are within the single-valued acceptance limits based on test predictions using methodology described in Subsection 15.0.2.

5.2 The DPS initiates a reactor trip upon the turbine trip.

5.3 The ESFAS is not actuated.

5.4 The pressurizer POSRVs and the MSSV are not open.

5.5 The plant responds as described in Subsection 15.2.2.

14.2.12.4.6 Unit Load Rejection Test

1.0 OBJECTIVE

1.1 To demonstrate that the plant responds and is controlled as designed following a 100 percent load rejection with RPCS in service

2.0 PREREQUISITES

2.1 The reactor is operating above 95 percent power.

2.2 The SBCS, FWCS, RRS, CEDMCS, RPCS, and pressurizer pressure and level control 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 Plant condition prior to load rejection

4.2 The following acceptance criteria parameters are monitored prior to and throughout the transient:

4.2.1 Pressurizer pressure and level

4.2.2 RCS hot leg temperatures

4.2.3 SG pressures

4.3 Additional key plant parameters are monitored for baseline data.

5.0 ACCEPTANCE CRITERIA

5.1 The measured values of the acceptance criteria parameters in step 4.2 (above) are within the single-valued acceptance limits based on test predictions using methodology described in Subsection 15.0.2.

5.2 A reactor trip does not occur during the test.

5.3 The RPCS operates as described in Subsection 7.7.1.1 e.

5.4 The plant responds as described in Subsection 15.2.1.

14.2.12.4.7 Shutdown from Outside the Main Control Room Test

1.0 OBJECTIVE

1.1 To demonstrate that the plant can be maintained in hot standby from outside the main control room (MCR) following a reactor trip

1.2 To demonstrate the potential for safely cooling down the plant from hot standby to cold shutdown conditions 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 from the remote shutdown console (RSC) 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 remote shutdown location has been demonstrated to be operational.

2.5 The remote shutdown instrumentation controls and systems have been preoperationally tested.

3.0 TEST METHOD

3.1 The operating crew evacuates the MCR (standby crew remains in the control room).

3.2 The reactor is tripped from outside the MCR.

3.3 The reactor is brought to hot standby by the minimum shift operating crew from outside the MCR and is maintained in this condition for at least 30 minutes.

3.4 Transfer of control to the RSC is demonstrated from switches near the MCR exits and at appropriate locations inside the channelized equipment rooms.

3.5 Following the hot standby demonstration, starting from approximately 176.7 °C (350 °F), reduce the reactor coolant temperature by at least 10 °C (50 °F) from outside the control room using the RSC.

3.6 Transfer of control back to MCR from RSC is demonstrated, using the switches provided in the channelized equipment rooms.

* Testing is conducted in accordance with NRC RG 1.68.2 (Reference 4).

4.0 DATA REQUIRED

4.1 Time-dependent data:

4.1.1 Pressurizer pressure and level

4.1.2 RCS temperatures

4.1.3 Steam generator pressure and level

4.1.4 CEA drop times

5.0 ACCEPTANCE CRITERIA

5.1 The ability to achieve and control the reactor at hot standby from outside the MCR is demonstrated as described in Subsection 7.4.1.1.

5.2 The potential ability to cool down from hot standby to cold shutdown conditions from outside the control room is demonstrated by reducing the reactor coolant temperature by at least 10 °C (50 °F) using the RSC from outside the control room.

14.2.12.4.8 Loss of Offsite Power Test

1.0 OBJECTIVE

1.1 To verify that the reactor can be shut down and maintained in hot standby in the event of loss of 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 Time-dependent data:

4.1.1 Steam generator pressure and levels

4.1.2 Pressurizer pressure and level

4.1.3 RCS temperatures

4.1.4 Boron concentration

4.1.5 CEA drop times

5.0 ACCEPTANCE CRITERIA

5.1 The reactor is shut down and maintained in hot standby on emergency power for at least 30 minutes during a simulated loss of offsite power as described in Subsection 15.2.1.

14.2.12.4.9 Biological Shield Survey Test

1.0 OBJECTIVE

1.1 To measure the radiation levels in accessible locations of the plant outside the biological shield

1.2 To determine occupancy times for these areas during power operation

2.0 PREREQUISITES

2.1 Radiation survey instruments have been calibrated.

2.2 Results of the radiation surveys performed at zero-power conditions are available.

3.0 TEST METHOD

3.1 Measure gamma and neutron dose rates at 50 and 100 percent power levels.

4.0 DATA REQUIRED

4.1 Power level

4.2 Gamma dose rates in the accessible locations

4.3 Neutron dose rates in the accessible locations

5.0 ACCEPTANCE CRITERIA

5.1 Accessible areas and occupancy times during power operation have been defined as described in Subsection 12.3.2.

5.2 The biological shield performs as described in Subsection 12.3.2.2.

14.2.12.4.10 Steady-State Core Performance Test

1.0 OBJECTIVE

1.1 To determine core power distributions using in-core instrumentation

1.2 To demonstrate that the core has been assembled as designed

2.0 PREREQUISITES

2.1 The reactor is operating at the desired power level and control element assembly (CEA) configuration with equilibrium xenon.

2.2 The in-core instrumentation system is in operation.

3.0 TEST METHOD

3.1 Selected information processing system (IPS) outputs and core protection calculator (CPC) outputs are recorded.

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 measurements

4.1.2 CEA positions

4.1.3 Boron concentration

4.1.4 Core average burnup

4.1.5 Selected plant computer outputs and CPC outputs

4.1.6 In-core detector maps

5.0 ACCEPTANCE CRITERIA

5.1 Agreement between the predicted and measured power distributions and core peaking factors are within the acceptance criteria as described in Table 14.2-6.

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 OBJECTIVE

1.1 To verify that the process variable inputs/outputs of the plant protection system (PPS), core protection calculators (CPCs), information processing system (IPS), qualified information and alarm system inputs (QIAS), and console instruments are consistent

2.0 PREREQUISITES

2.1 The plant is operating at the desired conditions.

2.2 All CPCs, control element assembly calculators (CEACs), and the IPS and QIAS are operable.

3.0 TEST METHOD

3.1 Process variable inputs/outputs of the PPS, CPCs, QIAS, IPS, and console instruments 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, QIAS, and the console instruments, as described in Subsections 7.5.1 and 7.7.1, are within the limits of the uncertainty analysis.

14.2.12.4.12 Verification of Core Protection Calculator Power Distribution Related Constants Test

1.0 OBJECTIVE

1.1 To verify the planar radial peaking, temperature annealing, CEA shadowing factors, and shape annealing matrix and boundary point

power correlation constants, and to verify the algorithms used in the CPCs to relate ex-core signals to in-core 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 safety channels have been properly calibrated.

3.0 TEST METHOD

3.1 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.

3.2 The CEA shadowing factors are verified by comparing ex-core detector responses for various CEA configurations with the unrodded ex-core responses.

3.3 The shape annealing factors are measured by comparing in-core power distributions and ex-core detector responses during a free xenon oscillation.

3.4 The temperature shadowing factors are verified by comparing core power and ex-core detector responses for various RCS temperatures.

4.0 DATA REQUIRED

4.1 Conditions of the measurement:

4.1.1 Power level

4.1.2 Burnup

4.2 Time-dependent data:

4.2.1 In-core and ex-core detector readings

4.2.2 CEA position

4.2.3 RCS temperatures

5.0 ACCEPTANCE CRITERIA

5.1 Measured radial peaking factors determined from in-core flux maps are no higher than the corresponding values used in the CPCs.

