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14.0 INITIAL TEST PROGRAM

14.1 SPECIFIC INFORMATION TO BE INCLUDED IN PRELIMINARY SAFETY ANALYSIS REPORTS

This section is not applicable to the Dresden Station UFSAR.

14.2 SPECIFIC INFORMATION TO BE INCLUDED IN FINAL SAFETY ANALYSIS REPORTS

The material in this section deals with the initial startup of the units. As of the date of commercial operation, given in Chapter 1, this material has had only historical value and has not been updated. The material reflects plant conditions at the time it was written and it has been left in the future tense.

14.2.1 Summary of Test Program and Objectives

14.2.1.1 Preoperational Startup Program

An extensive preoperational test program is planned for the reactor unit being started. This program will start approximately 6 months before initial fuel loading. The actual duration of each test is short relative to the entire 6-month program; the longest test, the control rod drive system checkout, takes approximately 1 month. The multiplicity and the sequencing of the preoperational tests dictate the length of the preoperational program.

Key systems are sequenced for completion and testing early enough to provide auxiliary services for testing and operation of other systems or for construction activities; e.g., the use of the makeup system for chemical cleaning. This results in an early requirement for electrical systems, demineralized water makeup, and cooling water systems.

After fuel is loaded in the reactor, all interconnected auxiliary systems are treated as potentially radioactive; in time many of these systems will become sufficiently radioactive to impose restrictions and time limitations on maintenance work. Because of access limitations during normal plant operation, all of the nuclear steam supply auxiliary systems are normally tested before fuel loading.

The preoperational test period is an important phase in the training of CECo operators. Experience and understanding of plant systems and components is gained with a minimum of risk to the equipment or personnel. No restrictions are imposed on either the operators or the testing, except those required by interconnections with the other units on the site. This gives maximum opportunity to evaluate and train individual operators and to troubleshoot plant systems. In addition, plant equipment and systems are operated for a sufficient period of time to discover and correct any design, manufacturing, or installation errors.

14.2.1.2 Startup and Power Test Program

The startup and power test program is performed to assure that the plant is capable of operating safely and satisfactorily. Systems and components, which cannot be fully checked out in the preoperational test phase, are tested at power to confirm reactor parameters and characteristics determined by an extensive program of analysis and tests executed prior to initial fuel loading. The nuclear characteristics of fuel, control rods, and control curtains are calculated with methods which are continuously compared with results of experiments in the GE Vallecitos Atomic Laboratory's critical facilities, including measurements of similar or identical components. In addition, startup tests and operating data from other BWRs in commercial operation and other measurements throughout the nuclear industry are used to confirm the applicability of the analytical methods.

The tests listed in Sections 14.2.4.2.1, 14.2.4.2.2, and 14.2.4.2.3 will be conducted on Unit 2 and the results will be considered in preparing the specific tests to be performed on Unit 3.

Tests which are unnecessary for Unit 3 are as follows: 14.2.4.2.1.G, Control Rod Sequence; 14.2.4.2.3.S, Calibration of Rods; 14.2.4.2.3.U, Rod Pattern Exchange; and 14.2.4.2.2.K and 14.2.4.2.3.V, Steam Separator-Dryer Measurements. Tests which will be modified, depending on the Unit 2 results, to collect a limited amount of data are as follows: 14.2.4.2.1.C, Radiation Measurements; 14.2.4.2.1.D, Vibration Measurements; 14.2.4.2.1.H, Source Range Monitor (SRM) Performance; 14.2.4.2.3.H, Recirculation Jet Pumps; and 14.2.4.2.3.T, Axial Power Distribution.

The startup procedures will be written with individual detailed subsections.

14.2.2 Organization and Staffing

Consistent with its role as prime contractor for Dresden, GE will coordinate and be responsible for the preoperational and startup testing programs. GE will specify, after consultation with CECo, the testing required to verify plant design and the techniques to be utilized in carrying out the requirements of the test procedures.

