14.0 INITIAL TESTS AND OPERATION

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[HISTORICAL] [14.0 INITIAL TESTS AND OPERATION

An extensive testing program was conducted during the initial period of testing and operation of Farley Nuclear Plant (FNP) Units 1 and 2 to ensure that the health and safety of the public would not be endangered and that the structures, systems, and components met the safety-related requirements. The test program was directed by Alabama Power Company's (APC) startup staff. Technical assistance was provided during the test program by Westinghouse Electric Corporation, Bechtel Power Corporation, and vendor technical representatives.

An advisory committee was formed of onsite personnel from APC, Bechtel Power Corporation, and Westinghouse Electric Corporation. This advisory committee was called the joint test group. The function of the joint test group was to assist in resolving various discrepancies or deficiencies that occurred during the testing program; to review, comment on, and recommend approval of system test procedures; and to review and recommend approval of test data.

14.1 TEST PROGRAM

The test program for FNP Units 1 and 2 was divided into three phases: Phase I, construction tests; Phase II, acceptance and preoperational test; and Phase III, fuel loading and initial startup testing. This chapter is limited to the discussion of Phase II preoperational testing and all of Phase III.

Phase II preoperational testing started when the installation of individual systems or subsystems was completed and continued through the successful completion of a hot functional test of the reactor coolant system until the beginning of fuel loading. Primary objectives of preoperational testing were to verify that equipment and systems perform in accordance with design and safety requirements for initial fuel loading.

After the operating license was received, Phase III testing began with fuel loading, continued through initial criticality, zero power operation, and ascension to power operation, and was completed when the plant was fully licensed and placed in commercial operation. Primary objectives of Phase III testing were to verify nuclear parameters and that all portions of the plant can operate at rated capacity without endangering the health and safety of the public.

To ensure quality control, all testing was conducted using approved written procedures. Test procedures were prepared, reviewed, approved, and executed; the test results were evaluated and the completed test approved and documented in accordance with established administrative procedures.

When procedure changes or system modifications were required during the test program, they were effected in accordance with administrative procedures established for this purpose.

The testing program for FNP Units 1 and 2 was developed, administered, and conducted by APC's startup and operating staffs and by the Westinghouse startup services group under the direction of the plant manager.

Compliance with regulations, with regard to the development of the preoperational and startup test programs, was in accordance with Regulatory Guide 1.68, Preoperational and Initial Startup Test Programs for Water Cooled Power Reactors, as outlined in subsections 14.1.2 and 14.1.3. The modified startup physics test program for Unit 2 is described in an APC letter to the Nuclear Regulatory

Commission (NRC) dated July 7, 1980. The preparation and content of procedures for preoperational tests, fuel loading, startup to criticality, and initial ascension to power was in accordance with Appendix C of Regulatory Guide 1.68. Participation in the testing program by the plant operations staff demonstrated that the operations staff was knowledgeable about the plant and plant operating procedures and was prepared to operate the facility in a safe manner.

Demonstration and evaluation of the procedures for operating the plant are discussed in subsection 14.1.4.

Startup observed housekeeping practices during the testing program that were in compliance with the requirements of Regulatory Guide 1.39, Housekeeping Requirements for Water Cooled Nuclear Power Plants. While there were few instances in which startup had direct control of area housekeeping, every effort was made to coordinate with construction and operation forces to ensure the maintenance of those standards which were applicable to startup activities. Control of facilities, utilization of tools and equipment, training of personnel, and maintenance of inspection requirements and records was in accordance with the applicable operations procedures which were prepared to comply with Regulatory Guide 1.39.

Startup activities involved with the installation, inspection and testing of instrumentation, electrical equipment, mechanical equipment, and systems were accomplished in accordance with Regulatory Guide 1.30, Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electrical Equipment, and American National Standards Institute (ANSI) N45.2.8, Supplementary Quality Assurance Requirements for Installation, Inspection and Testing of Mechanical Equipment and Systems for the Construction Phase of Nuclear Power Plants.

Equipment was inspected by startup prior to acceptance from construction forces to verify that installation standards were met and that all nonconforming items and temporary conditions were properly identified. Any nonconforming items or temporary conditions which were identified/ necessitated by the testing program were handled in accordance with startup administrative procedures.

Instrument and electrical/mechanical devices were calibrated prior to the performance of Phase II tests. Phase II and III tests demonstrated that the installation and operation of these instruments and devices were in accordance with design requirements.

The program for the testing of systems was in compliance with the requirements of Regulatory Guide 1.30, ANSI N45.2.8, and other regulations and standards as referenced in this chapter.

The startup staff was responsible for ensuring the quality control of all safety-related startup activities as described in subsection 13.4.2 and section 17.2.

Preoperational cleaning and layup, and associated activities involving the cleanliness of safety-related fluid systems, were performed in accordance with Regulatory Guide 1.37, Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water Cooled Nuclear Power Plants. These activities included preparation of procedures for cleaning and layup of systems and preparation of procedures for work activities performed by startup which could affect the maintenance of installation cleanliness. The administration of the cleaning program including review and approval of procedures and records were in accordance with the administrative procedures/practices discussed in this chapter.

A system of internal audits was established, as described in subsection 17.2.18, to verify that the elements of the operations quality assurance program which were applicable to startup were developed, documented, and implemented in accordance with specified requirements. Implementing procedures delineated the organizational responsibilities; personnel selection, qualification, and training requirements; planning, documentation, and implementation of guidelines; and the requirements for maintenance of records in accordance with ANSI N45.2.12, Requirements for Auditing of Quality Assurance Programs for Nuclear Power Plants. These procedures included the development of a checklist specifying the various subjects to be audited and the frequency of audits.

14.1.1 ADMINISTRATIVE PROCEDURES (TESTING)

14.1.1.1 Procedure Development, Test Execution, Data Evaluation, and Documentation

The procedure followed for developing and approving test procedures, conducting tests, obtaining approval of test data, and documenting tests and test results for FNP Units 1 and 2 during the test program were as follows. (See figure 14.1-1.)

The responsibility of each planned test was assigned to a system engineer. A writer prepared a test procedure draft which was subject to internal review and a walkthrough of the test procedure. The writer resolved comments resulting from the review and walkthrough and incorporated the necessary changes into the test procedure.

The test procedure was then reviewed by an assigned engineer, members of the joint test group, and plant staff members (as required).

Once satisfied with the procedure, the joint test group recommended approval of the test procedure to the plant manager who, when he concurred, approved the test procedure by affixing his signature to the original. One copy of the approved procedure labeled "official test copy" was released for execution.

A test engineer or the assigned system engineer was responsible for having the test conducted in strict accordance with the official test copy of the approved procedure.

Upon completion of the test, the completed test procedure and test data were reviewed by the assigned system engineer, joint test group members, the plant manager, and other parties (as necessary).

Once the reviewers were satisfied with the test results, the plant manager approved the test results. The official test copy of the test procedure, data sheets, and documentation associated with the test and approval of the test results were filed with the permanent plant records.

For initial fuel loading and startup tests, the procedures were reviewed by the Plant Operations Review Committee (PORC) and approved by the plant manager. Startup test results were reviewed by the PORC and approved by the plant manager prior to ascending to the next power level as required by Regulatory Guide 1.68, November 1973.

14.1.1.2 Personnel Qualification

All startup personnel who were assigned the responsibility and authority to perform project functions involving inspection and testing activities affecting quality were certified according to their level of capability in accordance with Regulatory Guide 1.58, Revision 0, Qualification of Nuclear Power Plant Inspection, Examination and Testing Personnel. Determination of the applicability of prior experience in the basis for certification was made by the plant manager or his designated representative.

Appropriate training and certification records for each person designated to perform project functions were maintained by the plant manager or his designated representative. Personnel performance evaluations were maintained in the general office and not as a part of the certification records.

For a discussion of plant manager qualifications, see paragraph 13.1.3.2.1.

14.1.2 TEST OBJECTIVES AND PROCEDURES

The following listing is a compilation of the preoperational tests to be conducted during the testing program for FNP Units 1 and 2. Those tests marked with an asterisk (*) are further designated as precritical tests.

1. *Reactor coolant system heatup*
2. *Reactor coolant system at temperature*
3. *Reactor coolant system cooldown*
4. *Reactor coolant system flow measurement**
5. *Reactor coolant system flow coastdown**
6. *Reactor coolant system thermal expansion*
7. *Reactor coolant system leak test**
8. *Reactor coolant system post-hot functional inspection, cleaning, and testing*
9. *Boric acid system*
10. *Boron thermal regeneration system*
11. *Chemical and volume control system*
12. *Automatic reactor control system*
13. *Incore movable detectors**
14. *Nuclear instrumentation system*
15. *Reactor protection time response measurement*
16. *Reactor protection operational check**
17. *Safeguards system operational check*
18. *Rod drive mechanism timing**
19. *Rod control system**
20. *Rod drop time measurement**
21. *Rod position indication system**
22. *Core loading instrumentation**
23. *Power conversion system thermal expansion*
24. *Power conversion system vibration measurements*
25. *Auxiliary feedwater system*
26. *Component cooling water system*
27. *Residual heat removal system*
28. *Fire protection system*

29. Service water system
30. River water system
31. Control room ventilation system
32. Auxiliary building ventilation system (radioactive portion)
33. Plant response to loss of instrument air
34. Pressurizer relief tank
*35. Pressurizer effectiveness test**
36. Heat tracing system (boric acid)
37. 120-V instrument power systems
38. 600-V electrical load centers
39. 600-V motor control centers
40. 4160-V electrical system
41. Unit auxiliary and startup auxiliary transformers
42. Direct current systems
43. Communications system
44. Emergency diesel generators
45. Diesel fuel oil system
46. Containment integrated leak rate
47. Containment structural integrity
48. Containment cooling system
49. Containment spray and additive system
50. Containment isolation system
51. Postaccident containment combustible gas control system
52. Penetration room filtration system
53. Emergency core cooling system vibration measurement
54. Emergency core cooling system thermal expansion
55. Safety injection system
56. Reactor components and fuel handling tools and fixtures
57. Fuel transfer system
58. Spent fuel pool cooling system
59. Process and area radiation monitoring system
60. Personnel monitoring and survey instruments
61. Laboratory equipment
*62. Water quality tests**
63. Radioactive waste systems
64. Reactor coolant pressure boundary leakage detection system
65. Service water pond (shared)

The following synopsis outlines the test objectives, prerequisites, test methods, and acceptance criteria for each preoperational test. Also included are the provisions to simulate normal and abnormal operating conditions, which are incorporated into the test methods where appropriate.

REACTOR COOLANT SYSTEM HEATUP

1.0 Objective

Perform functional checks on the reactor coolant system and associated systems components and instrumentation required to bring the plant from a cold shutdown condition to normal operating temperature and pressure.

2.0 Prerequisites

2.1 Reactor coolant system and all supporting systems valve lineups for normal operation completed and normal flow paths established.

2.2 Reactor coolant system cold hydrostatic test completed.

2.3 Specified preoperational and acceptance tests completed.

2.4 Specified instrumentation and control checkouts and calibrations completed.

2.5 Secondary system ready to receive steam and return feedwater to the steam generators.

2.6 Diesel generators fully operable and ready for emergency power requirements. Batteries and battery chargers are in service.

2.7 Specified systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Establish specified charging and letdown flowrate and seal water flow to the reactor coolant pumps.

3.2 Energize pressurizer heaters and conduct solid system pressure control demonstration.

3.3 Start reactor coolant pumps to commence plant heatup.

3.4 Commence recording reactor coolant pump vibration data.

3.5 Perform chemistry adjustment demonstrations.

3.6 Form pressurizer steam bubble.

3.7 Check operability of pressurizer power-operated relief valves, pressurizer spray valves, and steam generator atmospheric steam dump valves.

3.8 At approximately 100°F intervals, stabilize all system parameters and record required data, measurements, and observations for incore thermocouple and resistance temperature detector

(RTD) cross-calibration, reactor coolant pump vibration measurements, and reactor coolant system thermal expansion measurements.

3.9 Verify ability to maintain steam generator levels by operation of the atmospheric steam dump and the auxiliary feedwater system.

3.10 Continue heatup to specified conditions.

4.0 Acceptance Criteria

4.1 All systems, components, instrumentation, and controls function as described in the Final Safety Analysis Report (FSAR), vendors' instruction manuals, and applicant's inquiries.

4.2 Reactor coolant pump vibration readings are within the values specified in vendors' instruction manuals

REACTOR COOLANT SYSTEM AT TEMPERATURE

1.0 ***Objective***

Perform functional checks on the reactor coolant system and associated systems components and instrumentation required during normal hot plant operation.