5.2 The CEA shadowing factors and temperature shadowing factors used in the CPCs are conservative than the measured values.

5.3 The shape annealing matrix has been measured, and the boundary point power correlation constants are measured and installed in the CPC.

14.2.12.4.13 Feedwater and Auxiliary Feedwater Systems Test

1.0 OBJECTIVE

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	×	

Evolution	FW	AFW
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 steam bypass control system (SBCS), feedwater control system (FWCS), reactor regulatory system (RRS), reactor power cutback system (RPCS), control element drive mechanism control system (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 perform as designated by the system description and as described.

5.2 No effects due to water hammer are 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 decreases as the feedwater valves are throttled.

14.2.12.4.14 Core Protection Calculator Verification

1.0 OBJECTIVE

1.1 To verify departure from nucleate boiling ratio (DNBR) and local power density (LPD) calculations of the core protection calculators (CPCs)

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.

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(5) Acceptance criteria can be satisfied by performing a system walkdown when conditions permit entry to containment.

2.3 The in-core detector system is operational.

3.0 TEST METHOD

3.1 Specified values are recorded from the CPCs.

3.2 The values for the LPD and DNBR obtained from the CPCs are compared with the values calculated for the same conditions using the CPC program simulator.

4.0 DATA REQUIRED

4.1 Reactor power

4.2 CEA positions

4.3 Boron concentration

4.4 Specified CPC inputs, outputs, and constants

5.0 ACCEPTANCE CRITERIA

5.1 The values of the DNBR and LPD calculated by the CPCs are consistent with the values calculated by the CPC program.

14.2.12.4.15 Main Steam Atmospheric Dump and Turbine Bypass Valves Capacity Test

1.0 OBJECTIVE

1.1 To demonstrate that the maximum steam flow capacity of each main steam atmospheric dump valve (MSADV) upstream of the main steam isolation valves (MSIVs) is less than that assumed for the safety analysis

1.2 To demonstrate the throttling capability of the MSADVs

1.3 To measure the capacity of each turbine bypass valve individually to determine that the capacity of each steam bypass valve is less than the value used in the safety analysis

2.0 PREREQUISITES

2.1 The reactor power is ≥ 25 percent full power.

2.2 Control systems are in automatic where applicable.

2.3 The operation of the main steam atmospheric dump valves, turbine bypass valves, and shutdown cooling system have been demonstrated as part of the hot functional testing.

3.0 TEST METHOD

3.1 The individual steam flows through each of the MSADVs upstream of the MSIVs are measured.

3.2 Throttle each MSADV over its operating range to verify throttle capability.

3.3 The capacity of each turbine bypass valve is measured.

4.0 DATA REQUIRED

4.1 Reactor power and turbine power

4.2 RCS temperatures

4.3 Pressurizer pressure

4.4 Steam generator levels and pressure

4.5 Steam dump and turbine bypass valve positions

4.6 Feedwater flow rates and feedwater temperatures

5.0 ACCEPTANCE CRITERIA

5.1 The capacities of the individual MSADVs are less than the values used in the safety analysis but greater than the values required for a safe cooldown.

5.2 The capacity of each turbine bypass valve has been measured and is less than the value used in the safety analysis.

14.2.12.4.16 In-core Detector Test

1.0 OBJECTIVE

1.1 To verify proper operation of the fixed in-core detector system and conversion of the fixed in-core signals to fluxes

2.0 PREREQUISITES

2.1 The reactor is at the specified power level and conditions.

2.2 The IPS is operable.

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 The fixed in-core detector responses have been obtained and reviewed to identify potential detector failures and miswirings.

5.2 Background detector signals are less than 10 percent of the midplane detector signal.

14.2.12.4.17 Core Operating Limit Supervisory System Verification

1.0 OBJECTIVE

1.1 To verify the core operating limit supervisory system (COLSS) secondary calorimetric, departure from nucleate boiling ratio (DNBR), and local power density (LPD) calculations

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 Specified values are recorded from the COLSS.

3.2 The values for secondary calorimetric power, LPD, and DNBR obtained from the COLSS are compared with independently calculated values using the COLSS algorithms.

4.0 DATA REQUIRED

4.1 Reactor power

4.2 CEA positions

4.3 Boron concentration

4.4 Specified COLSS inputs, outputs, and constants

4.5 In-core detector maps

5.0 ACCEPTANCE CRITERIA

5.1 The values of COLSS secondary calorimetric power, DNBR, and LPD obtained from the COLSS agree with the independently calculated values within the uncertainties in computer processing contained in the COLSS uncertainty analysis.

14.2.12.4.18 Baseline Nuclear Steam Supply System Integrity Monitoring

1.0 OBJECTIVE

1.1 To obtain baseline internals vibration monitoring system (IVMS) data at various power plateaus

1.2 To obtain baseline acoustic leak monitoring system (ALMS) data at various power plateaus

1.3 To obtain baseline loose parts monitoring system (LPMS) data at various reactor coolant pump configurations and power plateaus

1.4 To obtain baseline RCP vibration monitoring system (RCPVMS) data at various reactor coolant pump configurations and power plateaus

1.5 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 IVMS, ALMS, LPMS, and RCPVMS are 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, temperature, and pressure

4.2 Baseline data for ALMS, IVMS, LPMS, and RCPVMS

5.0 ACCEPTANCE CRITERIA

5.1 Baseline data have been collected at 0, 20, 50, 80, and 100 percent power.

5.2 Alarm setpoints have been evaluated for adequacy.

14.2.12.4.19 Loss of One Main Feedwater Pump

1.0 OBJECTIVE

1.1 To evaluate system response to the loss of one main feedwater pump (MFWP) among three operating MFWPs

2.0 PREREQUISITES

2.1 Loss of one MFWP among three operating MFWPs

2.1.1 Plant is operating at 100 percent rated thermal power (RTP).

2.1.2 Three MFWPs are operating.

2.2 The reactor regulatory system (RRS), feedwater control system (FWCS), steam bypass control system (SBCS), reactor power cutback system (RPCS), pressurizer level control, and pressurizer pressures are in automatic.

3.0 TEST METHOD

3.1 Loss of one MFWP among three operating MFWPs

3.1.1 Trip one MFWP among three operating MFWPs.

4.0 DATA REQUIRED

4.1 Time-dependent data:

4.1.1 Pressurizer level and pressure

4.1.2 RCS temperatures

4.1.3 Power level

4.1.4 Steam generator levels and pressures

4.1.5 Feedwater and steam flows

4.1.6 Feedwater temperatures

4.1.7 Parameters of turbine setback and runback

5.0 ACCEPTANCE CRITERIA

5.1 The control systems stabilize the plant to normal operating control bands.

5.2 No safety actuation limits are exceeded.

14.2.12.4.20 Penetration Temperature Survey Test

1.0 OBJECTIVE

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 OBJECTIVE

1.1 To verify that various heating, ventilation, and air conditioning (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 Temperature conditions are maintained in the reactor containment building, control room area, and each area in the auxiliary building and compound building in accordance with Section 9.4.

14.2.12.4.22 Natural Circulation Test

1.0 OBJECTIVE

1.1 To evaluate natural circulation flow conditions

2.0 PREREQUISITES

2.1 The reactor is operating to provide a satisfactory heat source after a trip.

3.0 TEST METHOD

3.1 All reactor coolant pumps are secured essentially simultaneously.

3.2 The plant is tripped.

3.3 Reactor coolant system (RCS) temperatures, pressurizer pressure and level, and steam generator levels and pressures are continuously recorded.