Appropriate records of manufacturing, construction and preoperational tests will be maintained for later reference or use in the plant operation, inspection, and maintenance. CECo will provide a staff of operating personnel to operate the Unit 2 plant beginning with operation of any permanent plant equipment under the technical direction of GE supervisory personnel. Starting with the loading of fuel into the reactor, and until turnover and acceptance of Unit 2 by CECo, AEC-licensed GE supervisory personnel will provide technical direction for AEC-licensed CECo operators through and in cooperation with AEC-licensed CECo supervisors and management.

Resumes for CECo and GE startup personnel are provided in Appendix 14A.

14.2.2.1 GE Organization and Responsibilities

During the preoperational test period, there will be a gradual transition from construction to testing and operational activities. The GE startup organization will become similar in structure to the CECo operating organization at their upper three levels. Organization charts for GE and CECo are shown in Figure 14.2-1.

14.2.2.1.1 GE Operations Manager

The GE Operations Manager has overall responsibility for the execution and completion of the testing and startup program from the beginning of preoperational testing through acceptance of the unit by CECo. He is responsible for development of the plans, procedures, and functional staff required for the safe and expeditious conduct of the test program; review of construction test records and concurrence with completion of construction testing responsibilities; integration of preoperational testing with construction completion; review and approval of all test procedures and issuance of supplementary procedures; and review and approval of test results.

He is responsible for GE's operation of the unit throughout the test, startup, and acceptance programs.

14.2.2.1.2 GE Operations Superintendent

The GE Operations Superintendent is responsible for the day-to-day operation of the plant. He is responsible for detailed planning and scheduling of tests and other operational activities in cooperation with CECo. He is expected to have complete knowledge of all work in progress and the status of the plant at all times. He reports on operating problems to the GE Operations Manager and CECo and initiates corrective action as required. He is responsible for the preparation and updating of all operating procedures (normal and abnormal) for CECo review and approval and for issuance of such procedures to the appropriate CECo personnel. He directs the activities of and issues instructions to the GE reactor operations engineers to implement the preceding functions.

When the Operations Manager is absent, the Operations Superintendent acts for him.

14.2.2.1.3 GE Operational Test Engineer

The GE Operational Test Engineer is responsible for the technical content and planning in the test program.

His specific responsibilities include:

A. Review of all preoperational test procedures and supervision of other engineers in this function;

B. Preparation of preoperational test supplementary procedures for special procedures as may be required;

C. Coordination of the efforts of the test directors in verifying that all prerequisites have been accomplished, that test equipment is at hand, and that all preparations are completed for starting a preoperational test;

D. Coordination of the efforts of the test directors (vendor representatives, shift supervisors, and other GE engineers) where they function as test directors during preoperational testing;

E. Coordination of the work of GE Atomic Power Equipment Department (APED) design engineers and specialists where they are assigned to assist in obtaining preoperational test data;

F. Evaluation of test results and data (or obtaining additional evaluation or assistance from GE, Sargent & Lundy [S&L], or from vendors as required) and specifying additional testing or recommending approval of test results to the Operational Manager or his delegate; and

G. Maintenance of adequate records of field repairs and modifications.

14.2.2.1.4 GE Unit 2/3 Shift Supervisor

When around-the-clock shift coverage is started by GE personnel, the assigned GE Shift Supervisor will be responsible for technical direction of all activities relating to Unit 2 plant operation and safety on his shift. No work or activity on any Unit 2 system will be conducted without the express approval of the assigned GE Shift Supervisor. From the initiation of fuel loading, no work on Unit 2/3 interface systems will be conducted without the approval of the assigned GE Shift Supervisor. The Shift Supervisor is to provide technical direction on all Unit 2 and Unit 2/3 activities on his shift through his CECo counterpart. As a general principle, he will not give instructions directly to CECo operators, but he is expected to do so if warranted by the circumstances.