2.0 ***Prerequisites***

2.1 *Reactor coolant system heatup completed, with conditions of 515°F to 547°F and 2250 ± 25 psig being maintained.*

2.2 *Specified systems completed to the extent necessary to allow conduct of this test.*

3.0 ***Test Methods***

3.1 *Check the response, stability, and general control characteristics of the pressure control system.*

3.2 *Transfer process systems controls to remote station. Demonstrate ability to maintain hot shutdown conditions.*

3.3 *Perform other tests which require the reactor coolant system to be at normal operating no-load temperature and pressure.*

3.4 *Check operational setpoints of the steam generator safety valves.*

3.5 *Conduct initial turbine roll test.*

4.0 ***Acceptance Criteria***

All systems, components, instrumentation, and controls function as described in the FSAR, vendors' instruction manuals, and applicant's inquiries.

REACTOR COOLANT SYSTEM COOLDOWN

1.0 Objective

Perform functional checks on the reactor coolant system and associated systems components and instrumentation required to bring the plant to the cooled down, depressurized condition.

2.0 Prerequisites

2.1 Reactor coolant system at temperature test completed, with conditions of 515°F to 547°F and 2250 ± 25 psig being maintained.

2.2 Primary water storage tank contains sufficient quantity of Grade A water to accommodate the contraction of the primary coolant during cooldown.

2.3 Specified systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Secure two reactor coolant pumps and commence plant cooldown by decreasing the set pressure of the steam dump valves.

3.2 Record data as required for incore thermocouple and RTD cross-calibration.

3.3 When reactor coolant temperature and pressure are below 350°F and 450 psig, place the residual heat removal system in operation

3.4 Collapse the steam bubble.

3.5 Continue pressurizer and reactor coolant system cooldown to 140°F and reduce pressure to 50 psig.

3.6 Establish conditions for reactor coolant system draining.

4.0 Acceptance Criteria

All systems, components, instrumentation, and controls function as described in the FSAR, vendors' instruction manuals, and applicant's inquiries.

REACTOR COOLANT SYSTEM FLOW MEASUREMENT

1.0 Objective

Obtain the data to compute actual reactor coolant system flowrates as they relate to the design flowrates.

*2.0 **Prerequisites***

2.1 Core installed.

2.2 Reactor plant is in hot shutdown condition with all control rods fully inserted.

2.3 Reactor coolant pumps operable.

*3.0 **Test Methods**[a]*

3.1 Measure loop temperatures and loop elbow tap Δp indications at hot shutdown conditions with all reactor coolant pumps running.

3.2 Compute actual reactor coolant system flowrate.

*4.0 **Acceptance Criteria***

Reactor coolant system flowrates are verified to design values.

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a. Prior to going critical on Unit 2, with the reactor at 547°F and fully loaded, the measured loop elbow tap Δp was compared to the Unit 1 value to verify gross flowrate with respect to Unit 1. Absolute flow measurements were performed using a new elbow tap procedure at 50 percent power and above.

REACTOR COOLANT SYSTEM FLOW COASTDOWN

1.0 Objective

1.1 Measure the rate at which reactor coolant system flow changes subsequent to reactor coolant pump stops and starts.

1.2 Measure time delays associated with the loss of flow accident.

2.0 Prerequisites

2.1 Core installed.

2.2 Reactor plant is in hot shutdown condition with all control rods fully inserted.

3.0 Test Methods

3.1 Selectively trip reactor coolant pumps from various configurations of pump operation.

3.2 Measure required flow data and response times for each configuration of pump operation.

4.0 Acceptance Criteria

4.1 Time delays associated with the loss of flow accident are within the values specified in the approved test procedure.

4.2 Rate of change of reactor coolant flow is within the limits specified in the approved test procedure.

REACTOR COOLANT SYSTEM THERMAL EXPANSION

1.0 Objective

Verify that the reactor coolant system piping can expand without obstruction during initial heatup to normal operating conditions.

2.0 Prerequisites

2.1 To be performed in conjunction with the reactor coolant system heatup test.

2.2 Hanger lock pins removed and expansion clearances set to the proper cold values.

2.3 Reference points for measurements established.

3.0 Test Methods

3.1 Log cold settings on all hangers.

3.2 Heat up system to normal operating condition.

3.3 Log hot setting movements at specified points in the system.

3.4 Operate power conversion system under transient conditions.

3.5 Log movements.

4.0 Acceptance Criteria

4.1 All hangers remain within cold and hot setpoints.

4.2 Piping movements do not cause piping rubs or interference with other equipment.

4.3 Piping movements do not cause undue stresses on associated pumps or cause misalignments.

REACTOR COOLANT SYSTEM LEAK TEST

1.0 Objective

Verify that there is no leakage past the reactor vessel head and vessel seal following installation of the reactor vessel head after core loading.

2.0 Prerequisites

2.1 Core installed, reactor vessel head installed, and reactor vessel head studs torqued.

2.2 Reactor coolant system pressure integrity verified in accordance with American Society of Mechanical Engineers code prior to core loading.

3.0 Test Methods

3.1 Establish normal operating no-load temperature and pressure conditions for reactor coolant system.

3.2 Increase system pressure to 100 psi above operating pressure and check for leakage past the head and vessel seal.

4.0 Acceptance Criteria

No detectable leakage past reactor vessel head and vessel seal.

REACTOR COOLANT SYSTEM POST-HOT FUNCTIONAL INSPECTION, CLEANING, AND TESTING

1.0 Objective

1.1 Ensure that the reactor coolant system, including the reactor vessel internals, is properly inspected and cleaned after hot functional testing.

1.2 Ensure that baseline inservice inspections are completed and acceptable prior to core loading.

2.0 Prerequisites

2.1 Reactor coolant system cooled down in preparation for draining.

2.2 Preparations completed to the extent possible for removing vessel head and internals.

3.0 Test Methods

3.1 Drain the reactor coolant system.

3.2 Complete preparations for removal of reactor vessel head.

3.3 Remove reactor vessel head and internals.

3.4 Dye check thermal shield fixtures.

3.5 Visually inspect internal clad surfaces of the pressurizer, reactor vessel, and primary side of the steam generators as required for preservice inspection baseline data.

3.6 Flush internals packages with Grade A water.

3.7 Visually inspect internals.

3.8 Examine reactor vessel closure head, studs, nuts, and washers as required for preservice inspection baseline data.

3.9 Perform preservice inspection of reactor vessel shell and nozzle welds.

3.10 Complete final cleanness procedures and inspections of vessel, piping, and components.

4.0 Acceptance Criteria

4.1 Cleanness requirements meet specifications as described in the approved test procedure.

4.2 Inservice inspection data collected and documented in accordance with the approved test procedure.

BORIC ACID SYSTEM

1.0 Objective

Verify proper functioning of equipment and instrumentation utilized in batching, storage, transfer, and recirculation of boric acid solutions.

2.0 Prerequisites

2.1 Boric acid system installation and component checks completed.

2.2 Adequate supply of Grade A water available.

2.3 Steam supply available to batching tank jacket heater.

2.4 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align system for normal operation.

3.2 Verify boric acid tank and batching tank level setpoints, controller functions, and steam delivery to batching tank heaters.

3.3 Verify capability of boric acid transfer pumps to deliver solution from the batching tank to the boric acid tanks and to recirculate each boric acid tank.

3.4 Verify capability of supplying emergency boration to the charging pump suction.

3.5 Verify boron injection tank and surge tank recirculation capability and temperature control functions.

4.0 Acceptance Criteria

4.1 System provides for batching, storage, transfer, and recirculation of boric acid solutions in accordance with the FSAR system description and the approved test procedure.

4.2 Interlocks, automatic functions, alarms, flows, and pressures are in accordance with the system description and the approved test procedure.

BORON THERMAL REGENERATION SYSTEM[a]

1.0 Objective

1.1 Operationally check out the boron thermal regeneration system and operate the system with borated letdown flow to determine the operational capabilities of the storage and release of boron at several reactor coolant system boron concentrations.

1.2 Verify calculated storage and release times for finite boron concentrations changes and determine the response times of the demineralizer to letdown flow temperature change.

2.0 Prerequisites

2.1 Boron thermal regeneration system installation and component checks completed.

2.2 The reactor coolant system at normal zero power operating temperature and pressure and borated to specified concentration.

2.3 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Method

3.1 Align the system for normal operation.

3.2 Operate the system in the dilution and the boration phases at specified reactor coolant system boron concentrations.

4.0 Acceptance Criteria

Dilution and boration times and temperature lag times within the design limits as specified in the approved test procedure.

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a. This section, related to testing at various boron concentrations, is applicable only to Unit 1.

CHEMICAL AND VOLUME CONTROL SYSTEM

1.0 Objective

Demonstrate that the chemical and volume control system performs as required during plant operation.

2.0 Prerequisites

2.1 Chemical and volume control system installation and component checks completed.

2.2 Reactor coolant system at the condition specified in the approved test procedure.

2.3 Adequate supply of Grade A water available in refueling water storage tank.

2.4 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align chemical and volume control system for normal operation and establish normal flow paths.

3.2 Verify capacities of letdown orifices and pressure drop of reactor coolant filter.

3.3 Check operation of the letdown line temperature and pressure controllers with the demineralizers bypassed.

3.4 Verify operation of the excess letdown and seal water subsystems.

3.5 Verify flowrates and pressure drops of demineralizers.

3.6 Verify charging pumps flowrates and the seal water flowrate for each reactor coolant pump.

3.7 Verify volume control tank level controller operation.

3.8 Check reactor makeup control system response to inventory changes of volume control tank. Verify flowrates in the dilute, alternate dilute, and borate modes.

3.9 Verify regulation of hydrogen supply to volume control tank.

4.0 Acceptance Criteria

4.1 System performance is in accordance with vendors' instruction manuals, FSAR system description, and the approved test procedure.

4.2 Interlocks, automatic functions, flows, alarms, temperatures, and pressures are in accordance with the system description and the approved test procedure.

AUTOMATIC REACTOR CONTROL SYSTEM

1.0 Objective

Verify proper functioning of the automatic reactor control system prior to power operation. (System performance in maintaining coolant average temperatures will be demonstrated during initial operations under steady state and transient conditions.)

2.0 Prerequisites

2.1 Automatic reactor control system installation and component checks completed.

2.2 All process instrumentation channels providing inputs to the automatic reactor control system calibrated and aligned.

2.3 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Energize equipment for the specified warmup period.

3.2 Perform static and dynamic test of automatic reactor control system as prescribed in vendors' instructional manuals and other procedures as appropriate.

4.0 Acceptance Criteria

System performance is in accordance with vendors' instruction manuals.

INCORE MOVABLE DETECTORS

1.0 ***Objective***

Verify proper response of the individual channels of instrumentation and the ability to accurately position the detectors of the incore movable detector system.

2.0 ***Prerequisites***

2.1 *Incore movable detector system installation and component checks completed.*

2.2 *Manual local operation has been checked using a dummy cable.*

2.3 *Core installed.*

2.4 *Gas purge system and leak detection system installation and component checks completed.*

3.0 ***Test Methods***

3.1 *Align system for normal operation.*

3.2 *Verify proper operation of all transfer devices, isolation valves, safety and limit switches, and readout and control equipment.*

3.3 *Compare position readouts with observed position of detectors.*

4.0 ***Acceptance Criteria***

4.1 *System provides mapping capability as described in vendors' instruction manuals and FSAR system description.*

4.2 *Gas purge and leak detection system components, alarms, and interlocks function as described in vendors' instruction manuals and FSAR system description.*

NUCLEAR INSTRUMENTATION SYSTEM

1.0 Objective

Verify that the nuclear instrumentation system performs the required indication and control functions through the source, intermediate, and power ranges of operation.

2.0 Prerequisites

2.1 Nuclear instrumentation system installed with calibration and initial alignments completed.

2.2 System energized for a minimum of 4 h prior to commencing this test.

3.0 Test Methods

Using the installed test facilities, verify proper performance of instrumentation, including output signals to the reactor control system, reactor protection system, and remote indications.

4.0 Acceptance Criteria

System performance is in accordance with vendors' instruction manuals, FSAR system description, and the approved test procedure.

REACTOR PROTECTION TIME RESPONSE MEASUREMENT

1.0 Objective

Verify the reactor protection system response times and functioning of each trip path, excluding the sensors.

2.0 Prerequisite

2.1 Reactor plant in cold shutdown condition prior to initial criticality.

2.2 All instrumentation and reactor protective systems installation checks and calibrations completed.

3.0 Test Methods

3.1 Utilizing test panels and temporary instrumentation as required, measure the time response and verify the functioning of each trip path in the reactor protective circuitry.

3.2 If measured times are greater than those in the specifications, analyze the test data to determine the suitability of the actual response times and corrective actions to be taken.