3.4 The natural circulation power-to-flow ratio is calculated at hot standby conditions and at reduced plant pressure and temperature.

3.5 The RCS pressure is lowered using the chemical and volume control system (CVCS) auxiliary pressurizer spray.

4.0 DATA REQUIRED

4.1 RCS temperature

4.2 Pressurizer pressure and level

4.3 Steam generator levels and pressure

4.4 RCS boron concentration

5.0 ACCEPTANCE CRITERIA

5.1 The natural circulation power-to-flow ratio is less than 1.0.

14.2.12.4.23 Liquid Waste Management System Test

1.0 OBJECTIVE

1.1 To demonstrate that the operation of the liquid waste management system (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.

14.2.12.4.24 Gaseous Waste Management System Test

1.0 OBJECTIVE

1.1 To demonstrate that the operation of the gaseous waste management system (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.

14.2.12.4.25 Pseudo-ejected CEA Test

1.0 OBJECTIVE

1.1 To determine the power distribution associated with the CEA ejection from about the full power dependent insertion limit (FPDIL) 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 (FSCEA) 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 RPD ratios is less than or equal to ± 20 percent for all fuel assemblies.

14.2.12.4.26 Pseudo Dropped CEA Test

1.0 OBJECTIVE

1.1 To determine the power distribution resulting from a “dropped” CEA with the reactor at 50 percent of rated thermal power

* The full-strength CEA (FSCEA) 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 (PSCEA) with the reactor at 50 percent 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 (FSCEA) chosen to be dropped is the one that results in the highest peaking factor relative to steady state, all rods out conditions.

A. Insert the selected CEA to the lower electrical limit (LEL) 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 (PSCEA) chosen to be dropped is the one that results in the highest peaking factor relative to steady state, all rods out conditions.

A. Insert the selected CEA to the lower electrical limit (LEL) 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 (RPD)

5.0 ACCEPTANCE CRITERIA

5.1 The difference between the measured and predicted assembly average RPD ratios is less than or equal to ± 0.2 for all fuel assemblies.

14.2.13 Combined License Information

COL 14.2(1) The COL applicant is to develop the site-specific organization and staffing level appropriate for its facility.

COL 14.2(2) The COL applicant is to prepare the site-specific test procedures and/or guidelines that is to be used for the conduct of the plant startup program.

COL 14.2(3) The COL applicant is to prepare a startup administrative manual and also provide preoperational and startup test summaries that contain testing objectives and acceptance criteria applicable for its scope of the plant design. 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.

COL 14.2(4) The COL applicant is to perform review and evaluation of individual test results.

COL 14.2(5) The COL applicant is to develop the detailed description of test and acceptance criteria for the Security System.

COL 14.2(6) The COL applicant is to develop a 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 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(7) 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(8) The COL applicant that references the APR1400 design certification is to identify the specific 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(9) The COL applicant is to prepare the pre-operational test of cooling tower and associated auxiliaries, and raw water and service water cooling systems.

COL 14.2(10) The COL applicant is to develop the test program of personnel monitors and radiation survey instruments.

COL 14.2(11) The COL applicant is to develop the test procedure of the communication system.

14.2.14 References

1. 'Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,' "Domestic Licensing of Production and Utilization Facilities," Energy, Title 10, Code of Federal Regulations, 50, Appendix B, U.S. Nuclear Regulatory Commission, Washington, DC.

2. Quality Assurance Program Requirements (Design and Construction), NRC RG 1.28, Rev. 4, U.S. Nuclear Regulatory Commission, Washington, DC, June 2010.

3. Initial Test Programs for Water-Cooled Nuclear Power Plants, NRC RG 1.68, Rev. 3, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

4. Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants, NRC RG 1.68.2, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, DC, April 2010.

5. Preoperational Testing of Instrument and Control Air Systems, NRC RG 1.68.3, Rev. 0, U.S. Nuclear Regulatory Commission, Washington, DC, September 2012.

6. Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors, NRC RG 1.79, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, September, 1975.

7. "Rules for Construction of Nuclear Power Plant Components," Boiler and Pressure Vessel Code, 2007 Edition. ASME Section III, American Society of Mechanical Engineers.

8. Containment System Leakage Testing Requirements, ANSI/ANS-56.8-1994, American National Standard Institute, January 1994.

9. Comprehensive Vibration Assessment (CVAP) Program for Reactor Internals during Pre-operational and Initial Startup Testing, Regulatory Guide 1.20, Rev. 3, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

10. Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants, Regulatory Guide 1.140, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, DC, June 2001.

11. 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, Regulatory Guide 1.52, Rev. 4, U.S. Nuclear Regulatory Commission, Washington, DC, September 2012.

Table 14.2-1 (1 of 5)

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 5)

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 handling and storage 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	Safety depressurization and 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 5)

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 MSIV bypass valves 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 5)

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 generator auxiliary systems test
14.2.12.1.89	Alternate AC source system test
14.2.12.1.90	Alternate AC source support systems test
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 area HVAC system test
14.2.12.1.99	Compound building HVAC system test
14.2.12.1.100	Balance of control room area 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	Airborne and area radiation monitoring system test

Table 14.2-1 (5 of 5)

Subsection	Test
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
14.2.12.1.110	Unit main power system test
14.2.12.1.111	13,800 V normal auxiliary power system test
14.2.12.1.112	4,160 V normal auxiliary power system test
14.2.12.1.113	480 V normal 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 room area HVAC systems 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

Table 14.2-2

Post-core Hot Functional Tests

Subsection	Test
14.2.12.2.1	Post-core hot functional test controlling document
14.2.12.2.2	Loose parts monitoring system
14.2.12.2.3	Reactor coolant system flow measurements
14.2.12.2.4	Post-core control element drive mechanism performance
14.2.12.2.5	Post-core reactor coolant and secondary water chemistry data
14.2.12.2.6	Post-core pressurizer spray valve and control adjustments
14.2.12.2.7	Post-core reactor coolant system leak rate measurement
14.2.12.2.8	Post-core in-core instrumentation test
14.2.12.2.9	Post-core instrument correlation
14.2.12.2.10	Post-core acoustic leak monitor system test
14.2.12.2.11	Post-core ex-core neutron flux monitoring system test

Table 14.2-3

Low-power Physics Tests

Subsection	Test
14.2.12.3.1	Low-power biological shield survey test
14.2.12.3.2	Isothermal temperature coefficient test
14.2.12.3.3	Shutdown and regulating control element assembly group worth test
14.2.12.3.4	Differential boron worth test
14.2.12.3.5	Critical boron concentration test
14.2.12.3.6	Control element assembly symmetry

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	Baseline nuclear steam supply system integrity monitoring
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	Natural circulation test
14.2.12.4.23	Liquid waste management system test
14.2.12.4.24	Gaseous waste management system test
14.2.12.4.25	Pseudo-ejected CEA test
14.2.12.4.26	Pseudo-dropped CEA 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	50, 80 %
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 % Δρ, whichever is greater
Total Worth (Net Shutdown)	± 10 %
Temperature Coefficient	$\pm 0.36 \times 10^{-4}$ Δρ/°F
Critical Boron Concentration	± 50 ppm
Boron Worth	± 15 ppm/ %Δρ
Power Ascension Physics Test	
Power Distribution (Radial and Axial)	RMS(2) ≤ 5 % (3 %(3))
Peaking Factors (F_{xy}, F_r, F_z, F_q)	± 7.5 %
Temperature Coefficient	$\pm 0.36 \times 10^{-4}$ Δρ/°F
Power Coefficient	$\pm 0.2 \times 10^{-4}$ Δρ/% power
Pseudo-ejected CEA	± 20 %
Pseudo-dropped CEA	± 0.2

(1) If CEA exchange methods are used, the acceptance criterion for reference bank is ± 10 %.