His duties and responsibilities include:

A. Knowledge of the Unit 2 and Unit 2/3 work in progress and the status of systems and equipment;

B. Control of access to all Unit 2 restricted areas of the plant;

C. Approval of any work or activities in Units 2 and 3 relating to Unit 2 plant operation or safety;

D. Provision of technical direction and monitoring of all activities relating to Unit 2 plant operation and certain construction and maintenance activities, as well as those activities directly related to Unit 2 testing;

E. Maintenance of appropriate records of the Unit 2/3 activities during his shift;

F. Execution of the properly approved preoperational test procedures and service as test director if required; and

G. Operation of the Unit 2 plant during his shift, including Unit 2/3 interface systems and equipment.

14.2.2.1.5 GE Principal Test Design and Analysis Engineer

The Principal Test Design and Analysis Engineer is responsible for planning and detailing the startup test program, beginning with fuel loading including coordination and supervision of startup test preparation, and obtaining final approvals of the procedures. He is responsible for the technical direction of all test engineers assigned to him. He is responsible for compiling and evaluating test data, specifying further testing, and recommending approval of test results to the Operations Manager and CECo.

14.2.2.1.6 GE Test Directors

Each preoperational test will have a test director assigned to be responsible for the satisfactory performance of that test. The test director will be knowledgeable in the necessary details of the system to be tested and in the proposed test procedure. He will review the results of construction tests with CECo to assure that the prerequisites for a given preoperational test or portion thereof are satisfied before commencing the test. He shall keep the Operational Test Engineer advised as to the status of the system(s) assigned to him.

In conducting a preoperational test, he will work through the GE Shift Supervisor (if he himself is not the GE Shift Supervisor), who will arrange for the assignment of the operational personnel who will actually perform the testing with technical direction from GE. CECo technical staff personnel will witness and record data for evaluation of all steps of the procedure.

The following are examples of test directors' possible assignments:

A. An installation and service engineering (I&SE) or large steam turbine generator (LSTG) representative as test director for the turbine generator and auxiliaries;

B. A person from Nuclear Instrument Department (NID) as test director for NID systems;

C. An I&SE electrical test engineer as test director on electrical systems;

D. A GE equipment representative as test director for the process computer; or

E. GE engineers as test directors for most other systems.

14.2.2.1.7 Technical Support Personnel

GE will supply technical support personnel for consultation in specialized areas of plant operation and testing. They will be technically responsible to the Principal Test Design and Analysis Engineer but will report directly to the GE Shift Supervisor during testing or operational activities related to their specialty. Technical support positions are described in the following subsections.

14.2.2.1.7.1 GE Shift Test Engineer

A GE Shift Test Engineer will be assigned to each shift commencing with fuel loading. He will analyze test results and advise the GE Shift Supervisor of their adequacy; if in doubt, he will refer such evaluation to the Principal Test Design and Analysis Engineer or to the appropriate consultants.

14.2.2.1.7.2 Other GE Personnel

Other specialized support personnel will be provided by GE to be utilized for special tests or unusual problems. Examples of areas where such people will probably be employed are as follows:

A. Vibration measurements of reactor pressure vessel internals;

B. Reactor core thermal hydraulics;

C. Jet pump hydraulics;

D. Radiochemistry;

E. Plant dynamics and control;

F. Steam separator dryer performance;

G. Warranty measurements for electrical output and heat rate; and

H. Nuclear and conventional instrumentation.

14.2.2.2 CECo Organization and Responsibilities

CECo, as owner of the plant, has the responsibility of coordinating all station (Units 1, 2, and 3) activities with all regulatory and other organizations and has overall responsibility for the safe and efficient conduct of operation. CECo will collaborate with GE in the startup program up to plant turnover in order to accomplish stated objectives in a safe manner. CECo has the direct responsibility of station operation and the conduct of operating personnel.

The station organization will function for the Unit 2/3 plant as nearly as possible to that now in effect for the Unit 1 plant and will merely be an extension of those functions to the new plant, with additional provisions as noted below. It is expected that CECo maintenance personnel will perform normal routine maintenance on equipment after acceptance by CECo at the end of the preoperational test. This is not intended to apply to corrections of contractor or vendor efficiency prior to the expiration of warranty agreements. Major repair to correction work will be accomplished by returning the equipment to GE.