4.0 Acceptance Criteria

4.1 Response times of the individual trip paths are less than the maximum allowable times specified in the approved test procedure.

4.2 System functional responses to the various input signals are in accordance with vendors' instruction manuals and FSAR system description.

REACTOR PROTECTION OPERATIONAL CHECK

1.0 Objective

Verify the correct installation and proper operation of the reactor trip portion of the reactor protection system.

2.0 Prerequisites

2.1 Reactor plant in cold shutdown condition.

2.2 All instrumentation and reactor protection systems installation checks and calibrations completed.

3.0 Test Methods

3.1 Utilizing the appropriate train test panels, conduct individual tests of each train's tripping logic.

3.2 Conduct overall logic test for both trains simultaneously.

4.0 Acceptance Criteria

4.1 System performance is in accordance with vendors' instruction manuals, FSAR system description, and the approved test procedure.

4.2 Systems demonstrate the required redundancy in accordance with applicable design codes.

SAFEGUARDS SYSTEM OPERATIONAL CHECK

1.0 Objective

Verify the operation of the safeguards logic systems for all conditions of trip logic.

2.0 Prerequisites

2.1 All instrumentation and safeguards systems installation checks and calibration completed.

2.2 Reactor plant in cold shutdown condition prior to core loading.

3.0 Test Methods

3.1 Conduct individual train logic tests.

3.2 Conduct overall logic test for both trains simultaneously.

3.3 Verify redundant tripping of each safeguard channel through to the relay or controller that actuates the safeguards device.

4.0 Acceptance Criteria

4.1 System performance is in accordance with vendors' instruction manuals, FSAR system description, and the approved test procedure.

4.2 System demonstrates the required redundancy in accordance with applicable design codes.

ROD DRIVE MECHANISM TIMING

1.0 Objective

Verify proper timing of each rod control system slave cycler and conduct an operational check of each full length control rod drive mechanism.

2.0 Prerequisites

2.1 All full length control rod drive mechanism equipment installed with rod cluster control assemblies attached.

2.2 Reactor coolant system filled and vented.

2.3 Boron concentration equal to or greater than that required for refueling shutdown.

2.4 Baseline count rates established for each source range channel.

2.5 Test is to be performed at cold and hot shutdown conditions.

3.0 Test Methods

3.1 Verify the timing of each power cabinet's slave cycler.

3.2 Conduct individual mechanism operational checks by withdrawing and inserting each mechanism a specified number of steps while obtaining an oscillograph trace.

4.0 Acceptance Criteria

Mechanism timing and operational checks verified in accordance with the approved test procedure.

ROD CONTROL SYSTEM

1.0 Objective

Verify that the full length rod control system satisfactorily performs all required control and indication functions.

2.0 Prerequisites

2.1 Rod drop time measurement, rod position indication system test, and rod drive mechanism timing test completed.

2.2 Both source range protection channels in operation and an audible signal from one channel available in the control room.

2.3 Reactor plant in hot shutdown condition.

2.4 Boron concentration equal to or greater than that required for refueling shutdown.

3.0 Test Methods

3.1 Alternately withdraw and insert all banks the specified number of steps, verifying rod positions and status and alarm annunciator operation.

3.2 Check bank overlap settings by withdrawing and inserting control banks with bank selector switch in manual.

3.3 Conduct simultaneous rod drop test by initiating a manual scram with all banks withdrawn 50 steps or greater.

4.0 Acceptance Criteria

4.1 System performs all required control and indication functions in accordance with FSAR system description and the approved test procedure.

4.2 Ability to manually scram the reactor is satisfactorily demonstrated.

ROD DROP TIME MEASUREMENT

1.0 Objective

Determine the drop time for each full length control rod at cold no-flow, cold full-flow, and hot full-flow conditions.

2.0 Prerequisites

2.1 Core installed and reactor vessel head in place.

2.2 Boron concentration equal to or greater than that required for refueling shutdown.

2.3 Rod position indication system operable.

2.4 Both source range protection channels in operation with an audible signal from one channel available in the control room.

3.0 Test Methods

3.1 Withdraw selected bank to the fully withdrawn position.

3.2 Conduct individual rod drop tests, recording rod drop time, rod travel time, and other specified data.

3.3 Repeat for all banks of full length rods in required conditions of flow and temperature.

4.0 Acceptance Criteria

Drop time for all rods is less than the maximum value specified in the plant technical specifications.

ROD POSITION INDICATION SYSTEM

1.0 Objective

1.1 Demonstrate that the rod position indication system performs the required indication and alarm functions for each full length rod cluster control assembly.

1.2 Demonstrate performance of the full length rod cluster control assemblies over their full range of travel.

2.0 Prerequisites

2.1 Reactor coolant system at normal operating no-load temperature and pressure.

2.2 Boron concentration equal to or greater than that required for refueling shutdown.

2.3 Cold shutdown alignment and adjustments of rod position indication system completed.

3.0 Test Methods

3.1 Simulate the operation of rod position indication system for each rod cluster control assembly. Observe indications and alarms for proper operation.

3.2 Alternately insert and withdraw each control bank in selected increments. Collect data to calibrate the applicable step counters.

4.0 Acceptance Criteria

4.1 All indicators and alarms function in accordance with vendors' instruction manuals, FSAR system description, and the approved test procedure.

4.2 Rod cluster control assembly and bank position indicators properly calibrated.

4.3 Detector output voltages and rod bottom bistable setpoints are in accordance with the approved test procedure.

CORE LOADING INSTRUMENTATION

1.0 Objective

Verify proper operation of the source range instrumentation channels prior to fuel loading operations.

2.0 Prerequisites

2.1 Temporary source range instrumentation installation checks completed.

2.2 Permanent source range channels operable.

3.0 Test Methods

3.1 Perform calibration of each source range channel.

3.2 Verify response of each channel to a neutron source.

3.3 Verify audible signal from at least one permanent channel available in control room.

4.0 Acceptance Criteria

Instrumentation provides monitoring of source range neutron level for loading fuel as required by the plant technical specifications.

POWER CONVERSION SYSTEM THERMAL EXPANSION

1.0 Objective

Demonstrate that piping and hanger deflections are within acceptable limits during heatups, cooldowns, and power transients.

2.0 Prerequisites

2.1 Power conversion system operable and available for transient operations.

2.2 Hanger lock pins removed and expansion clearances set to the proper cold values.

2.3 Reference points for measurements established.

3.0 Test Methods

3.1 Log cold settings on all hangers.

3.2 Heat up system to normal operating conditions.

3.3 Log hot setting movements at specified points in the system.

3.4 Operate power conversion system under transient conditions.

3.5 Log movements.

4.0 Acceptance Criteria

4.1 All hangers remain within cold and hot setpoints.

4.2 Piping movements do not cause piping rubs or interference with other equipment.

4.3 Piping movements do not cause undue stresses on associated components or cause misalignments.

4.4 Piping and components return to approximate baseline position on cooldown.

POWER CONVERSION SYSTEM VIBRATION MEASUREMENTS

1.0 Objective

Demonstrate that power conversion system vibration levels are within acceptable limits.

2.0 Prerequisites

Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Line up system for normal operation.

3.2 Operate each selected item of rotating equipment at various plant conditions.

3.3 Measure vibration levels at specified locations for each plant condition.

4.0 Acceptance Criteria

Vibration levels within the limits stated in the vendors' instruction manuals and applicant's inquiries.

AUXILIARY FEEDWATER SYSTEM

1.0 Objective

Demonstrate that the auxiliary feedwater system is capable of providing adequate quantities of feedwater for the removal of decay heat.

2.0 Prerequisites

2.1 Auxiliary feedwater system installation and component checks completed.

2.2 To be performed in conjunction with hot functional testing of the reactor coolant system.

3.0 Test Methods

3.1 Align system for normal operation.

3.2 Verify manual and automatic initiation of system.

3.3 Verify pump performance curve.

3.4 Verify ability to control steam generator levels within specified band.

3.5 Verify operation of motor-operated supply valves from service water system (not done during hot functional test).

3.6 Simulate actuation signals to steam generator auxiliary feed inlet valves.

4.0 Acceptance Criteria

4.1 Feedwater flow capability of the system meets the design requirements.

4.2 All system interlocks, alarms, and logic function in accordance with vendors' instruction manuals, FSAR system description, and the approved test procedure.

4.3 All required valve operations take place within the time limits specified in the approved test procedure.

COMPONENT COOLING WATER SYSTEM

1.0 Objective

Demonstrate the capability of the component cooling system to supply adequate cooling water in all modes of operation.

2.0 Prerequisites

2.1 Component cooling system installation and component checks completed.

2.2 Adequate supply of demineralized water available.

2.3 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align system for operation and establish normal flow paths and rates.

3.2 Initiate safeguards actuation signal and evaluate postaccident operation.

3.3 Demonstrate operation for normal plant cooldown.

4.0 Acceptance Criteria

4.1 System flow requirements are met for all modes of operation.

4.2 System response to safeguards actuation signal is in accordance with FSAR system description and the approved test procedure.

RESIDUAL HEAT REMOVAL SYSTEM

1.0 *Objective*

Demonstrate the capability of the residual heat removal system to maintain the specified design cooldown rate of the reactor coolant system.

2.0 *Prerequisites*

2.1 To be performed in conjunction with reactor coolant system cooldown test.

2.2 Residual heat removal system installation and component checks completed.

3.0 *Test Methods*

3.1 When reactor coolant system temperature and pressure have been reduced to less than 350°F and 425 psig, place the residual heat removal system in service.

3.2 Adjust heat exchanger hand control valves and flow control valves to obtain specified cooldown rate.

4.0 *Acceptance Criteria*

4.1 System is capable of establishing and maintaining the specified cooldown rate in accordance with design requirements and FSAR system description.

4.2 System flow, pressure, interlock operation, and automatic functions are in accordance with design requirements, FSAR system description, and the approved test procedure.

FIRE PROTECTION SYSTEM

1.0 Objective

Demonstrate that the fire protection system is capable of providing adequate fire protection under all conditions, including loss of power to the electric-driven pump.

2.0 Prerequisites

2.1 Adequate supply of water available in fire water storage tanks.

2.2 Fire protection system installation and component checks completed

3.0 Test Methods

3.1 Align the system for operation and establish normal flow paths.

3.2 Check operation of water sprinkler, chemical, and cooling tower deluge systems. (Cooling tower deluge system has been removed with installation of new towers.)

3.3 Verify pump heads and flowrates under both normal and emergency power conditions.

3.4 Verify operation and response of detector systems.

4.0 Acceptance Criteria

4.1 Alarms, interlocks, and detection devices function as described in vendors' instruction manuals and applicant's inquiries.

4.2 System is capable of providing protection in accordance with applicable fire protection codes.

SERVICE WATER SYSTEM

1.0 <u>Objective</u>

Demonstrate the capability of the service water system to provide adequate cooling water in both the normal and engineered safeguards modes of operation.

2.0 <u>Prerequisites</u>

2.1 Service water system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 <u>Test Method</u>

3.1 Align system for normal operation.

3.2 Verify pump flowrates.

3.3 Simulate a safety injection actuation signal.

3.4 Demonstrate performance from emergency power source.

3.5 Demonstrate normal and emergency recirculation to the pond.

4.0 <u>Acceptance Criteria</u>

4.1 System response to actuation signal is in accordance with FSAR system description and the approved test procedure.

4.2 System flow, pressure, and automatic functions are in accordance with design requirements, FSAR system description, and the approved test procedure.

RIVER WATER SYSTEM

1.0 <u>Objective</u>

Verify that the river water system provides adequate water flow to the storage pond/service water intake structure.

2.0 <u>Prerequisites</u>

2.1 River water system installation and component checks completed.

2.2 Service water intake structure wet pit completed.

2.3 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 <u>Test Methods</u>

3.1 Align system for normal operation.

3.2 Shift to alternate river water supply line.

3.3 Check response of system to high and low pond level signals.

3.4 Check operation of river water system in each mode of operation from both normal and emergency power sources.

4.0 <u>Acceptance Criteria</u>

4.1 System flow in accordance with design requirements for all modes of operation.

4.2 System responds to controls in each mode of operation as required by design.

CONTROL ROOM VENTILATION SYSTEM

1.0 Objective

Demonstrate that the control room ventilation system is capable of providing a controlled environment during normal and abnormal conditions.

2.0 Prerequisites

2.1 Control room ventilation system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align system for normal operation.

3.2 Simulate smoke detection and recirculation signals and observe system response.

3.3 Measure airflows and temperatures maintained at specified locations in each mode of operation.

4.0 Acceptance Criteria

4.1 The dampers and fans respond to smoke detection and recirculation signals in accordance with FSAR system description and the approved test procedure.