(2) $\mathrm{RMS} = \sqrt{\frac{\sum_i^N (\mathrm{RPD}^{\mathrm{PAED}} - \mathrm{RPD}^{\mathrm{MEAS}})^2}{N}}$

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 15)

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	Pre-core hot functional test controlling document Pre-core reactor coolant system expansion measurements
1.a.(2) (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 Safety depressurization and 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)	14.2.12.1.41 14.2.12.1.42 14.2.12.1.43	Internals vibration monitoring system test Loose parts monitoring system test Acoustic leak monitoring 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.

Table 14.2-7 (2 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.a.(3)	14.2.12.1.41 14.2.12.1.42 14.2.12.1.43 14.2.12.1.51	Internals vibration monitoring system test Loose parts monitoring system test Acoustic leak monitoring system test Pre-core reactor coolant system expansion measurements
1.a.(4)	14.2.12.1.35	Reactor coolant system hydrostatic test
1.b.(1)	14.2.12.1.27 14.2.12.1.28 14.2.12.1.32 14.2.12.1.36 14.2.12.1.54	Digital rod control system test Reactor regulating system test Reactor power cutback system test Control element drive mechanism cooling system test Pre-core control element drive mechanism performance test
1.b.(2)	14.2.12.1.5 14.2.12.1.7 14.2.12.1.58 14.2.12.1.60 14.2.12.1.84 14.2.12.1.112 14.2.12.1.113 14.2.12.1.114	Chemical and volume control system letdown subsystem test Chemical and volume control system charging subsystem test Pre-core chemical volume control system integrated test Pre-core boration / dilution measurements Heat tracing system test 4,160 V normal auxiliary power system test 480 V normal auxiliary power system test Non-Class 1E dc power systems test
1.b.(3)	-	Not applicable This is not a design feature of the APR1400.
1.c	14.2.12.1.23 14.2.12.1.24 14.2.12.1.39 14.2.12.1.47 14.2.12.1.49 14.2.12.1.54 14.2.12.1.115	Engineered safety features – component control system test Plant protection system test Integrated engineered safety features / loss of power test Pre-core instrument correlation Diverse protection system test Pre-core control element drive mechanism performance test Class 1E dc power systems test
1.d.(1)	14.2.12.1.29 14.2.12.1.65	Steam bypass control system test Main steam system test

Table 14.2-7 (3 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.d.(2)	14.2.12.1.65	Main steam system test
1.d.(3)	14.2.12.1.63	Main steam safety valve test
1.d.(4)	14.2.12.1.63	Main steam safety valve test
1.d.(5)	14.2.12.1.20	Shutdown cooling system test
1.d.(6)	-	Not applicable This is not a design of the APR1400.
1.d.(7)	14.2.12.1.64	Main steam isolation valves and MSIV bypass valves test
1.d.(8)	14.2.12.1.34	Auxiliary feedwater system test
1.d.(9)	14.2.12.1.79	Condensate storage system test
1.d.(10)	-	Not applicable This is not a design feature of the APR1400.
1.d.(11)	14.2.12.1.71 14.2.12.1.75 14.2.12.1.76 14.2.12.1.78	Circulating water system test Essential service water system test Component cooling water system test Turbine building closed cooling water system test
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 MSIV bypass valves 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 14.2.12.1.70	Main turbine systems test Turbine steam seal system test
1.e.(7)	14.2.12.1.69	Condensate system 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

Table 14.2-7 (4 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.e.(11)	14.2.12.1.52 14.2.12.1.67 14.2.12.1.69	Pre-core reactor coolant and secondary water chemistry data Main condenser and condenser vacuum systems test 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.
1.f.(3)	-	Exception The COL applicant is to prepare the pre-operational test of raw water and service water cooling systems.
1.g.(1)	14.2.12.1.110 14.2.12.1.111 14.2.12.1.112 14.2.12.1.113 14.2.12.1.116	Unit main power system test 13,800 V normal auxiliary power system test 4,160 V normal auxiliary power system test 480 V normal auxiliary power system test Offsite power system test
1.g.(2)	14.2.12.1.108 14.2.12.1.109 14.2.12.1.81	4,160 V Class 1E auxiliary power system test 480 V Class 1E auxiliary power system test Emergency lighting system test
1.g.(3)	14.2.12.1.86 14.2.12.1.87 14.2.12.1.88 14.2.12.1.89 14.2.12.1.90	Emergency diesel generator mechanical system test Emergency diesel generator electrical system test Emergency diesel generator auxiliary systems test Alternate AC source system test Alternate AC source support systems test
1.g.(4)	14.2.12.1.81 14.2.12.1.114 14.2.12.1.115	Emergency lighting system test Non-Class 1E dc power systems test Class 1E dc power systems test
1.h.(1) (a)	14.2.12.1.117 14.2.12.1.118	BOP piping thermal expansion measurement test BOP piping vibration measurement test
1.h.(1) (b)	14.2.12.1.20 14.2.12.1.21	Shutdown cooling system test Safety injection system test

Table 14.2-7 (5 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.h.(1) (c)	14.2.12.1.20 14.2.12.1.21	Shutdown cooling system test Safety injection system test
1.h.(1) (d)	14.2.12.1.20 14.2.12.1.21	Shutdown cooling system test Safety injection system test
1.h.(1) (e)	14.2.12.1.7 14.2.12.1.21	Chemical and volume control system charging subsystem test Safety injection system test
1.h.(2)	14.2.12.1.22 14.2.12.1.37 14.2.12.1.59	Safety injection tank subsystem test Safety depressurization and vent system test Pre-core safety injection check valve test
1.h.(3)	14.2.12.1.38	Containment spray system test
1.h.(4)	14.2.12.1.101 14.2.12.1.102	Hydrogen mitigation system test 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 14.2.12.1.94 14.2.12.1.95 14.2.12.1.98 14.2.12.1.100	Reactor containment building HVAC system test Reactor containment purge HVAC system test Control room area HVAC system test Fuel handling area HVAC system test Balance of control room area HVAC system test
1.h.(8)	14.2.12.1.21 14.2.12.1.22 14.2.12.1.40	Safety injection system test Safety injection tank subsystem test 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 14.2.12.1.75	Condensate system test Essential service water system 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

Table 14.2-7 (6 of 15)

RG 1.68 App. A	Subsection #	Individual 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 14.2.12.1.93 14.2.12.1.94	Control element drive mechanism cooling system test Reactor containment building HVAC system test 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.
1.i.(20)	-	Not applicable This is not a design feature of the APR1400.