Appropriate records will be kept of equipment maintenance and operating history. CECo will provide radiation protection services including appropriate records as required for personnel involved in the startup of the plant.

CECo will assist GE in obtaining data required for the startup programs. CECo will follow closely the conduct of the startup tests in order to benefit from the knowledge and experience gained during the tests. CECo will review the test data, analyses, and reports made by GE during the startup test program and will make evaluations and reports as required by regulatory agencies and good power plant practice.

14.2.2.2.1 Startup Organization Chart

The organization chart for Dresden Station personnel shown in the SAR Figure 13.1-2 has been expanded, as shown in Figure 14.2-1, to show the specific areas of responsibility for the startup test in operation. Positions held by personnel of the GE startup organization are also shown in connection with the CECo personnel with whom close liaison will be maintained.

CECo has assigned an Assistant Station Superintendent (G.L. Redman) and five startup engineers (who will act as shift foremen on Unit 2) to devote full time (i.e., no responsibility for Unit 1) to the startup work activities. Except as noted in the following sentences, the entire organization shown in the Startup Organization Chart Figure 14.2-1, will be available by assignment to assist in the startup work activities. These assignments will not reduce the Unit 1 manning below previously agreed-to levels. One Assistant Station Superintendent (R.H. Holyoak) and Operating Engineer Mechanical (F.S. Morris) will devote full time to Unit 1. The Operating Engineer Electrical (W.P. Worden) will be primarily assigned as Operating Engineer for Unit 2 and secondarily assigned to Unit 1 for electrical operating matters. After Unit 2 turnover to CECo, the operation of Units 1 and 2 will be integrated.

14.2.2.2.2 Role of Licensed Personnel

The plant operation will be conducted by supervisors and operators having appropriate senior reactor operator (SRO) and reactor operator (RO) licenses. After proper approvals from the Station Superintendent and other authorization by regulatory boards, the implementation of startup tests will be by order of the Assistant Superintendent and/or the Operating Engineer Electrical to the Shift Engineer responsible for all station operations on his shift. A Shift Foreman or Startup Engineer will have the responsibility of direct supervision of the work activities of operators assigned to Unit 2 operations in order to accomplish the startup test and operations. The Shift Engineer and Shift Foreman will work closely with the GE Shift Supervisor to accomplish specific operations required for the startup test.

The licensed Fuel Handling Foreman will have the direct responsibility of the work being done by the fuel handling crew and will directly supervise the crew's work during fuel loading into the reactor. He will communicate with the Shift Engineer, the Shift Foreman, or a nuclear engineer, one of whom will be in the control room during the fuel loading operations. He will be informed by the Shift Engineer or Shift Foreman of any special conditions existing and special actions required from time to time during conduct of fuel loading operations.

When the fuel handling crew is performing fuel loading, it will be in direct communication with the Nuclear Station Operator (NSO) operating the controls of the reactor.

The center desk NSO will work with the NSO as required and will remain informed of overall plant operations while coordinating operations of the equipment operator and equipment attendants on all units. The equipment operator and center desk NSO will assist a unit NSO when required. Common services for which controls are provided in the control room are normally operated by the center desk NSO.

14.2.3 Preoperational Test Program Schedule

The following key points were considered in developing the sequence and schedule of preoperational tests:

A. Systems are sequenced for early testing and placed in routine operation to provide necessary auxiliary services for other systems. Examples are plant electrical systems, instrument air systems, and makeup water supply systems.

B. Preoperational testing is coordinated with construction to permit fuel loading as early as possible, without compromising nuclear safety or impeding construction work. As a result, fuel loading occurs while construction work is still in progress on noncritical systems and areas.

C. Stricter controls of plant operation and maintenance work will be required following fuel loading. Acceptance testing is performed before fuel loading on all systems which could consequently be exposed to radioactive contamination, to minimize possible contamination problems.