4.2 Heating, cooling, and recirculation capabilities meet design requirements.

AUXILIARY BUILDING VENTILATION SYSTEM (RADIOACTIVE PORTION)

1.0 Objective

Demonstrate that the auxiliary building radioactive ventilation system functions in its various modes of operation and that it is capable of providing a controlled environment.

2.0 Prerequisites

2.1 Auxiliary building ventilation system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align system for normal operation.

3.2 Test supply and exhaust fans for capacity and static pressure.

3.3 Test positioning on all pneumatically operated dampers.

3.4 Measure airflows and temperatures maintained at specified locations in each mode of operation.

4.0 Acceptance Criteria

4.1 System provides for control and disposal of airborne radioactivity in accordance with design requirements and FSAR system description.

4.2 Environment control maintained in all modes of operation in accordance with design requirements.

PLANT RESPONSE TO LOSS OF INSTRUMENT AIR

1.0 Objective

Demonstrate that pneumatically operated valves fail to their safe position on a loss of instrument air.

2.0 Prerequisites

2.1 Instrument air system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

Note: Specific valves and systems may be tested individually.

3.1 Align system for normal operation.

3.2 Reduce instrument air pressure to 0 psig.

3.3 Observe the response of pneumatically operated valves during loss of air pressure and record the position to which each valve fails.

4.0 Acceptance Criteria

Pneumatically operated valves fail to their safe position as specified in the approved test procedure.

PRESSURIZER RELIEF TANK

1.0 <u>Objective</u>

Verify that the pressurizer relief tank provides for adequate control of the discharge from the primary power reliefs and safety valves.

2.0 <u>Prerequisites</u>

2.1 Hydrostatic test of pressurizer relief tank completed.

2.2 Pressurizer relief tank installation checks completed.

2.3 Radioactive waste disposal system completed to the extent necessary to allow conduct of this test.

2.4 Adequate supply of Grade A water available.

3.0 <u>Test Methods</u>

3.1 Fill pressurizer relief tank with Grade A water.

3.2 As pressure increases, verify alarms, interlock operations, and spray flow control.

3.3 Demonstrate ability to maintain nitrogen blanket in pressurizer relief tank.

3.4 Verify transfer flow paths from pressurizer relief tank.

4.0 <u>Acceptance Criteria</u>

Pressurizer relief tank provides for control and disposal of primary plant coolant discharge in accordance with design requirements and FSAR system description.

PRESSURIZER EFFECTIVENESS TEST

1.0 Objective

1.1 Establish proper continuous spray flowrate.

1.2 Verify pressurizer normal control spray effectiveness.

1.3 Verify pressurizer heater effectiveness.

2.0 Prerequisites

2.1 Core installed.

2.2 Plant is in hot shutdown condition at approximately the normal operating no-load temperature and pressure.

3.0 Test Methods

3.1 Adjust continuous spray flowrate to the minimum which results in a 200°F or less ΔT between the pressurizer and spray lines and which keeps the spray line low temperature alarms clear.

3.2 Check normal control spray effectiveness by spraying down to approximately 2000 psig.

3.3 Check heater effectiveness by energizing all heaters with power-operated relief valves in close and spray and level controls in manual. Allow pressure to increase to approximately 2300 psig.

4.0 Acceptance Criteria

4.1 Continuous spray flow adjusted as specified in step 3.1.

4.2 Heater and normal control spray effectiveness are in accordance with design requirements and the approved test procedure.

HEAT TRACING SYSTEM (BORIC ACID)

1.0 Objective

Demonstrate the ability of the heat tracing system to maintain proper temperature control in the various piping systems involved in transporting/storing boric acid solutions.

2.0 Prerequisites

2.1 Heat tracing system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Energize heat tracing system.

3.2 Systematically place systems involved in transporting/storing boric acid in operation and establish transfer flow paths.

3.3 Monitor temperatures maintained by each heat tracing circuit at specified locations in each system.

4.0 Acceptance Criteria

Each heat tracing circuit maintains temperature as specified in the approved test procedure.

120-V INSTRUMENT POWER SYSTEMS

1.0 Objective

Demonstrate the capabilities of the 120-V vital instrument power system and the 120 V-ac regulated instrument power system to supply power to essential and nonessential instrumentation and control loads under normal and emergency conditions.

2.0 Prerequisites

2.1 The 120-V instrument power systems installation and component checks completed.

2.2 The 600 V-ac system available.

2.3 The 125 V-dc system operable.

3.0 Test Methods

3.1 Energize 120-V instrument power buses from their normal power sources.

3.2 Demonstrate ability to transfer each vital instrument bus manually to a regulated instrument bus and back to its static inverter.

3.3 Trip the normal power supplies to the static inverters. Verify automatic transfer to alternate dc source. Verify transfer back to normal supply when reenergized.

3.4 Demonstrate ability to transfer each regulated instrument panel manually to its alternate source.

4.0 Acceptance Criteria

4.1 All vital and regulated buses or panels can be manually transferred to alternate sources.

4.2 Voltage and frequency changes resulting from transient conditions do not exceed the design requirements.

4.3 All system interlocks and alarms function properly.

600-V ELECTRICAL LOAD CENTERS

1.0 Objective

1.1 Verify that the 600-V safeguard and nonsafeguard load centers can be energized from their normal and alternate sources.

1.2 Verify that electrical and mechanical interlocks function properly.

2.0 Prerequisites

2.1 Meters, relays, and protective devices calibrated and tested.

2.2 The 125 V-dc and 4.16-kV buses energized.

2.3 Phase rotation checked on 600-V buses.

3.0 Test Methods

3.1 Close 4.16-kV breakers to energize load center transformers and buses.

3.2 Measure voltage and verify phase relationship.

3.3 Shift buses to alternate power sources as applicable.

3.4 Initiate loss of power and safeguards actuation signals.

4.0 Acceptance Criteria

4.1 The 600-V safeguard and nonsafeguard buses are capable of being energized from their normal and alternate sources, and proper phase relationship is exhibited.

4.2 The 600-V load centers respond correctly to a loss of station power and safeguards actuation signals.

4.3 Interlocks function as described in vendors' instruction manuals and applicant's inquiries.

600-V MOTOR CONTROL CENTERS

1.0 Objective

1.1 Verify that the 600-V safeguard and nonsafeguard motor control centers can be energized from their normal and emergency sources.

1.2 Verify that electrical and mechanical interlocks function properly.

2.0 Prerequisites

2.1 Meters, relays, and protective devices calibrated and tested.

2.2 The 125 V-dc system available.

2.3 The 600-V buses energized.

2.4 Phase rotation checked on motor control centers.

3.0 Test Methods

3.1 Rack in and close motor control center supply breakers.

3.2 Manually transfer motor control centers to emergency power supplies as applicable.

3.3 Measure voltage and verify phase relationship.

3.4 Initiate loss of power and safeguards actuation signals.

4.0 Acceptance Criteria

4.1 Safeguard and nonsafeguard motor control centers are capable of being energized from their normal and emergency sources, and proper phase relationship is exhibited.

4.2 The 600-V motor control centers respond correctly to a loss of station power and safeguards actuation signals.

4.3 All system interlocks and alarms function properly.

4160-V ELECTRICAL SYSTEM

1.0 Objective

1.1 Verify that the 4160-V buses can be energized from their respective normal and alternate source.

1.2 Verify that all electrical and mechanical interlocks function properly.

2.0 Prerequisites

2.1 Meters, relays, and protective devices calibrated and tested.

2.2 The 125 V-dc system available.

2.3 Phase rotation checked on 4160-V buses.

3.0 Test Methods

3.1 Rack in and close 4160-V breakers to energize associated 4160-V buses.

3.2 Record voltage and verify phase relationship.

3.3 Shift buses to alternate power sources as applicable.

3.4 Initiate loss of power and safeguards actuation signals.

4.0 Acceptance Criteria

4.1 The 4160-V buses are capable of being energized from their normal and alternate source, and proper phase relationship is exhibited.

4.2 The 4160-V system responds correctly to a loss of power and safeguards actuation signals.

4.3 All system interlocks and alarms function properly.

UNIT AUXILIARY AND STARTUP AUXILIARY TRANSFORMERS

1.0 <u>Objective</u>

1.1 Demonstrate the capability of the unit auxiliary and startup auxiliary transformers to supply electrical power to the 4160-V buses.

1.2 Verify operation of protective devices and functional operation of controls and interlocks.

2.0 <u>Prerequisites</u>

2.1 All meters, relays, and protective devices calibrated and tested.

2.2 The 125 V-dc system available.

2.3 All erection work on transformers and switchgear completed.

2.4 Transformer oil and gas systems tested and in service.

2.5 Isolated phase bus tested and ready for service.

2.6 Breaker controls and transfer scheme verified.

2.7 PT and CT circuits checked for polarity and continuity.

3.0 <u>Test Methods</u>

3.1 Simulate signals to temperature controls and verify operation of transformer oil pumps and fans.

3.2 Simulate signals to verify annunciators for transformer protective devices.

3.3 Verify dead bus transfer capability to start up auxiliary transformers when unit auxiliary transformers are deenergized.

4.0 <u>Acceptance Criteria</u>

Transformers provide reliable source of electrical power to 4160-V buses in accordance with design requirements and FSAR system description.

DIRECT CURRENT SYSTEMS

1.0 Objective

Demonstrate the capability of the dc system to provide a source of reliable, uninterruptible dc power for all normal and emergency instrumentation, control, and power loads.

2.0 Prerequisites

2.1 The 600 V-ac power available.

2.2 Battery room ventilation system operable.

2.3 Batteries, battery chargers, and dc distribution system, including protective devices, installation, and component checks, completed.

3.0 Test Methods

3.1 Energize the battery chargers.

3.2 Adjust alarms and interlocks.

3.3 Discharge the batteries at a controlled rate and determine Ah capacity.

3.4 Adjust chargers to supply dc load and charge batteries simultaneously.

3.5 Deenergize battery chargers while the applicable busses are carrying their rated station power.

4.0 Acceptance Criteria

4.1 All system interlocks and alarms function properly.

4.2 Batteries are capable of supplying plant dc power upon deenergization of their chargers.

4.3 Battery chargers are capable of maintaining normal bus loads concurrently with charging the batteries.

COMMUNICATIONS SYSTEM

1.0 Objective

1.1 Demonstrate the adequacy of the plant public address system, intracommunication between all local stations, and interconnection to commercial telephone service.

1.2 Demonstrate that the evacuation signal can be heard from any location in the plant under all required conditions.

2.0 Prerequisites

2.1 All communications systems installation and component checks completed.

2.2 Sound levels established for locations where noise levels might interfere with communications.

3.0 Test Methods

3.1 Test the portable stations, hand set stations, and jack stations for proper operation in all modes.

3.2 Test interconnection to commercial phone service.

3.3 Test all alarms.

3.4 Shift applicable equipment to alternate power sources and verify operation.

4.0 Acceptance Criteria

4.1 Communication system provides for paging, normal plant communications, interconnection to commercial telephone service, and alarm signaling in accordance with design requirements and FSAR system description.

4.2 Evacuation alarm can be heard from any location in the plant.

EMERGENCY DIESEL GENERATORS

1.0 Objective

1.1 Demonstrate manual start and synchronization of the diesel generators.

1.2 Demonstrate automatic start and sequencing of diesel generators. Demonstrate load carrying capacity of diesel generators.

1.3 Demonstrate independence among redundant, onsite power sources and their load groups.

2.0 Prerequisites

2.1 Station batteries charged and dc control power available.

2.2 Relays calibrated and all normal bus protective devices checked and in service.

2.3 Diesel engine auxiliary systems installation, component checks, and acceptance tests completed as specified.

2.4 Diesel room ventilation and fire protection systems operable.

3.0 Test Methods

3.1 Demonstrate manual start and synchronization of each diesel generator.

3.2 Verify diesel generator response to engineered safeguards actuation signals, 4160-V buses undervoltage signals, and low pond level signals.

3.3 Verify timing of diesel generators starting sequence.

3.4 Verify capability to control diesel generators in all modes of operation.

3.5 Verify load group assignments of onsite emergency power systems as required in Regulatory Guide 1.41.

3.6 Conduct load carrying duration test.

4.0 Acceptance Criteria

4.1 Regulators function to regulate and maintain voltage in all modes of operation in accordance with design requirements.

4.2 Diesel generators function in maintaining the 4160-V emergency buses in accordance with design requirements, FSAR system description, and the approved test procedure.

4.3 Diesel generators do not overspeed when load is removed.

4.4 Each redundant onsite power source and its load group can function without any dependence upon any other redundant load group or portion thereof.

4.5 Direct current and onsite ac buses and related loads not under test will be monitored to verify absence of voltage at these buses and loads.