Table 14.2-7 (7 of 15)

RG 1.68 App. A	Subsection #	Individual Test
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
1.j.(2)	14.2.12.1.30 14.2.12.1.34 14.2.12.1.68	Feedwater control system test Auxiliary feedwater system test Feedwater system test
1.j.(3)	14.2.12.1.29 14.2.12.1.65	Steam bypass control system test Main steam system test
1.j.(4)	-	Not applicable This is not a design feature of the APR1400.
1.j.(5)	14.2.12.1.106 14.2.12.1.107	Process and effluent radiological monitoring system test Airborne and area radiation monitoring system test
1.j.(6)	14.2.12.1.42	Loose parts monitoring system test
1.j.(7)	14.2.12.1.106 14.2.12.1.107	Process and effluent radiological monitoring system test Airborne and area radiation monitoring system test
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 14.2.12.1.26	Ex-core neutron flux monitoring system test Fixed in-core nuclear signal channel test
1.j.(14)	14.2.12.1.23	Engineered safety features – component control system 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

Table 14.2-7 (8 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.j.(17)	14.2.12.1.68 14.2.12.1.69 14.2.12.1.73	Feedwater system test Condensate system test 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 14.2.12.1.102	Hydrogen mitigation system test Containment hydrogen recombiner system test
1.j.(24)	14.2.12.1.23 14.2.12.1.24	Engineered safety features – component control system test Plant protection system test
1.j.(25)	14.2.12.1.31	Core operating limit supervisory system test
1.k.(1)	14.2.12.1.18 14.2.12.1.106 14.2.12.1.107	Process radiation monitor subsystem test Process and effluent radiological monitoring system test Airborne and 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.
1.k.(3)	14.2.12.1.106	Process and effluent radiological monitoring system test
1.k.(4)	14.2.12.1.94 14.2.12.1.95 14.2.12.1.98 14.2.12.1.99	Reactor containment purge HVAC system test Control room area HVAC system test Fuel handling area HVAC system test Compound building HVAC system test
1.l.(1)	14.2.12.1.103	Liquid waste management system test
1.l.(2)	14.2.12.1.105	Gaseous waste management system test

Table 14.2-7 (9 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.l.(3)	14.2.12.1.104	Solid waste management system test
1.l.(4)	14.2.12.1.66	Steam generator blowdown system test
1.l.(5)	14.2.12.1.67	Main condenser and condenser vacuum systems test
1.l.(6)	14.2.12.1.94 14.2.12.1.95 14.2.12.1.98 14.2.12.1.132	Reactor containment purge HVAC system test Control room area HVAC system test Fuel handling area HVAC system test Auxiliary building controlled area HVAC system test
1.l.(7)	14.2.12.1.103 14.2.12.1.107	Liquid waste management system test Airborne and area radiation monitoring system test
1.l.(8)	14.2.12.1.83	Process sampling system test
1.m.(1)	14.2.12.1.77 14.2.12.1.107	Spent fuel pool cooling and cleanup system test Airborne and area radiation monitoring system test
1.m.(2)	14.2.12.1.33	Fuel handling and storage system test
1.m.(3)	14.2.12.1.77	Spent fuel pool cooling and cleanup system test
1.m.(4)	14.2.12.1.33	Fuel handling and storage system test
1.m.(5)	14.2.12.1.33	Fuel handling and storage system test
1.m.(6)	14.2.12.1.98	Fuel handling area HVAC system test
1.n.(1)	14.2.12.1.75	Essential service water system test
1.n.(2)	14.2.12.1.74 14.2.12.1.78	Chilled water system test Turbine building closed cooling water system test
1.n.(3)	14.2.12.1.76	Component cooling water system test
1.n.(4)	14.2.12.1.13	Reactor makeup subsystem test
1.n.(5)	14.2.12.1.52 14.2.12.1.83	Pre-core reactor coolant and secondary water chemistry data Process sampling system test
1.n.(6)	14.2.12.1.7 14.2.12.1.66	Chemical and volume control system charging subsystem test Steam generator blowdown system test
1.n.(7)	14.2.12.1.85	Fire protection system test

Table 14.2-7 (10 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.n.(8)	14.2.12.1.7	Chemical and volume control system charging subsystem test
1.n.(9)	14.2.12.1.10 14.2.12.1.103	Equipment drain tank subsystem test Liquid waste management system test
1.n.(10)	14.2.12.1.5	Chemical and volume control system letdown subsystem test
1.n.(11)	14.2.12.1.82	Compressed air system test
1.n.(12)	14.2.12.1.15	Boric acid concentrator subsystem test
1.n.(13)	-	Exception The COL applicant is to develop the test procedure under the communication system description defined in Section 9.5.2.
1.n.(14) (a)	14.2.12.1.132	Auxiliary building controlled area HVAC system test
1.n.(14) (b)	14.2.12.1.93 14.2.12.1.94	Reactor containment building HVAC system test Reactor containment purge HVAC system test
1.n.(14) (c)	14.2.12.1.131	Electrical and I&C equipment room area HVAC systems test
1.n.(14) (d)	14.2.12.1.97	Emergency diesel generator area HVAC system test
1.n.(14) (e)	14.2.12.1.93 14.2.12.1.94 14.2.12.1.96 14.2.12.1.99 14.2.12.1.133	Reactor containment building HVAC system test Reactor containment purge HVAC system test Turbine generator building HVAC system test Compound building HVAC system test Auxiliary building clean area HVAC system test
1.n.(14) (f)	14.2.12.1.95 14.2.12.1.100	Control room area HVAC system test Balance of control room area HVAC system test
1.n.(15)	-	Not applicable This is not a design feature of the APR1400.
1.n.(16)	-	Not applicable This is not a design feature of the APR1400.
1.n.(17)	-	Not applicable This is not a design feature of the APR1400.
1.n.(18)	14.2.12.1.84	Heat tracing system test
1.o.(1)	14.2.12.1.91 14.2.12.1.92	Containment polar crane test Fuel handling area cranes test

Table 14.2-7 (11 of 15)

RG 1.68 App. A	Subsection #	Individual Test
1.o.(2)	14.2.12.1.91 14.2.12.1.92	Containment polar crane test Fuel handling area cranes test
1.o.(3)	14.2.12.1.91 14.2.12.1.92	Containment polar crane test Fuel handling area cranes test
2.a	14.2.12.2.1	Post-core hot functional test controlling document
2.b	14.2.12.2.4	Post-core control element drive mechanism performance
2.c	14.2.12.1.24 14.2.12.2.4	Plant protection system test Post-core control element drive mechanism performance
2.d	14.2.12.2.7	Post-core reactor coolant system leak rate measurement
2.e	14.2.12.2.1 14.2.12.2.5	Post-core hot functional test controlling document Post-core reactor coolant and secondary water chemistry data
2.f	14.2.12.2.2 14.2.12.2.3 14.2.12.2.10	Loose parts monitoring system Reactor coolant system flow measurements Post-core acoustic leak monitor system test
2.g	14.2.12.2.11	Post-core ex-core neutron flux monitoring system test
2.h	14.2.12.2.8	Post-core in-core instrumentation test
3	14.2.12.3.3 14.2.12.3.5	Shutdown and regulating CEA group worth test Critical boron concentration test
4.a	14.2.12.3.2 14.2.12.3.5	Isothermal temperature coefficient test Critical boron concentration test
4.b	14.2.12.3.3	Shutdown and regulating CEA group worth test
4.c	14.2.12.4.25	Pseudo ejected CEA test
4.d	14.2.12.2.9 14.2.12.2.11	Post-core instrument correlation Post-core ex-core neutron flux monitoring system test
4.e	14.2.12.4.10 14.2.12.4.17	Steady-state core performance test Core operating limit supervisory system verification
4.f	14.2.12.4.9	Biological shield survey test
4.g	14.2.12.1.106	Process and effluent radiological monitoring system test

Table 14.2-7 (12 of 15)