D. Preoperational tests provide an important phase of the CECo operators' training program and are scheduled on key systems to permit maximum participation by all operators prior to AEC licensing examinations.

E. Temporary construction power may be required for initial tests at the beginning of the preoperational test program. However, the use of temporary power and improvised setups is to be avoided due to the possibility of costly errors and inconsistency with the ultimate objective of proving the final installation.

F. Electrical jumpers may be used to facilitate preoperational testing in some instances, but their use shall be minimized and controlled by proper identification of such jumpers and by logbook records. All jumpers shall be removed before fuel loading.

G. When the plant is ready for fuel loading, construction workers will be excluded from the reactor building and drywell, and strict control will be enforced over access to the control room, electrical equipment rooms, access control building, reactor building tunnel, and possibly the radioactive waste treatment building.

H. CECo will operate the plant and equipment (under the technical supervision of GE) during preoperational testing. However, some testing requirements actually precede the CECo responsibility. These will be categorized as construction tests and will be performed by subcontractors, despite the fact that they resemble preoperational tests in that they are defined by formalized procedures and data sheets and require formal reporting and acceptance.

Construction testing is further defined by listing the following examples:

1. Containment final leak rate testing.
2. System hydrostatic tests.
3. Chemical cleaning and flushing.
4. Wiring continuity checks.
5. Megger and high potential tests.
6. Electrical system tests to and including energizing; e.g., checking grounding, checking relays, checking circuit breaker operation and controls, megger tests, checking phasing, high potential measurements, and energizing of buses.
7. Initial adjustment and bumping of motors.
8. Checking control and interlock functions of instruments, relays, and control devices.
9. Calibrating instruments and rechecking or setting initial trip setpoints.
10. Pneumatic testing of instrument and service air systems and blowout of lines.
11. Adjustments such as alignment, greasing, and tightening of bolts.
12. Surveillance of proper equipment operation during preoperational tests, as required. The primary intent of this item is to cover those instances where measurements are required to insure proper operation but are not obtainable until the entire system is operated during preoperational tests. Examples include measuring motor current and voltage; bearing, lubricating oil, cooling water and seal temperatures; vibration; torque; speed; etc. These measurements are primarily of importance for protection of equipment, troubleshooting, or supplementing installed instrumentation.

13. Checking and adjusting relief and safety valves.

14. Complete tests of motor-operated valves including adjusting torque switches and limit switches, checking all interlocks and controls, measuring motor current and operating speed, and checking leak-tightness of stem packing and valve seat during hydrotests.

15. Complete tests of air-operated valves including checking all interlocks and controls, adjusting limit switches, measuring operating speed, checking leak-tightness of stem packing and valve seat during hydrotest, checking leak-tightness of pneumatic operators, and checking for proper operation of controllers, pilot solenoids, etc.

I. Specialized electronic equipment manufactured by GE Nuclear Electronics Business Section (NEBS) and preoperationally tested by representatives of NEBS assisted by CECo personnel.

J. Detailed test procedures will be prepared by GE or S&L, depending upon system design responsibility. These procedures will be specific regarding intent, method, and operating requirements for completing the test and will include detailed blank data sheets to be completed during the test.

K. In general, tests will be performed using permanently installed instrumentation for the required data. Where it has not been possible to run pumps or similar equipment for an extended period of time prior to the system preoperational test, it will be necessary to install the usual test thermometers, vibrameters, stroboscopes, or other test instrumentation to ensure safe operation of the equipment. Special instrumentation will be specified in the preoperational test procedure. Any test requiring artificial simulation of a plant parameter will have the method to be used detailed in the procedure, as well as the means for assuring that the system is returned to normal.

L. Where the unit being tested shares components or systems with a unit either still under construction or in operation, the detailed preoperational test procedure will define the interactions and control procedures necessary to maintain operating continuity, system integrity, and plant safety without compromising test efficiency.

14.2.4 Individual Test Descriptions

14.2.4.1 Summary of Preoperational Test Content and Sequence

14.2.4.1.1 Station Grounding - Construction Tests

Adequate grounding of all major structures and electrical equipment must be demonstrated before the electrical system is energized and routinely operated. This test is performed by construction personnel rather than CECo.