DIESEL FUEL OIL SYSTEM

1.0 <u>Objective</u>

Demonstrate that the diesel fuel oil system supplies adequate quantities of fuel oil to the diesel oil day tanks.

2.0 <u>Prerequisites</u>

2.1 Fire protection system operable.

2.2 Diesel fuel oil system installation and component checks completed.

3.0 <u>Test Methods</u>

3.1 Align system for operation and establish normal transfer flow paths.

3.2 Verify capability to transfer fuel oil at specified rate.

4.0 <u>Acceptance Criteria</u>

Fuel transfer capability of the system meets the design requirements.

CONTAINMENT INTEGRATED LEAK RATE

1.0 Objective

Demonstrate that the containment leak rate is within allowable limits.

2.0 Prerequisites

Containment structural integrity test completed.

3.0 Test Methods

Integrated leak rate testing of the containment will be conducted in accordance with the procedures described in the proprietary Bechtel Corporation Topical Report BN-TOP-1, Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants, Revision 1, November 1, 1972.

4.0 Acceptance Criteria

Integrated leak rate meets the requirements of the applicable Regulatory Guides and the approved test procedure.

CONTAINMENT STRUCTURAL INTEGRITY

1.0 Objective

Verify the structural integrity of the containment building.

2.0 Prerequisites

2.1 Containment penetrations installed and penetration leak tests completed.

2.2 Containment ventilation systems operable to extent required to control containment internal temperature.

3.0 Test Methods

3.1 In accordance with NRC Acceptance Criteria (NRC SER NUREG 75/034 dated May 2, 1975), prior to initial fuel loading, the containment will be subjected to a pressure equivalent to 115 percent of the containment design pressure. This test demonstrates that the containment is capable of resisting the postulated accident pressure. In addition, by measuring the structural response and comparing the results with analytical predictions, the test verifies that the structure does behave as anticipated.

3.2 Instrumentation, measuring systems, pressurization procedure, deformation, strain and temperature measurements, crack pattern mapping, and data acquisition schedules for the preoperational structural integrity test will be in accordance with the proprietary Bechtel Corporation Topical Report BC-TOP-5, Prestressed Concrete Nuclear Reactor Containment Structures, Revision 1, December 1972.

4.0 Acceptance Criteria

The containment structure meets structural integrity requirements as required by applicable Regulatory Guides and the approved test procedure.

CONTAINMENT COOLING SYSTEM

1.0 Objective

Demonstrate that the containment cooling system is capable of providing adequate ventilation and cooling in normal operation and in the engineered safeguards mode of operation.

2.0 Prerequisites

2.1 Containment penetration installed.

2.2 Containment cooling system installation and component checks completed.

2.3 Service water system operable.

2.4 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align system for normal operation.

3.2 Test capacity and static pressure of fans in various operating configurations.

3.3 Simulate safety injection signal and observe system response.

4.0 Acceptance Criteria

4.1 System response to safety injection actuation signal is in accordance with design criteria, FSAR system description, and the approved test procedure.

4.2 System interlocks, instrumentation, and alarms function properly.

CONTAINMENT SPRAY AND ADDITIVE SYSTEM

1.0 Objective

Demonstrate the capability of the containment spray and additive system to respond properly to a containment spray actuation signal.

2.0 Prerequisites

2.1 Containment spray and additive system installation and component checks completed.

2.2 Sufficient Grade A water available in the refueling water storage tank and spray additive tank.

3.0 Test Methods

3.1 Align system to recirculate to the refueling water storage tank.

3.2 Align eductor suction to the spray additive tank.

3.3 Initiate a containment spray actuation signal and observe sequencing of active components.

3.4 Remotely initiate recirculation spray flow with each spray pump.

3.5 Measure flowrates and pump heads in both injection and recirculation modes.

3.6 Force air or smoke through each spray nozzle to verify that nozzles are free of obstructions.

4.0 Acceptance Criteria

4.1 System responds to actuation signal and provides adequate cooling in accordance with design criteria, FSAR system description, and the approved test procedure.

4.2 System provides for chemical addition to spray flow in accordance with design requirements and FSAR system description.

CONTAINMENT ISOLATION SYSTEM

1.0 Objective

Demonstrate the capability of the containment isolation system to respond properly to a containment isolation actuation signal.

2.0 Prerequisites

2.1 Containment isolation system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow the conduct of this test.

3.0 Test Methods

3.1 Containment isolation system and the applicable isolation valves in associated systems aligned for normal operation.

3.2 Simulate a safety injection actuation signal.

3.3 Simulate containment isolation actuation signals.

3.4 Record isolation valve response times to the actuation signals.

4.0 Acceptance Criteria

System response to both safety injection and containment isolation actuation signals is in accordance with FSAR system description, design requirements, and the approved test procedure.

POSTACCIDENT CONTAINMENT COMBUSTIBLE GAS CONTROL SYSTEM

1.0 Objective

Demonstrate the capability of the postaccident containment combustible gas control system to provide for circulation, sample collection, and removal of combustible gases following a loss-of-coolant accident.

2.0 Prerequisites

2.1 System installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align system for normal operation.

3.2 Verify remote actuation of active components.

3.3 Check flowrates of postaccident containment mixing fans, reactor cavity hydrogen dilution fans, and postaccident containment air sample fan.

3.4 Demonstrate ability to obtain atmospheric samples from each sample point.

3.5 Verify proper operation of each hydrogen recombiner.

4.0 Acceptance Criteria

4.1 System provides for circulating and sampling containment atmosphere in accordance with FSAR system description.

4.2 Hydrogen recombiners function as described in vendors' instruction manuals and FSAR system description.

PENETRATION ROOM FILTRATION SYSTEM

1.0 Objective

Demonstrate the effectiveness of the penetration room filtration system in controlling the release of containment leakage to the atmosphere.

2.0 Prerequisites

2.1 Test assemblies installed to simulate filter pressure drops.

2.2 Penetration room filtration system installation and component checks completed.

2.3 Associated systems completed to the extent necessary to allow the conduct of this test.

3.0 Test Methods

3.1 With system operating, verify circulation flow paths within the penetration room.

3.2 Simulate containment isolation actuation signal and observe system response.

3.3 Check penetration room leak rate.

3.4 Inhibit operation of the recirculation fan exhaust valve in one system and observe performance of the system.

4.0 Acceptance Criteria

System responds to actuation signals and provides for controlled handling of containment leakage in accordance with FSAR system description and design requirements.

EMERGENCY CORE COOLING SYSTEM VIBRATION MEASUREMENT

1.0 Objective

Verify that emergency core cooling system rotating equipment vibration levels are within acceptable limits.

2.0 Prerequisites

2.1 Emergency core cooling system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Align system for normal operation.

3.2 Operate rotating equipment in the various system operating conditions.

3.3 Measure vibration levels at specified points in the system in each mode of operation.

4.0 Acceptance Criteria

Vibration levels within the limits specified in the vendors' instruction manuals and applicable codes.

EMERGENCY CORE COOLING SYSTEM THERMAL EXPANSION

1.0 Objective

Verify that the emergency core cooling system piping can expand without obstruction upon system heatup to operating conditions.

2.0 Prerequisites

2.1 Emergency core cooling system installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow conduct of this test.

3.0 Test Methods

3.1 Record cold baseline data.

3.2 Heat up system to normal operating temperatures.

3.3 Record hot setting movements.

3.4 Record movements due to thermal expansion or contraction during the operation of injection pumps and recirculation pumps.

3.5 Verify that piping and components return to approximately cold baseline position upon cooldown.

4.0 Acceptance Criteria

4.1 Piping movements do not cause piping rubs, misalignments, or excessive hanger deflections.

4.2 Piping and components return to approximate baseline position upon cooldown.

SAFETY INJECTION SYSTEM

1.0 Objective

1.1 Verify operation of the boron injection tank heaters.

1.2 Verify that the boron injection tank remains full during normal operation.

1.3 Verify that safety injection accumulators discharge flow to the reactor coolant system.

1.4 Verify that the system properly responds to a safety injection actuation signal.

1.5 Verify that the flowrates delivered through each injection flow path, using all pump combinations, are within the design specifications (not including the recirculation mode from the containment sump).

1.6 Verify that the high pressure safety injection pumps are capable of taking suction from the residual heat removal pumps.

1.7 Verify that the safety injection pumps will not trip under conditions of maximum flow.

1.8 Verify the operability of the check valves in the safety injection system that are subject to an elevated temperature during normal operation, at as close as possible to accident conditions.

1.9 Verify proper motor-operated valve operation under maximum expected differential pressure conditions.

1.10 Verify that the accumulator isolation valves will open with zero pressure in the reactor coolant system and with normal pressure in the accumulator.

2.0 Prerequisites

2.1 Reactor vessel head removed prior to core loading.

2.2 Boron injection tank is filled and refueling water storage tank is filled to its normal level.

2.3 Installation and calibration checks completed on safety injection system instruments and components.

2.4 Temporary arrangements have been made to use an alternative source of water for the recirculation test.

3.0 Test Methods

3.1 Demonstrate boron injection tank heater operation in automatic and manual modes. Establish normal recirculation path from the boron injection surge tank to the boron injection tank and verify that injection tank level is maintained.

3.2 Establish specified conditions and initiate safety injection signals from each train. Verify proper actuation of active components in response to signals from each train.

3.3 Conduct miniflow tests of safety injection pumps.

3.4 Pressurize accumulators to minimum pressure required to move water and demonstrate injection through cold loop injection valves to reactor vessel from each accumulator.

3.5 Conduct system pressure/flow verifications.

4.0 Acceptance Criteria

4.1 Boron injection tank heaters maintain temperature in accordance with design requirements.

4.2 Boron injection tank remains full during normal operation.

4.3 System response to safety injection signals is in accordance with FSAR system description, design requirements, and the approved test procedure.

4.4 Accumulator injection flow path to reactor vessel is free of obstructions.

4.5 System pressure/flow characteristics meet the design specifications.

REACTOR COMPONENTS AND FUEL HANDLING TOOLS AND FIXTURES

1.0 Objective

Verify the adequacy of the special equipment required for refueling operations.

2.0 Prerequisites

Equipment to be checked out is onsite and inspected in accordance with the routine receiving inspection.

3.0 Test Methods

3.1 Inspect the mating surface fit and grip of each tool.

3.2 Check each tool for smooth performance and complete actuation.

3.3 Check adequacy of locating devices, guides, and chambers.

3.4 Verify operation of all interlocks and/or safety devices.

3.5 Load test all lifting devices.

4.0 Acceptance Criteria

Equipment provides for safe handling of fuel assemblies and reactor components as described in vendors' instruction manuals, applicant's inquiries, and FSAR system description.

FUEL TRANSFER SYSTEM

1.0 Objective

1.1 Provide functional demonstration of the fuel transfer system and fuel handling tools prior to initial core load.

1.2 Provide functional demonstration of the refueling canal water system.

2.0 Prerequisites

2.1 Reactor components and fuel handling tools and fixtures test completed.

2.2 Fuel transfer system and refueling canal water system installation and component checks completed.

2.3 Reactor vessel head and internals stored in the refueling positions.

2.4 Dummy fuel assembly stored in a new fuel storage rack.

3.0 Test Methods

3.1 Demonstrate flooding, draining, and adjusting level in the refueling water canal.

3.2 With canal drained, conduct the various fuel handling evolutions with the dummy fuel assembly.

4.0 Acceptance Criteria

4.1 System provides for storage, transfer, and handling of fuel assemblies in accordance with vendors' instruction manuals, FSAR system description, and design requirements.

4.2 Refueling canal water system provides for flooding, draining, and adjusting level in accordance with FSAR system description and design requirements.

SPENT FUEL POOL COOLING SYSTEM

1.0 Objective

Verify the cooling and purification capabilities of the spent fuel pool cooling system.

2.0 Prerequisites

2.1 Spent fuel pool cooling system installation and component checks completed.

2.2 Adequate supply of Grade A water available.

3.0 Test Methods

3.1 Demonstrate filling and draining the spent fuel pool.

3.2 Demonstrate circulation through demineralizer, heat exchanger, and skimmer loops.

3.3 Demonstrate that the spent fuel pool can be drained only by deliberate action.

4.0 Acceptance Criteria

System provides for filling, draining, and purification of the spent fuel pool in accordance with FSAR system description and design requirements.

PROCESS AND AREA RADIATION MONITORING SYSTEM

1.0 Objective

Demonstrate the capability of the process and area radiation monitoring system to monitor effectively the levels of radiation in the plant area and effluents and to initiate isolation and alarms as required.