RG 1.68 App. A	Subsection #	Individual Test
4.h	14.2.12.4.4	Reactor coolant and secondary chemistry and radiochemistry test
4.i	14.2.12.1.27 14.2.12.1.54 14.2.12.2.4	Digital rod control system test Pre-core control element drive mechanism performance test Post-core control element drive mechanism performance
4.j	14.2.12.4.21	HVAC capability test
4.k	14.2.12.1.34 14.2.12.1.62	Auxiliary feedwater system test Main turbine systems test
4.l	14.2.12.1.64	Main steam isolation valves and MSIV bypass valves test
4.m	-	Not applicable This is not a design feature of the APR1400.
4.n	14.2.12.4.3 14.2.12.4.11	Control systems checkout test Intercomparison of plant protection system, core protection calculator, information processing system, and qualified information and alarm system inputs
4.o	14.2.12.2.4	Post-core control element drive mechanism performance
4.p	14.2.12.1.3 14.2.12.1.63	Pressurizer pilot-operated safety relief valve test Main steam safety valve test
4.q	14.2.12.1.20 14.2.12.1.65	Shutdown cooling system test Main steam system test
4.r	14.2.12.1.5 14.2.12.1.7	Chemical and volume control system letdown subsystem test Chemical and volume control system charging subsystem 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.t	14.2.12.4.22	Natural circulation test
4.u	14.2.12.4.3	Control systems checkout test
5.a	14.2.12.4.1	Variable T_{avg} (isothermal temperature coefficient and power coefficient) test

Table 14.2-7 (13 of 15)

RG 1.68 App. A	Subsection #	Individual Test
5.b	14.2.12.4.10 14.2.12.4.12	Steady-state core performance test 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 14.2.12.4.14 14.2.12.4.17	Unit load transient test Core protection calculator verification Core operating limit supervisory system verification
5.e	14.2.12.4.25	Pseudo ejected CEA test
5.f	14.2.12.4.26	Pseudo dropped CEA test
5.g	14.2.12.1.27 14.2.12.2.4	Digital rod control system test Post-core control element drive mechanism performance
5.h	14.2.12.2.4	Post-core control element drive mechanism performance
5.i	-	Not applicable This is not a design feature of the APR1400.
5.j	14.2.12.4.2 14.2.12.4.6	Unit load transient test Unit load rejection test
5.k	14.2.12.1.21 14.2.12.1.22 14.2.12.1.59	Safety injection system test Safety injection tank subsystem test Pre-core safety injection check valve test
5.l	14.2.12.4.7 14.2.12.4.13 14.2.12.4.15	Shutdown from outside the main control room test Feedwater and auxiliary feedwater system test Main steam atmospheric dump and turbine bypass valve test
5.m	14.2.12.2.3	Reactor coolant system flow measurements
5.n	14.2.12.4.18	Baseline nuclear steam supply system integrity monitoring
5.o	14.2.12.2.10	Post-core acoustic leak monitor system test
5.p	-	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).

Table 14.2-7 (14 of 15)

RG 1.68 App. A	Subsection #	Individual Test
5.q	-	Not applicable This is not a design feature of the APR1400.
5.r	14.2.12.4.3 14.2.12.4.14 14.2.12.4.17	Control systems checkout test Core protection calculator verification Core operating limit supervisory system verification
5.s	14.2.12.4.1 14.2.12.4.3 14.2.12.4.8 14.2.12.4.13	Variable T_{avg} (isothermal temperature coefficient and power coefficient) test Control systems checkout test Loss of offsite power test Feedwater and auxiliary feedwater system test
5.t	14.2.12.1.3 14.2.12.1.63 14.2.12.4.5 14.2.12.4.15	Pressurizer pilot-operated safety relief valve test Main steam safety valve test Turbine trip test 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 14.2.12.4.5 14.2.12.4.13	Unit load transient test Turbine trip test 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 14.2.12.4.11 14.2.12.4.12 14.2.12.4.14 14.2.12.4.16 14.2.12.4.17	Control systems checkout test Intercomparison of plant protection system, core protection calculator, information processing system, and qualified information and alarm system inputs Verification of CPC power distribution related constants test Core protection calculator verification In-core detector test Core operating limit supervisory system verification

Table 14.2-7 (15 of 15)

RG 1.68 App. A	Subsection #	Individual Test
5.z	14.2.12.1.18 14.2.12.1.19	Process radiation monitor subsystem test 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	14.2.12.4.23 14.2.12.4.24	Liquid waste management system test Gaseous waste management system test
5dd	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 14.2.12.4.22	Loss of offsite power test Natural circulation 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.ll	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.oo	14.2.12.1.51 14.2.12.1.117 14.2.12.1.118	Pre-core reactor coolant system expansion measurements Balance-of-plant piping thermal expansion measurement test Balance-of-plant piping vibration measurement 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 Tier 1, Chapter 1: Introduction

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 sstate 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 General Provisions

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 Tier 1, Chapter 2: Design Descriptions and ITAAC

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		Tier 1 Section
Section	Title	
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:

   1) Whether the feature or function in question is necessary to satisfy 10 CFR 20 (Reference 35), 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.

i. 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.

l. 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 compliance 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 complies

with the ITAAC. However, in certain circumstances, documentation that verifies compliance of an inspection, test, or analysis at one plant may be used as a basis to demonstrate compliance 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 noncompliance.

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 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 treatment of motor-operated valves (MOVs), power-operated valves (POVs), and check valves as well as dynamic qualification, welding, fasteners, and safety classification of SSCs 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 safety-related piping systems included in the APR1400 design. The scope is not limited to ASME Code Class 1, 2, and 3 piping and supports. Rather, the scope includes buried piping, instrumentation lines, interaction of non-seismic Category I piping with seismic Category I piping, and any safety-related piping designed to industry standards other than the ASME Code. 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.

ITAAC for piping systems to verify the existence of related documents are as follows:

a. A stress report to provide reasonable assurance that the ASME Code Class 1, 2, and 3 piping systems and components are designed to retain their pressure boundary integrity and functional capability under internal design and operating pressures and design basis loads

b. A pipe break analysis report, which documents that the as-built SSCs that are required to be functional during and following a safe shutdown earthquake (SSE) have adequate high-energy pipe break mitigation features

c. An LBB evaluation report, which documents that the as-built piping and piping materials comply with the LBB acceptance criteria for the systems to which LBB is applied

System-specific ITAAC for components and systems 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 built in accordance with the stress report

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

These system-specific ITAAC are covered in each system ITAAC such as Sections 2.4, 2.7, and 2.11 of Tier 1.

The COL applicant is to provide a DAC closure schedule for implementing the piping DAC. Piping DAC will be closed in accordance with the guidance in NRC RG 1.215 (Reference 33) and Section 8.3.1 of NEI 08-01(Reference 34), “Closure through the COLA Review Process.”

14.3.2.4 ITAAC for Reactor Systems

Section 2.4 of Tier 1 includes reactor systems, fuel, control rods, loose parts monitoring system, and core cooling systems 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 compliance 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 compliance with the following GDC set forth in 10 CFR 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

l. 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 ITAAC for Electrical Systems

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

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

1) 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

1) 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 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.

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 offsite 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 aspects of the plant:

a. MCR

b. RSR

c. Safety-related local control stations (LCS) and those LCS associated with risk-important and credited human actions

d. Technical support center (TSC)

e. Emergency operation facility (EOF)

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 28). 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.

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-of-coolant 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.

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), SRP 17.4 (Reference 29), and DC/COL-ISG-018 (Reference 30).