14.2.4.1.2 DC Systems - Construction Tests

The dc systems must be placed into service, as required, to provide auxiliary power to the plant in a safe manner. Other portions of the dc system may be completed as required.

Equipment in the reactor protection system and vital bus power supply will require functional preoperational testing to verify adequacy of design and installation. Other testing in this system will be in the nature of construction tests on wiring and individual components, such as the following:

A. Continuity checks;

B. Megger tests of wiring;

C. Calibration of meters; and

D. Proper operation of controls and interlocks.

These tests will be performed by construction personnel, but data sheets and formal test records are required.

14.2.4.1.3 138-kVac Electrical System - Construction Tests

This system must be operational to provide adequate power for large motors. Preoperational test requirements for this system include the following:

A. Continuity and phasing checks;

B. Megger tests on all control and power wiring;

C. Relay tests and adjustments;

D. Proper operation of transformer cooling and instrumentation;

E. Check circuit breaker operation;

F. High potential tests, if required;

G. Calibration of meters; and

H. Proper operation of all controls;

These tests will be performed by construction personnel, but data sheets and formal test records are required.

14.2.4.1.4 345-kVac Electrical System - Construction Tests

Test requirements are similar to those of Section 14.2.4.1.3. Tests will be performed by construction personnel, but data sheets and formal test records are required.

14.2.4.1.5 4160-Vac Electrical System - Construction Tests

After dc control power is available, 4160-Vac circuit breakers may be functionally tested and the system may be energized.

Test requirements are similar to those of Section 14.2.4.1.3. Tests will be performed by construction personnel, but data sheets and formal test records are required.

14.2.4.1.6 480-Vac Electrical System - Construction Tests

The 480-Vac power centers may now be energized and individual motors started or motor control centers energized as required by the detailed schedule. Extreme caution must be exercised during this period to protect personnel and equipment. Energized equipment must be properly identified and operation controlled by CECo personnel.

Other test requirements are similar to those of Section 14.2.4.1.3. Tests will be performed by construction personnel, but data sheets and formal test records are required.

14.2.4.1.7 220-Vac and 115-Vac Systems - Construction Tests

These systems may be tested and energized as required. Test requirements are similar to those of Section 14.2.4.1.3. Tests will be performed by construction personnel, but data sheets and formal test records are required.

14.2.4.1.8 Makeup Water and Domestic Water Systems

The makeup and domestic water systems should now be placed in service to provide demineralized water for cleaning, flushing, hydrotesting, and initial filling of plant systems.

In testing the systems, all pumps, valves, controls and instruments should be checked individually. The system should then be operated under simulated normal conditions before charging resins and using chemicals. This will reduce the risk of damaging or depleting the resins or using chemicals excessively before the system is in proper adjustment.

14.2.4.1.9 Service Water System

One or two service water pumps will be placed into service to provide cooling for the reactor and turbine building closed cooling water systems. Instrumentation will be calibrated and placed in service. During initial operation of the pumps, they will be monitored for proper meter current, temperatures, and vibration and will be checked to verify delivery of the appropriate flow by using the manufacturer's curves and installed system instrumentation.

14.2.4.1.10 Turbine Building Closed Cooling Water System

This system will be cleaned, flushed, hydrotested, and filled with inhibited water; the relief valves will be checked; the pumps and valves will be tested; and the system will be placed in normal service. Although some equipment serviced by this system will not be installed or piped in at this time, the lines to this equipment will be valved closed and/or capped to permit the system to be placed into operation supplying cooling water for the earliest scheduled preoperational tests. The first requirement is for instrument air compressors and then for various system pumps which will be used during chemical cleaning and flushing.