2.0 Prerequisites

2.1 Process and area radiation monitoring systems installation and component checks completed.

2.2 Associated systems completed to the extent necessary to allow the conduct of this test.

3.0 Test Methods

3.1 Align system for normal operation. Position valves in associated systems as necessary to allow response to isolation signals.

3.2 Verify proper functioning of system detectors by utilizing test sources and other procedures as appropriate.

3.3 Verify proper system response to simulated alarm conditions by monitoring controller outputs, alarm indications, and the operation of isolation valves where possible.

4.0 Acceptance Criteria

System effectively monitors and responds to levels of radiation in the plant areas and effluents in accordance with vendors' instruction manuals, design requirements, and FSAR system description.

PERSONNEL MONITORING AND SURVEY INSTRUMENTS

1.0 Objective

Verify the proper functioning of all personnel monitoring and radiation survey instruments.

2.0 Prerequisites

All personnel monitoring and radiation survey instruments calibrated within the specified time frame for each instrument.

3.0 Test Methods

Verify proper functioning of all personnel monitoring and radiation survey instruments by exposure to test sources and other procedures as appropriate.

4.0 Acceptance Criteria

Instruments function as specified in vendors' instruction manuals and applicant's inquiries.

LABORATORY EQUIPMENT

1.0 Objective

Verify the proper functioning of laboratory equipment utilized in radiological control processes.

2.0 Prerequisites

All applicable laboratory equipment calibrated within the specified time period for each apparatus.

3.0 Test Methods

Verify proper functioning of each apparatus by exposure to test sources and other procedures as appropriate.

4.0 Acceptance Criteria

Equipment functions as specified in vendors' instruction manuals and applicant's inquiries.

WATER QUALITY TESTS

1.0 *Objective*

Verify acceptable water quality of reactor coolant system fill and makeup water prior to initial criticality.

2.0 *Prerequisites*

2.1 Reactor coolant system filled and vented in preparation for initial criticality.

2.2 Reactor makeup system water storage at operating level.

3.0 *Test Methods*

3.1 Sample reactor coolant system and analyze in accordance with approved plant procedures.

3.2 Sample reactor makeup system and analyze in accordance with approved plant procedures.

4.0 *Acceptance Criteria*

All analyses are within the limits specified in the plant chemistry specifications.

RADIOACTIVE WASTE SYSTEMS

1.0 Objective

Demonstrate the ability of the radioactive waste systems to provide controlled handling and disposal of solid, liquid, and gaseous radioactive wastes.

2.0 Prerequisites

2.1 Solid waste processing, liquid waste processing, and gaseous waste processing systems installation and component checks completed.

2.2 Demineralized water available to utilize as working fluid.

2.3 Associated systems completed to the extent necessary to allow the conduct of this test.

3.0 Test Methods

3.1 Align radioactive waste systems for normal operation and establish normal flow paths.

3.2 Measure flowrates, capacities, and alarm setpoints as specified.

3.3 Verify proper functioning of all components, controllers, valves, and indicators.

4.0 Acceptance Criteria

Systems provide controlled handling and disposal of radioactive wastes in accordance with vendors' instruction manuals, FSAR system description, and design requirements.

REACTOR COOLANT PRESSURE BOUNDARY LEAKAGE DETECTION SYSTEM

1.0 Objective

Demonstrate system capability of detecting the presence of significant leakage from the reactor coolant loops to the containment atmosphere during normal operations.

2.0 Prerequisites

2.1 Reactor coolant pressure boundary leakage detection system installation and component checks completed.

2.2 Associated system completed to the extent necessary to allow the conduct of this test.

3.0 Test Methods

3.1 Verify proper functioning of containment air particulate monitor and radioactive gas monitor detectors by exposure to standard test sources.

3.2 Verify monitor's flowrates and associated controls, indications, and alarms.

3.3 Verify proper functioning of specific humidity monitoring devices in accordance with vendors' instruction manuals and the approved test procedure.

4.0 Acceptance Criteria

System provides for monitoring and indication of reactor coolant pressure boundary leakage in accordance with FSAR system description, design requirements, and the approved test procedure.

SERVICE WATER POND (SHARED)

1.0 Objective

Verify the seepage from the service water pond.

2.0 Prerequisites

2.1 Construction of the service water pond is complete.

2.2 Construction of the service water intake structure wet pit is complete.

2.3 The service water pond spillway is complete and operational.

2.4 The river water system is operational.

2.5 The river water flume is operational.

2.6 A volume versus elevation relationship has been established for the service water pond.

2.7 The rainfall 12 h prior to the test is less than 0.1 in./h.

3.0 Test Methods

3.1 The service water pond is filled to the normal level.

3.2 A measured water inventory is maintained on the service water pond throughout the test period.

4.0 Acceptance Criteria

Service water pond is deemed acceptable if the test verifies that the seepage rate does not exceed 15 ft^3/s.

14.1.3 FUEL LOADING AND INITIAL OPERATION

Fuel loading began when all prerequisite system tests and operations were satisfactorily completed and the NRC operating license received. Upon completion of fuel loading, the reactor upper internals and pressure vessel head were installed and additional mechanical and electrical tests performed prior to initial criticality. After final precritical tests were completed, initial operation of the reactor began.

The primary objectives of the fuel loading and initial operation phase were as follows:

- *A. To accomplish an orderly and safe initial fuel loading.*
- *B. To accomplish an orderly and safe approach to criticality.*
- *C. To accomplish an orderly and safe ascension to power.*

The procedures which will guide fuel loading, attainment of initial criticality, and ascension to power are described in subsections 14.1.3.1 and 14.1.3.2.

14.1.3.1 Fuel Loading

The reactor containment structure shall have been completed and the containment integrity established prior to commencing loading operations.

Fuel handling tools and equipment shall have been checked out and dry runs conducted in their use and operation.

The reactor vessel and associated components will be in a state of readiness to receive fuel. Water level will be maintained above the bottom of the nozzles and recirculation maintained to ensure a uniform boron concentration. Boron concentration can be increased via the recirculation system or by direct additions to the open vessel.

The overall responsibility and direction of the initial core loading will be exercised by the plant manager. The process of initial core loading will be directed from the charging floor of the containment structure. Procedures for the control of personnel access and the maintenance of containment security will be implemented prior to commencing loading operations.

The initial core configuration is specified as part of the core design studies, conducted well in advance of station startup.

In the event that during core loading operations mechanical damage is sustained to a fuel assembly of a type for which no spare is available onsite, core loading operations will be suspended until an alternate core loading scheme whose characteristics closely approximate those of the initially prescribed pattern has been determined.

The core will be assembled in the reactor vessel, submerged in Grade A water containing enough dissolved boric acid to maintain a calculated core effective multiplication factor ≤ 0.90. The refueling cavity will be dry during initial core loading. Core moderator chemistry conditions (particularly boron *concentration) will be prescribed in the core loading procedure documents and verified by chemical analysis of moderator samples taken prior to and at specified intervals during core loading operations.*

Core loading instrumentation consists of two permanently installed source range channels and two temporary incore source range channels plus a third temporary channel which can be used as a spare. The permanent channels are monitored in the main control room by licensed station operators; the temporary channels are installed in the containment structure and monitored by qualified engineering personnel and licensed station operators. At least one permanent channel is equipped with an audible count rate indicator. Both permanent channels have the capability of displaying the neutron flux level on a strip chart recorder. The temporary channels indicate on count rate meters with a minimum of one channel recorded on a strip chart recorder. Minimum count rates of 2 counts/s, attributable to core neutrons, are required on at least two of the four available source range channels at all times following installation of the initial nucleus of eight fuel assemblies.

At least two artificial neutron sources will be introduced into the core at specified points in the core loading program to ensure a minimum count rate of 2 counts/s for adequate monitoring of the core.

Fuel assemblies and inserted components will be placed in the reactor vessel one at a time in accordance with a previously established and approved sequence developed to provide reliable core monitoring while minimizing the possibility of core mechanical damage. The core loading procedure documents include detailed tabular check sheets which will prescribe and verify the successive movements of each fuel assembly and its specified inserts from its initial position in the storage racks to its final position in the core. Multiple checks will be made of component serial numbers and types at successive transfer points to guard against possible inadvertent exchanges or substitutions of components. Fuel assembly status boards are maintained throughout the core loading operation both in the main control room and in the containment.

An initial nucleus of eight fuel assemblies, the first of which contains an activated neutron source, is the minimum source fuel nucleus which permits subsequent meaningful inverse count rate monitoring. This initial nucleus is determined by calculation and previous experience to be markedly subcritical ($k_{eff} \leq 0.90$) *under the required conditions of loading.*

Each subsequent fuel addition will be accompanied by detailed neutron count rate monitoring to determine that the just loaded fuel assembly does not excessively increase the count rate and that the extrapolated inverse count rate ratio is not decreasing for unexplained reasons. The results of each loading step will be evaluated before the next prescribed step is started.

Criteria for safe loading require that loading operations stop immediately if:

A. An unanticipated increase in the neutron count rates by a factor of two occurs on all responding source range channels during any single loading step, after the initial nucleus of eight fuel assemblies are loaded (excluding anticipated change due to detector and/or source movement).

B. The neutron count rate on any individual source range channel increases by a factor of five during any single loading step, after the initial nucleus of eight fuel assemblies are loaded (excluding anticipated changes due to detector and/or source movements).

An alarm in the containment and main control room is coupled to the source range channels with a setpoint at five times the current count rate. This alarm automatically alerts the loading operation personnel of high count rate and requires an immediate stop of all loading operations until the situation is evaluated. In the event the alarm is actuated during core loading and after it has been determined that no hazards to personnel exist, preselected personnel will be permitted to reenter the containment vessel to evaluate the cause and determine future action.

Core loading procedures specify the condition of fluid systems to prevent inadvertent dilution of the reactor coolant, the movement of fuel to preclude the possibility of mechanical damage, and the conditions under which loading can proceed.

14.1.3.2 Initial Operation

Upon completion of core loading, the reactor upper internals and the pressure vessel head were installed and additional mechanical and electrical tests performed prior to initial criticality. The final pressure test was conducted after filling and venting was completed to verify the integrity of the vessel head installation.

Mechanical and electrical tests were performed on the control rod drive mechanisms. These tests included a complete operational checkout of the mechanisms and calibration of the individual rod position indication.

Tests were performed on the reactor trip circuits to test manual trip operation. The actual control rod assembly drop times were measured for each control rod assembly. The reactor control and protection system was checked with simulated signals to produce a trip signal for the various conditions that require plant trip.

At all times when the control rod drive mechanisms were being tested, the boron concentration in the coolant moderator was maintained so that criticality could not be achieved with all control rod assemblies fully withdrawn.

A complete functional electrical and mechanical check was made of the incore movable detector system at operating temperature and pressure. After completion of precritical tests, nuclear operation of the reactor began. This final phase of startup and testing included initial criticality, low power testing, and power level escalation. The purpose of these tests was to establish the plant operational characteristics, to acquire data for the proper calibration of setpoints, and to ensure that operation is within license requirements. A brief description of the testing is presented in the following sections. Table 14.1-1 summarizes the major tests which were performed following initial core loading, and figure 14.1-2 shows the startup test sequence.

14.1.3.2.1 Initial Criticality

The approach to initial criticality was conducted according to approved written procedures which specify the plant conditions, safety and precautionary measures, and specific instructions. The procedures also delineate the chains of responsibility and authority in effect during this period of operation. Alignment of the fluid system was specified to provide controlled start and stop as well as adjustments of the rate of the approach to criticality.

Initial criticality was achieved by a combination of shutdown and control bank withdrawal and reactor coolant system boron concentration reduction.

Inverse count rate ratio monitoring, using data from the normal plant source range instrumentation, was used as an indication of the proximity and rate of approach to criticality. Inverse count rate ratio data were plotted as a function of rod bank position during rod motion and as a function of primary water addition during reactor coolant system boron concentration reduction.

Initially, the shutdown and control banks of control rods were withdrawn incrementally in the normal withdrawal sequence, leaving the last withdrawn control bank inserted far enough in the core to provide effective control when criticality was achieved.

The boron concentration in the reactor coolant system was then reduced by the addition of primary water. Criticality was achieved during boron dilution or by subsequent rod withdrawal following boron dilution. The rate of primary water addition, and hence the rate of approach to criticality, could have been reduced as the reactor approached criticality to ensure that effective control was maintained. Throughout this period, samples of the primary coolant were obtained and analyzed for boron concentration.

Written procedures specify the plant conditions, precautions, and specific instructions for the approach to criticality.

Successive stages of control rod assembly group withdrawal and of boron concentration reduction were monitored by observing changes in neutron count rate, as indicated by the permanent source range nuclear instrumentation, as functions of group position during rod motion, reactor coolant boron concentration, and primary water addition to the reactor coolant system during dilution. Throughout this period, samples of the primary coolant were obtained and analyzed for boron concentration.