Section 17.4 describes the design reliability assurance program, which is developed in accordance with guidance in NUREG-0800, SRP 17.4 (Reference 29), and DC/COL-ISG-018 (Reference 30). 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 31), NRC RG 1.206 (Reference 1), SRP 14.2 (Reference 32), 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 Tier 1, Chapter 3: Interface Requirements

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 Elements of Design Material Incorporated into Tier 1

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 and Severe Accident Analysis 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 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 Designation of Tier 2* Information

Certain information [Tier 2*] in Tier 2, which is summarized in Table 1.1-1, is designated. Plant-specific changes to any of this Tier 2* design information requires prior NRC Staff approval. The requirement for prior NRC Staff approval expires for some of the designated information, as indicated in Table 1.1-1, when the COL holder achieves 100 percent power operation.

14.3.6 Design Acceptance Criteria

Design acceptance criteria (DAC) are a set of prescribed limits, parameters, procedures, and attributes upon which the NRC relies on, in a limited number of technical areas, in making a final safety determination to support a design certification. DAC are applied to (1) technologies, such as control room design, that are changing so rapidly that it would be unwise to freeze the details of the design many years before a plant is ready to be constructed and (2) design areas such as piping analyses, where the as-built or as-procured information to complete the final design is not available.

As described in NEI 08-01, Section 8.3.1 (Reference 34), which is endorsed by NRC RG 1.215 (Reference 33), There are three options to close a DAC, all of which involve the same level of design detail. The three options for a DAC closure are as follows:

a. Closure through an amendment of the design certification rule – Under this option, the design certification applicant would submit an amendment with design information that implements the DAC. Completed DAC would be deleted from the set of design certification ITAAC; however, the ITAAC on the as-built SSCs would remain (or be modified, as necessary) to demonstrate that the as-built facility conforms to the completed DAC. The NRC would review the amendment request, issue a safety evaluation, and conduct rulemaking to amend the design certification rule.

b. Closure through the COLA review process – Under this option, the COL application contains the additional design information needed to implement the DAC. The NRC reviews the design and includes the results of its review in the safety evaluation for the COL. The COL should reflect that the DAC has been completed. The as-built ITAAC would remain (or be modified as part of the NRC review of the COLA, as necessary) to demonstrate that the as-built facility conforms to the completed DAC.

c. Closure after COL issuance – Under this option, the COL is issued with the DAC. When the necessary additional design information is available, the licensee’s DAC implementation is inspected by the NRC as part of the engineering design verification (EDV) process, as described in Inspection Manual Chapter 2504. Following issuance of the NRC EDV inspection report, and resolution of any

findings that would otherwise preclude the DAC close-out, close-out of the DAC is accomplished via the ITAAC closure process described in this document (e.g., close-out is initiated by a licensee's ITAAC close-out letter to the NRC).

14.3.6.1 Piping DAC

In APR1400, DAC is applied in the piping design. Piping DAC consists of pipe break analyses and piping analyses including fatigue analyses in both air and reactor coolant environment. The piping design may be completed on a system-by-system basis for applicable systems. Information of piping DAC is made available to the NRC to facilitate reviews, inspections, and audits throughout the analyses process and the NRC may inform the licensee of concerns as they are identified so that adjustments may be made in a timely manner.

The ASME Section III (Reference 21) prescribes procedures and requirements of the ASME Section III that are to be followed for completing the piping design. The piping DAC includes a verification of the ASME Section III design report to verify that the appropriate design requirements of the ASME Section III for each system have been satisfied. The piping design information including ASME design reports will be provided to the NRC for review, inspection, and audit.

For completing analysis of protection against the dynamic effects of a piping rupture DAC, the analysis documents that essential structures, systems, and components (SSC) important to safety be protected from the dynamic and environmental effects of the postulated piping failures inside and outside the containment where consideration of these dynamic effects is not eliminated by LBB. Design features are to consider, as applicable, pipe whip, jet impingement, flooding, compartment pressurization, and environmental condition in the area where the piping is located.

For completing leak before break (LBB) DAC, the analyses documents the results to eliminate from the structural design bases the dynamic effects of double-ended guillotine breaks and equivalent longitudinal breaks for an applicable high energy piping system. LBB evaluations consider normal and abnormal loads and load combinations to demonstrate compliance with the LBB design criteria. LBB acceptance criteria is established and LBB evaluations including piping stress values are performed for each piping system designed to meet LBB criteria.

The following APR1400 DCD Tier 1 section contains the analysis on the protection against the dynamic effects of the piping rupture DAC and the evaluation of the LBB DAC, which are identified in Subsection 2.3.1.

In the APR1400 DCD Tier 1 sections below, piping DAC are identified with [DAC]

a. Section 2.4.2 Reactor coolant system

b. Section 2.4.3 In-containment water storage system

c. Sections 2.4.4 and 2.4.5 Safety injection/Shutdown cooling system

d. Section 2.4.6 Reactor coolant gas vent system

e. Section 2.4.7 Chemical and volume control system

f. Section 2.6.2 Emergency diesel generator system

g. Section 2.7.1.2 Main steam system

h. Section 2.7.1.4 Condensate and feedwater system

i. Section 2.7.1.5 Auxiliary feedwater system

j. Section 2.7.1.8 Steam generator blowdown system

k. Section 2.7.2.1 Essential service water system

l. Section 2.7.2.2 Component cooling water system

m. Section 2.7.2.3 Essential chilled water system

n. Section 2.7.2.5 Radioactive drain system

o. Section 2.7.2.6 Process and post-accidents sampling system

p. Section 2.7.4.3 Spent fuel pool cooling and cleanup system

q. Section 2.7.6.2 Gaseous radwaste system

r. Section 2.11.2 Containment spray system

14.3.7 Combined License Information

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 the proposed ITAAC for the facility’s emergency planning addressed in Subsection 14.3.2.10.

COL 14.3(3) The COL applicant is to provide the proposed ITAAC for the facility’s physical security hardware addressed in Subsection 14.3.2.12.

COL 14.3(4) The COL applicant is to provide a DAC closure schedule for implementing the piping DAC.

14.3.8 References

1. Combined License Applications for Nuclear Power Plants (LWR Edition), NRC RG 1.206, U.S. Nuclear Regulatory Commission, Washington, DC, June 2007.

2. ‘Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3. “Site Characteristics and Site Parameters,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 2.0, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

4. ‘Structural and Systems Engineering – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.2, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

5. ‘Piping Systems and Components – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.3, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

6. ‘Reactor Systems – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.4, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

7. Instrumentation and Controls – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.5, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

8. Electrical Systems – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.6, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

9. ‘Plant Systems – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.7, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

10. ‘Radiation Protection – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.8, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

11. ‘Human Factors Engineering – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.9, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

12. ‘Emergency Planning – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.10, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

13. ‘Containment Systems – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.11, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

14. ‘Physical Security Hardware – Inspections, Tests, Analyses, and Acceptance Criteria,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.3.12, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

15. “Domestic Licensing of Production and Utilization Facilities,” Energy. Title 10 CFR 50, U.S. Nuclear Regulatory Commission, Washington, DC.

16. “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Energy. Title 10 CFR 52, U.S. Nuclear Regulatory Commission, Washington, DC.

17. “Physical Protection of Plants and Materials,” Energy. Title 10 CFR 73, U.S. Nuclear Regulatory Commission, Washington, DC.

18. “Reactor Site Criteria,” Energy. Title 10 CFR 100, U.S. Nuclear Regulatory Commission, Washington, DC.

19. ‘Operation under a combined license,’ “Domestic Licensing of Production and Utilization Facilities,” Energy. Title 10 CFR 50.103(g), U.S. Nuclear Regulatory Commission, Washington, DC.

20. ‘General Design Criteria for Nuclear Power Plants,’ “Domestic Licensing of Production and Utilization Facilities,” Energy. Title 10 CFR 50, Appendix A, U.S. Nuclear Regulatory Commission, Washington, DC.