14.2.4.1.11 Fire Protection System

Prerequisites:

A. Piping complete and hydrotested;

B. Diesel starting batteries charged; and

C. Battery charging and control power available from dc system.

Test summary:

A. Operate diesel-driven fire pumps and check performance;

B. Operate 400-gal/min pond pump; and

C. Check all interlocks, remote controls, and automatic start features.

14.2.4.1.12 Instrument Air and Service Air Systems

These systems are required as early as possible to permit normal operation of valves and instrumentation during performance of other system preoperational tests. Construction and installation should be completed on the central portion of the system first, including air compressors, receivers, dryers, and main headers up to isolation valves. Tests on the compressors and dryers should be completed as soon thereafter as possible, without waiting for all air piping to be installed.

Prerequisites:

A. 480-Vac auxiliary power;

B. 115-Vac or 120-Vdc control power, as required;

C. Cooling water and service water; and

D. Instruments calibrated, interlocks and controls checked, and all other construction tests completed.

Test summary:

A. Check setpoints for compressor control: on, off, standby, start, mechanical unloading, and annunciator alarms;

B. Measure capacity of each compressor; and

C. Check dryer performance.

14.2.4.1.13 Condensate Demineralizer System

This test will cover the demineralizers, regeneration equipment, and recycle pump and associated controls. Piping must be completed from the main inlet to the main outlet valves. Condensate pumps and piping are not required for this test.

Prerequisites:

A. 480-Vac auxiliary power;

B. 115-Vac control and instrumentation power;

C. Condensate transfer water supply;

D. Instrument and service air; and

E. Construction tests completed on piping, valves, instruments, controls, pumps, etc.

Test summary:

A. Check calibration of all instruments;

B. Check operation of all valves;

C. Check all controls for both automatic and remote control;

D. Verify proper operation of recycle pump;

E. Simulate resin transfer from demineralizer to regeneration system (without resin);

F. Simulate all phases of regeneration with actual water and air flow but without resin;

G. Simulate return of resins to demineralizers;

H. Add resins to demineralizers and regenerate, if required (at least one charge should be regenerated even if not required);

I. Simulate, with plain water, transfer of resins from cleanup, fuel pool and radwaste demineralizers and return of resins to the proper demineralizer; and

J. Repeat resin transfer with an actual full charge of resin.

14.2.4.1.14 Plant Heating Boiler

Place the plant heating boiler in service to supply steam for the reactor vessel hydrotest and for subsequent chemical cleaning. Standard acceptance tests will be performed to verify that the boiler capacity and heat rate meet specifications and that all auxiliary equipment and controls are working properly.

14.2.4.1.15 Reactor Building Closed Cooling Water System

This system is required before operation and testing can begin on the variable speed recirculation pump motor-generator (M-G) sets, on the control rod hydraulic pumps, and in the radwaste building, as well as for cooling the process pumps which will be used for chemical cleaning and flushing.

Prerequisites:

A. 480-Vac electrical power;

B. Instrument air (for expansion tank level control); and

C. Main system headers to individual stop valves.

Test summary:

A. After hydrotest and chemical cleaning, fill system with inhibited water;

B. Operate pumps to verify proper performance;

C. Check operation of expansion tank level controls and alarms; and

D. Check all interlocks, alarms, controls and remote indicating devices. Use simulated inputs such as manometers, test pressure signals, and temperature baths where cold system conditions would otherwise restrict the test.

The system will then be operated routinely to provide services for other preoperational tests.

14.2.4.1.16 Reactor Vessel and Primary System Hydrotest - Construction Test

This test should be completed at the earliest possible date to permit installation and testing of control rod drive (CRD) mechanisms and reactor internals.

Prerequisites:

A. Installation of the reactor vessel, all drive and instrument thimbles, and blind flanges.

B. All interconnecting piping installed to the first valve. The shutdown cooling system and emergency cooling systems (which are closed loops) should be completed to permit chemical cleaning concurrently with the primary system.

C. Recirculation piping complete with blank flanges on pump bowls.

D. Source of heating available for raising reactor metal temperatures to approximately 100°F. This will be the permanent steam supply from the plant heating boiler to the shutdown cooling heat exchangers.