Inverse count rate ratio monitoring was used as an indication of the proximity and rate of approach to criticality during control rod assembly group withdrawal and during reactor coolant boron dilution. The rate of approach was reduced as the reactor approached the time extrapolated for criticality to ensure that effective control was maintained at all times.

14.1.3.2.2 Low Power Testing[a]

A prescribed program of reactor physics measurements was undertaken to verify that the basic static and kinetic characteristics of the core were as expected and that the values of the kinetic coefficients assumed in the safeguards analysis were indeed conservative.

The measurements were made at low power and primarily at or near operating temperature and pressure. Measurements were made, including verification of calculated values of control rod assembly group reactivity worths, of isothermal temperature coefficient under various core conditions, differential boron concentration reactivity worth, and critical boron concentrations as functions of control rod assembly group configuration. In addition, measurements of the relative power distributions were made. Concurrent tests were conducted on the instrumentation, including the source and intermediate range nuclear channels.

Procedures were prepared to specify the sequence of tests and measurements to be conducted and the conditions under which each was to be performed to ensure both safety of operation and the relevancy and consistency of the results obtained. If any significant deviations from design predictions existed, unacceptable behavior had been revealed, or apparent anomalies developed, the testing could have been suspended and the situation reviewed by the PORC, with technical assistance as required to determine whether a question of safety was involved, prior to resumption of testing.

14.1.3.2.3 Power Level Escalation

When the plant operating characteristics were verified by low power testing, a program of power level escalation brought the unit to its full rated power level. Operational characteristics were closely examined at each stage and the conformance with the safeguards analysis verified before escalation to the next programmed level.

Measurements were taken to determine the relative power distribution in the core as a function of power level and control rod assembly group position.

Secondary system heat balances were performed to ensure that the indications of power level were consistent and to provide a basis for calibration of the power range nuclear channels. The ability of the reactor coolant system to respond effectively to signals from primary and secondary instrumentation under a variety of conditions encountered in normal operations was verified.

At prescribed power levels, the dynamic response characteristics of the reactor coolant and steam systems were evaluated. The responses of the systems were measured for design step load changes of 10 percent, rapid 50 percent load reductions, and plant trips.

Adequacy of radiation shielding was verified by gamma and neutron radiation surveys at selected points inside the containment and throughout the station site at various power levels. Periodic sampling was performed to verify the chemical and radiochemical analysis of the primary coolant.

The sequence of testing following core loading was used as a basis for planning and scheduling tests. The existing plant condition and status of plant systems and components were the primary factors in determining which tests and operations could be performed at a given time. The schedule was modified to meet the particular needs and conditions at the time, but in no event was a test or operation undertaken without satisfying the prerequisites for that test or operation.

14.1.3.2.4 Special Test Program

In response to the requirements of NUREG 0694, dated June 1980, entitled "TMI-Related Requirements for New Operating Licenses," Section I.G.1, Training During Low Power Testing, APC has reviewed the special low power testing requirements of NRC for FNP Unit 2. Following are the tests which have been considered in this review:

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a. The modified startup physics test program for Unit 2 is described in an APC letter to the NRC dated July 7, 1980.

Test No.	*Description*
1	*Natural circulation demonstration*
2	*Natural circulation with simulated loss of offsite power*
3	*Natural circulation with loss of pressurizer heaters*
4	*Effect of steam generator secondary side isolation on natural circulation*
5	*Natural circulation at reduced pressure*
6	*Cooldown capability of the chemical and volume control system*
7	*Simulated loss of all offsite and onsite ac power*
8	*Establishment of natural circulation from stagnant conditions*
9a	*Forced circulation cooldown*
9b	*Boron mixing and cooldown with natural circulation*

Alabama Power Company performed tests 1 through 7 and 9a prior to exceeding 5 percent of rated thermal power. Several of these tests could be combined in a manner similar to that performed at the North Anna facility. In lieu of performing test 9b, credit was taken for test results at other operating plants that were directly applicable to FNP. In lieu of performing test 8, training was provided for FNP operators via a simulator that has been updated as necessary using the Westinghouse and Tennessee Valley Authority test data from Sequoyah.

14.1.4 ADMINISTRATIVE PROCEDURES (SYSTEM OPERATION)

Whenever possible, test procedures incorporate the use of plant operating procedures to demonstrate the adequacy and feasibility of normal and emergency operating procedures. Test procedures incorporate only plant operating procedures that have been prepared and approved in accordance with subsection 13.4.2.

When a plant operating procedure is included in a test procedure, the plant operating procedure becomes a part of the test procedure and is conducted as part of the test procedure described in subsection 14.1.1.1.

Should modification of a plant operating procedure that is part of a test procedure be found to be required during the conduct of the test, the required modification will be accomplished as described in subsection 13.4.2. After the test is completed and accepted, the plant operating procedure will be changed, if required, for plant operation in accordance with subsection 13.4.2.]

[HISTORICAL]
[TABLE 14.1-1 (SHEET 1 OF 9)

STARTUP TESTS

Test/Measurement	Prerequisite	Test Objective (1) Test Summary (2)	Acceptance Criteria
Low Power Tests			
Radiation surveys	Reactor is critical at various power levels from 0 to 100 percent, as specified by detailed procedures. Personnel monitoring and survey instruments test completed.	1. Measure radiation dose levels at selected points throughout the plant to verify shielding effectiveness. 2. At specified reactor power levels, detailed radiation surveys are conducted at selected points throughout the plant.	Measured radiation levels are within the within the limits of 10 CFR 20 for the zone designation of each area surveyed.
Calibration of nuclear instruments with power and determination of overlap (at low power and during power ascension as applicable)	Reactor is critical at the power level specified in the detailed procedure. Necessary test equipment is installed for secondary heat balance measurements.	1. Obtain nuclear instrumentation system channel overlap data; calibrate the power range channels to reflect actual power levels; obtain temperature data for overtemperature and overpower ΔT trip setpoints. 2. At specified low power level and selected levels during escalation, the following are determined/performed: a. Power range detector currents vs power level. b. Secondary heat balance and adjustment of power range channel gain. c. Hot and cold leg RTD readings and ΔT amplifier output. d. Source, intermediate, and power range channel outputs to establish channel overlaps.	Power range channels display linear output over normal operating range. Power range channels accurately reflect heat balance data. ΔT setpoint adjustments entered in accordance with test procedure. Consistent overlap data obtained on power level changes through the source, intermediate, and power ranges

TABLE 14.1-1 (SHEET 2 OF 9)

Test/Measurement	Prerequisite	Test Objective (1) Test Summary (2)	Acceptance Criteria
Effluent radiation monitors	Reactor has been at power for a time sufficient to produce representative effluents. Effluent monitors have been checked against known sources.	1. Verify the performance of the effluent monitors under actual plant discharge operations. 2. Following standard discharge procedures, discharge commences and the response of effluent monitors are observed. Effluents are sampled and monitor performance verified by radio-chemical analysis. This is repeated at selected power levels.	Installed effluent monitors perform in accordance with design standards and properly indicate the radioactive content of the effluent.
Physics measurements	Reactor plant is in hot zero power condition.	1. Perform reactor physics measurement as outlined below to verify that characteristics of the core, coolant, and physics parameters are as expected and that co-efficients of reactivity are as assumed in the safety analysis.	Plant characteristics and coefficients of reactivity are consistent with the safety analysis.
a. Moderator temperature reactivity coefficient		2a. At normal no-load temperature and no nuclear heating, reactor coolant system cooldown and heatup are accomplished using the steam dump and reactor coolant pumps operation as required. An approximate 5°F change in temperature is initiated, and during these changes T_{avg} and reactivity are recorded on an X-Y recorder. The temperature co-efficient is determined from these data.	a. Isothermal temperature coefficient is negative under all conditions of critical operation.

TABLE 14.1-1 (SHEET 3 OF 9)

Test/Measurement	Prerequisite	Test Objective (1) Test Summary (2)	Acceptance Criteria
b. Control rod reactivity worths		2b. Under zero power conditions at near operating temperature and pressure, the nuclear design predictions for rod cluster control assembly (RCCA) groups differential worths are validated. These validations are made from boron concentration sampling data, RCCA group positions, and recorder traces of reactivity. From these data, the integral RCCA group worths are determined. The minimum boron concentration for maintaining the reactor shutdown with the most reactive RCCA stuck in the full-out position is determined. The determination is made from analysis of boron concentration and RCCA worths.	b. Control rod reactivity worths meet FSAR design requirements for shutdown considerations; minimum shutdown boron concentration is within the limits of the safety analysis.
c. Boron reactivity worth measurement		2c. Differential boron worth measurements are made by monotonically increasing or decreasing reactor coolant boron concentration. Compensation for the reactivity effect of the boron concentration change is made by withdrawing or inserting respective control rods to maintain a moderator average temperature and power level constant and by observing the resultant accumulated change in core reactivity corresponding to these successive rod movements.	c. Measured boron worths are consistent with the trend of design values.
d. Determination of boron concentration of initial criticality and reactivity allocation		2d. All-rods-out boron concentration is determined as part of the approach to initial criticality, in that criticality is achieved by boron dilution with all but the controlling group of rods fully withdrawn. The amount of reactivity of the controlling group is then subsequently determined by withdrawal of the group, noting the amount of reactivity inserted, and converting this value to an equivalent amount of boron.	d. Critical boron concentration measurements are within the limits specified in the approved test procedure.

TABLE 14.1-1 (SHEET 4 OF 9)

Test/Measurement	Prerequisite	Test Objective (1) Test Summary (2)	Acceptance Criteria
e. Flux distribution measurements with normal rod patterns		2e. Incore movable detector system is used to map flux distribution for normal rod patterns	e. Analysis of flux distribution measurements yields hot channel factors less than or equal to design safety limits
f. Pseudo rod ejection test to verify safety analysis		2f. Incore measurements are made under pseudo ejected rod conditions simulating the zero power accident to determine the hot channel factors and verify that they are within assumptions made in the accident analysis.	f. Analysis of flux distribution measurements yields hot channel factors less than or equal to design safety limits.
Chemical tests to demonstrate ability to control water quality	At hot zero power conditions and during power escalation.	1. At hot zero power conditions and during power escalation, perform sampling and analysis to verify that plant chemistry is within specifications. 2. Demonstrations of adjustment of plant chemistry are performed as required.	Reactor plant chemistry is controlled within the limits of the plant chemistry specifications.
Power Ascension Tests			
Power reactivity coefficient evaluation and power defects measurements (approximately 30, 50, 75, and 100 percent)	Reactor is critical at various power levels from0 to 100 percent as specified	1. Determine the differential power coefficient of reactivity and the integral power defect.	Differential power coefficient is equal to or more conservative than the power coefficient assumed in the safety analysis.
	Necessary test equipment is installed for secondary heat balance measurements.	2. During each power escalation, recorder traces are made of reactor power vs reactivity changes; at selected power levels, plant systems are stabilized and secondary heat balances obtained to determine core power accurately; power coefficient and power defect are calculated from data obtained over the range from hot zero power to full power.	Measured power defect is compatible with shutdown margin calculations.

TABLE 14.1-1 (SHEET 5 OF 9)

Test/Measurement	Prerequisite	Test Objective (1) Test Summary (2)	Acceptance Criteria
Manual and automatic plant load changes (approximately 35, 50, 75, and 100 percent)	*Reactor is critical at various power levels from 0 to 100 percent as specified.*	*1. Verify plant response to load change conditions.* *2. Plant response to the following load changes is demonstrated:* *a. Step load change of ± 10 percent from Approximately 35, 75, and 100 percent power.* *b. Load reductions of 50 percent.* *c. Plant trips from power levels as specified in the approved test procedure.* *During the performance of these tests, recordings are analyzed for control systems behavior and requirements for realignment. At approximately 15 to 30 percent power, the automatic control systems are checked by simulating controlling parameters with a test signal, observing controller response and programmed step changes in the control parameter, switching to automatic, and observing the ability of the parameter to achieve the net setting without appreciable over-shoot or oscillation. During the transient tests, these systems are operationally checked under actual design load changing conditions.*	*Acceptance criteria, such as the plant not tripping(where applicable), relief and safety valves not lifting, and steam dump operating correctly, are identified in the individual procedures.* *Basic acceptance criteria are the proper response of individual systems and integrated plant response to each load change operation as described in the various sections of the FSAR.*
Evaluations of core performance (30, 50,75, and 100 percent)	*Reactor is critical at various power levels from 0 to 100 percent as specified.*	*1. Verify the core performance margins are within design predictions.* *2. At steady state power points, incore data are obtained and analysis performed to verify that the core performance margins are within design predictions for expected normal and abnormal rod configurations.*	*Core performance margins are within design predictions* *Nuclear and temperature instrumentation is responsive to reactor conditions, both changing and steady state.*

TABLE 14.1-1 (SHEET 6 OF 9)

Test/Measurement	Prerequisite	Test Objective (1) Test Summary (2)	Acceptance Criteria
		The data/measurements to be taken include: a. Power range detector currents vs power level. b. Secondary heat balance and adjustment of power range channel gain. c. RTD values and ΔT amplifier outputs. d. Excore detector signal voltages vs currents e. Overlap data for power and intermediate ranges. f. Data for calibration of steam and feedwater flow instruments.	
Turbine trip	Reactor plant at power level as specified in the approved test procedure.	1. Demonstrate capability of the automatic control systems and secondary plant to sustain a plant trip from power and achieve stable shutdown conditions; determine overall response time of reactor coolant system hot leg RTDs. 2. At steady state power level as specified in the approved test procedure and with all control systems in automatic mode, the turbine is manually tripped. Plant parameters are recorded on high speed recorders.	Pressurizer and steam generator safety valves do not rise. Safety injection is not initiated. RTD response time no greater than design specifications. Neutron flux must drop to15 percent within specified time. All full length control rods must drop. Controlled temperature reduction to no load.