21. “Construction of Nuclear Facility Components,” Boiler and Pressure Vessel Code – 2007 Edition. ASME Section III, American Society of Mechanical Engineers.

22. ‘Conditions of Construction Permits, Early Site Permits, Combined Licenses, and Manufacturing Licenses,’ “Domestic Licensing of Production and Utilization Facilities,” Energy. Title 10 CFR 50.55, U.S. Nuclear Regulatory Commission, Washington, DC.

23. IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations – Description. IEEE Standard 603-1991, Institute of Electrical and Electronic Engineers.

24. Guidance on Software Reviews for digital Computer Based Instrumentation and Controls Systems. Branch Technical Position 7-14.

25. “Instrumentation and Controls – Overview of Review Process,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 7, Rev. 5, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

26. Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants. RG 1.97, Rev. 4, U.S. Nuclear Regulatory Commission, Washington, DC, June 2006.

27. Reserved.

28. ‘Contents of Applications; Additional Technical Information,’ “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Energy. Title 10, Code of Federal Regulations, Part 52.80, U.S. Nuclear Regulatory Commission, Washington, DC.

29. ‘Reliability Assurance Program (RAP),’ “Quality Assurance,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 17.4, Initial Issuance, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

30. Interim Staff Guidance on Standard Review Plan, Section 17.4, “Reliability Assurance Program,” DC/COL-ISG-018.

31. Initial Test Programs for Water-Cooled Nuclear Power Plants, NRC RG 1.68, Rev. 3, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

32. ‘Initial Plant Test Program – Design Certification and New License Applicants,’ “Initial Test Program and ITAAC – Design Certification,” Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 14.2, Rev. 3, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

33. “Guidance for ITAAC Closure under 10 CFR PART 52, NRC RG 1.215,” Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, June 2007.

34. “Industry Guideline for the ITAAC Closure Process under 10 CFR Part 52,” Nuclear Energy Institute (NEI) 08-01, Revision 4, issued July 2010 (Ref. 1)

35 “Standards for Protection against Radiation,” Energy. Title 10, Code of Federal Regulations, Part 20, U.S. Nuclear Regulatory Commission, Washington, DC.

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 2470 ± 18 psia (173.7 ± 1.3 kg/cm^{2}A).	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 × 10^4 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 ≥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 ≥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.	5.2.3.4.3.1 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 155 gpm.	9.3.4.1.1 Table 9.3.4-2
1-15	2.4.7 ITAAC #9.b	Each CVCS charging pump provides seal injection flow greater than or equal to 6.6 gpm to each RCP.	9.3.4.1.2, Tables 9.3.4-2/3

Table 14.3.4-1 (3 of 4)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
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

Table 14.3.4-2 (1 of 7)

PRA and Severe Accident Analysis Key Design Features

Item #	Tier 1 Reference	Design Features	Tier 2 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	2.4.2 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
2-3	2.4.3 ITAAC #1, #9d	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
2-4	2.4.3 ITAAC #9.d	The IRWST sump for each SIS/CSS division has a strainer.	6.8.2.2 19.1.3
2-5	2.4.4 ITAAC #1, #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
2-6	2.4.4 ITAAC #9.e	The SIS can be manually realigned for simultaneous hot leg injection and direct vessel injection (DVI).	6.3.1 19.1.3
2-7	2.4.5 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)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
2-8	2.4.5 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
2-9	2.4.7 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
2-10	2.4.7 ITAAC #9.b	The CVCS supplies seal water to the RCP seals.	9.3.4.2.4 19.1.3
2-11	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
2-12	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
2-13	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
2-14	2.5.1 ITAAC #14	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
2-15	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
2-16	2.5.2 ITAAC #1, #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
2-17	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)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
2-18	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
2-19	2.5.2 ITAAC #7	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
2-20	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
2-21	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
2-22	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
2-23	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
2-24	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 stand-by mode.	8.3.1.1 19.1.3

Table 14.3.4-2 (4 of 7)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
2-25	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
2-26	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
2-27	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
2-28	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
2-29	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
2-30	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

Table 14.3.4-2 (5 of 7)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
2-31	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
2-32	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
2-33	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
2-34	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
2-35	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
2-36	2.6.6 ITAAC #4	The AAC source can be started 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
2-37	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
2-38	2.7.1.5 ITAAC #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

Table 14.3.4-2 (6 of 7)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
2-39	2.7.1.5 ITAAC #10.b	Each AFWST has sufficient capacity for eight hours of operation at hot standby condition and subsequent cooldown of the reactor coolant system within six hours to condition that permit operation of the shutdown cooling system.	10.4.9 19.1.3
2-40	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 re-open AFW isolation valves when SG water level drops below a low level setpoint.	10.4.9 19.1.3
2-41	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
2-42	2.7.2.1 ITAAC #9	The two mechanical divisions of the ESWS are physically separated.	9.2.1 19.1.3
2-43	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 instrumentations.	9.2.2 19.1.3
2-44	2.7.2.2 ITAAC #9	The two mechanical divisions of the CCWS are physically separated.	9.2.2 19.1.3
2-45	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

Table 14.3.4-2 (7 of 7)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
2-46	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
2-47	2.11.4 Design Description ITAAC #3	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 which 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
2-48	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
2-49	2.11.4 ITAAC #3.a	At least thirty PARs and eight hydrogen igniters are provided inside containment.	6.2.5 19.2.3
2-50	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

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

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
5-1	2.5.2 Design Description	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
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

Table 14.3.4-6 (1 of 2)

Radiological analysis Key Design Features

<table>
<tr><th>Item #</th><th>Tier 1 Reference</th><th>Design Features</th><th>Tier 2 Reference</th></tr>
<tr><td>6-1</td><td>2.2.1
ITAAC #2.d</td><td>The leakage rate through containment is 0.1 v/o/day during 0-24 hrs.</td><td>6.2.6
Table 6.5-1
15.6.5.5
Table 15.6.5-13</td></tr>
<tr><td>6-2</td><td>2.4.3
ITAAC #9.c</td><td>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.</td><td>6.5.2.3.2
Chapter 16 Bases 3.5.5</td></tr>
<tr><td>6-3</td><td>2.7.3.1
ITAAC #9, #10</td><td>The minimum time required to divert from the MCR normal makeup air supply to the emergency operation mode is 5 minutes.</td><td>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</td></tr>
<tr><td>6-4</td><td>2.7.3.1
Design Description
ITAAC #8</td><td>The control room is maintained at positive pressure with respect to the surrounding areas.</td><td>9.4.1.2</td></tr>
<tr><td>6-5</td><td>2.7.3.1
ITAAC #8.a</td><td>The efficiencies of the MCR emergency ventilation HEPA and charcoal filters used in radiological consequence analysis are 99 %.</td><td rowspan="3">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
Table 15.6.5-13</td></tr>
<tr><td rowspan="2">6-6</td><td rowspan="2">2.7.3.1
ITAAC #8.b</td><td>The main control room (MCR) emergency recirculation flow (filtered) is 122 m^3/min (4,300 cfm).</td></tr>
<tr><td>The MCR emergency makeup flow (filtered) is 105 m3/min (3,700 cfm).</td></tr>
</table>

Table 14.3.4-6 (2 of 2)

Item #	Tier 1 Reference	Design Features	Tier 2 Reference
6-7	2.7.3.1 ITAAC #8.b, #12	Prior 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 15.1.5-12 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 Table 15.6.5-13
6-8	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
6-9	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
6-10	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