TABLE 14.1-1 (SHEET 7 OF 9)

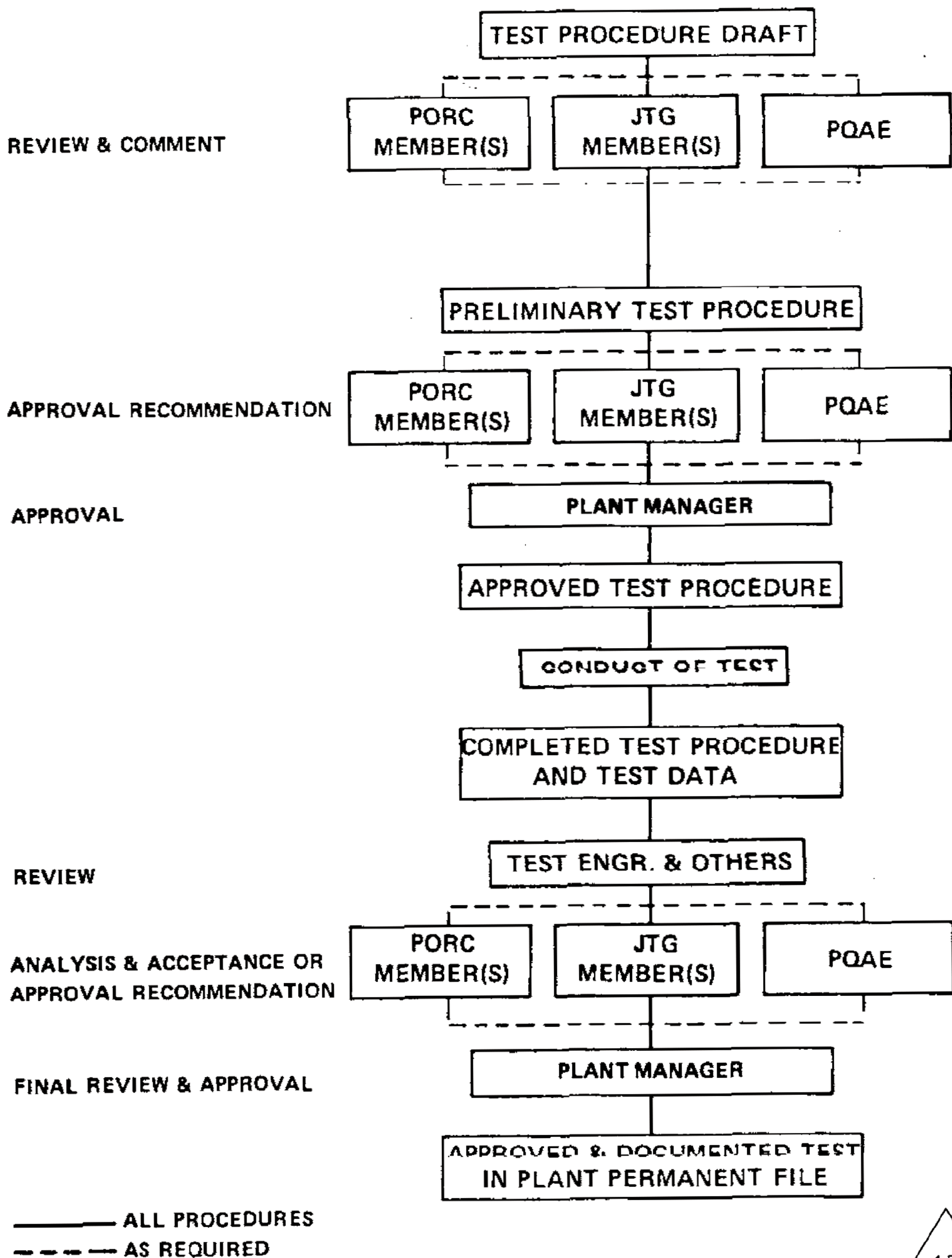
Test/Measurement	*Prerequisite*	*Test Objective (1)* *Test Summary (2)*	*Acceptance Criteria*
Incore/excore detector calibration	*Reactor plant critical at approximately 75 percent.*	*1. Establish relationships between incore and excore generated axial offsets and determine F (ΔI) setpoints.* *2. Data for power distribution measurements are obtained using incore movable detector system and thermocouples* *Additional data for generation of F (ΔI) setpoints are obtained.*	*Calibrated excore axial offset agrees with incore axial offset to within the values specified in the approved test procedure.*
Static RCCA drop and RCCA below-bank position measurements	*Reactor plant critical at approximately 50 percent.*	*1. Obtain worth of the most reactive below-bank RCCA; demonstrate excore and incore instrumentation response to a unit RCCA moving below bank; determine hot channel factors as a function of RCCA position.* *2. Unit RCCA worths are determined by RCCA movement in response to boron dilution.* *During RCCA insertion, the following data are recorded: excore detector currents, thermo-couple maps, and movable detector traces. This allows the computation of hot channel factors, core tilt, and excore sensitivity as a function of RCCA position.*	*Hot channel factors are within design safety limits when the unit RCCA is completely misaligned.* *The excore and/or incore instrumentation will detect a misaligned RCCA when the misalignment causes a significant power maldistribution.* *Misalignment within the limits of resolution of the rod position indicators will not cause a significant power maldistribution.*
Pseudo rod ejection and RCCA above-bank position measurement	*Reactor critical with plant at approximately 30 percent power.*	*1. Verify ejected rod worth and hot channel factors assumed in the accident analysis; demonstrate instrumentation response to an RCCA above-bank position and to an ejected rod.* *2. Unit RCCA worths are determined by RCCA movement in response to a continuous boration.*	*Flux tilt settings are made such that hot channel factors and power distributions assumed in the safety analysis will not be exceeded by a single RCCA out of bank.*

TABLE 14.1-1 (SHEET 8 OF 9)

Test/Measurement	*Prerequisite*	*Test Objective (1)* *Test Summary (2)*	*Acceptance Criteria*
		During RCCA withdrawal, the following data are recorded: excore detector currents, thermocouple maps, and movable detector traces. This allows the computation of hot channel factors, flux tilt, and excore sensitivity as a function of RCCA position.	
Loss of offsite power	*Reactor plant at power level specified in the approved test procedure.*	*1. Verify that, upon a loss of offsite power, the plant can be maintained in a safe hot shutdown condition.*	*Turbine and reactor trips function as described in the FSAR.*
		2. While operating at power, the 4160-V busses F, G, H, J, K, and L are isolated from the unit and auxiliary startup transformers. This test may be conducted one train at a time.	*Emergency power systems function as described in the FSAR.* *Plant is maintained in a safe hot shutdown condition in accordance with plant emergency procedures.*
Shutdown from outside control room	*Reactor plant at power level specified in the approved test procedure.*	*1. Demonstrate the capability of shutting down the reactor plant and maintaining a hot shutdown condition from outside the control room.*	*Capability to shutdown the reactor plant from outside the control room is demonstrated from an initial condition of power operation.*
		2. While operating at a power level greater than 10 percent MWe, the reactor is tripped and hot shutdown is maintained from the hot shutdown panel in accordance with approved procedures.	
Generator trip	*Reactor plant at power level as specified in the approved test procedure.*	*1. Demonstrate capability of the primary and secondary plant to sustain a loss of external load and to bring the plant to stable conditions following the transient.*	*Safety injection does not occur.*

TABLE 14.1-1 (SHEET 9 OF 9)

Test/Measurement	Prerequisite	Test Objective (1) Test Summary (2)	Acceptance Criteria
		2. At steady state power level as specified in the approved test procedure and with all control systems in automatic mode, the generator breaker is tripped. Plant parameters are recorded on high speed recorders.]	



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$$[HISTORICAL]$$

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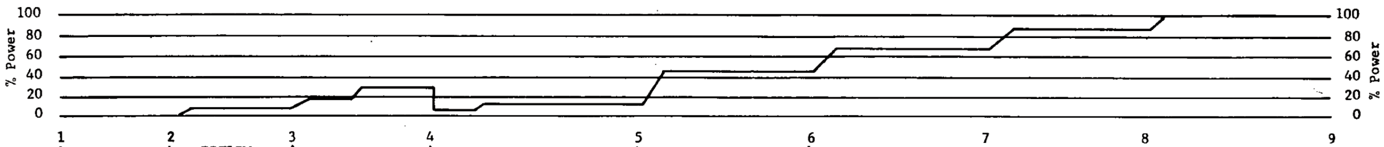
[TEST PROCEDURE DEVELOPMENT, TEST EXECUTION, DATA EVALUATION, AND DOCUMENTATION

FIGURE 14.1-1]



INITIAL CRITICALITY	PRELIM. ZERO POWER	ESCALATION TO 30%	ZERO POWER TESTS	ESCALATION TO 50%	ESCALATION TO 75%	ESCALATION TO 90%	ESCALATION TO 100%
Initial Criticality Chemical Test	Determination of Boron Concentration at Initial Criticality	Radiation Surveys NIS Power Range Calibration & Overlap Data Automatic Control Systems (Checkout STM. Generator, Reactor Control Turbine) Effluent & Effluent Monitoring System	Moderator Temperature Reactivity Coefficient Control Reactivity Rod Worth Boron Reactivity Worth Measurement Flux Distribution Measurements with Normal Rod Patterns Pseudo Rod Ejection Test	Chemical Analysis NIS Power Range Calibration Flux Distribution Measurements with Normal Rod Pattern Power Reactivity Coefficient Eval. & Power Defects Pseudo Rod Ejection Test Evaluation of Core Performance Radiation Surveys & Shielding Effectiveness Effluent & Effluent Monitoring System Plant Response to ± 10% Loadswing	Radiation Surveys NIS Power Range Calibration Flux Distribution Measurements with Normal Rod Pattern Power Reactivity Coefficient Eval. & Power Defects Plant Response to ± 10% Loadswing Evaluation of Core Performance Effluent & Effluent Monitoring System Part Length Rod Insertion/Withdrawal to Control Xenon Transient Chemical Analysis	NIS Power Range Calibration Power Reactivity Coefficient Eval. & Power Defects	Radiation Survey NIS Power Range Calibration Flux Distribution Measurements With Normal Rod Pattern Rod Reactivity Coefficient Eval. & Power Defects ± 10% Load Swing 50% Load Reduction Evaluation of Core Performance Effluent & Effluent Monitoring System Chemical Analysis

Loss of offsite power, shutdown from outside the control room, plant response to 50 percent load reduction, and turbine trip will be conducted at power levels as specified in the approved test procedures.

$$[HISTORICAL]$$

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JOSEPH M. FARLEY
NUCLEAR PLANT
UNIT 1 AND UNIT 2

[STARTUP TEST SEQUENCE

FIGURE 14.1-2]

[HISTORICAL] [14.2 AUGMENTATION OF APPLICANT'S STAFF FOR INITIAL TESTS AND OPERATION

During the period of initial testing and operation of Farley Nuclear Plant Units 1 and 2, Alabama Power Company's plan to use a separate startup staff, under the direction of the plant manager, was unique in that the plant operating staff served as an augmenting organization rather than being the primary organization. In addition to the plant operating staff, the startup staff was augmented by technical specialists furnished by Westinghouse Electric Corporation, Bechtel Power Corporation, and other contractors and vendors as required. Also, technical assistance was available from Southern Company Services, Inc., Alabama Power Company's Production and Engineering Departments, and competent technical personnel from other company facilities as needed.]