E. Reactor vessel filled with demineralized water for the hydrotest.

F. Other interconnected systems should be completed to the first valve, and preferably beyond to include the high pressure portions since the chemical cleaning immediately following reactor hydrotesting requires completed systems.

Test summary:

A. Heat reactor to required temperature using plant heating boiler steam supply to the shutdown cooling heat exchangers and recirculating the reactor water with the shutdown cooling pumps;

B. Hydrotest reactor, isolation condenser system, main steam lines and recirculation loops to 1560 psig;

C. Inspect all field welds to reactor vessel nozzles, piping, and valves included in the limits of this hydrotest.

14.2.4.1.17 Control Rod Hydraulic System

Prerequisites:

A. All piping and wiring installed and connected;

B. System flushed and cleaned per APED Specification 21A5564;

C. Demineralized water available in condensate storage tank;

D. CRD hydraulic supply pumps operational;

E. Instrument air available;

F. 480-Vac, 115-Vac and 120-Vdc available; and

G. Power available through reactor protection system (RPS) circuit to energize scram valves.

Test summary:

A. Calibrate instruments;

B. Check alarms, controls, and interlocks;

C. Obtain pump performance data such as head, flow, suction pressure, bearing and cooling water temperatures, motor current, and speed (see manufacturer's instruction book for special requirements);

(Note: Pump performance data may be obtained earlier when the pumps are used to flush the system under Prerequisite Item B above.)

D. Adjust flow control valves;

E. Check operation of proper valves from appropriate selector switches, interlocks, or trip signals, including:

1. Scram inlet and outlet valves and scram pilot solenoid valves,

2. Backup scram pilot valves,

3. Scram discharge volume dump and vent valves, and

4. Drive selection valves: withdraw, insert, and settle control.

F. After drives are installed, adjust individual flow control valves for proper drive speeds;

G. Monitor and record total system performance data with all drives installed, including:

1. Cooling water flow,

2. Total system flow,

3. Flow returned to reactor,

4. System pressures, and

5. Transient response of system during insert and withdraw operations, or following scram.

14.2.4.1.18 Drywell-Torus Leak Rate Measurement and Isolation Valves

Prerequisites:

A. All isolation valves and connected piping installed and hydrotested from reactor vessel to outside isolation valve;

B. All bellows seals installed;

C. All piping hangers, guides, and anchors installed and set properly (at least those which affect the containment joint);

D. All electrical penetrations installed and wire and cable in at least to the first terminal inside the drywell; and

E. Pressure reference systems installed inside drywell and torus.

Test summary:

A. Measure leakage across the seat (inside the process line) of all isolation valves which open directly into the containment;

B. Leak test all penetrations added since the previous leak test;

C. Leak test electrical penetrations at 24 psig;

D. Strength-test drywell and torus at 62 psig; repeat soap tests; and

E. Measure leak rate of drywell and torus simultaneously at 24 psig.

14.2.4.1.19 Fuel Pool Cooling

Test summary:

A. Calibrate all instrumentation.

B. Check alarms, controls, and interlocks.

C. Fill fuel pool with demineralized water (if thoroughly cleaned mechanically).

D. Recirculate through heat exchangers, bypassing filter and demineralizer.

E. Check operation of filter valves, precoat pumps, and filter aid pumps.

F. Simulate resin sluicing operation to and from demineralizer, using demineralized water only (and air as required).

After satisfactory simulation and when general cleanliness of fuel pool warrants, charge resins and place demineralizer into routine service. Verify system flowrates from pump head-flow characteristic.

G. Check level alarms in fuel pool and skimmer surge tanks against actual changes in level.

14.2.4.1.20 Fuel Handling Equipment

Equipment covered in this category will be tested with dummy fuel or blade guide assemblies through dry run simulations of the required operations. This is not one coordinated test of a system but consists of many separate operations using different pieces of equipment. The equipment is tested on the operating floor, in the fuel storage pool, and both over and in the reactor vessel.

Test summary (not necessarily in chronological order):

A. Tests in the fuel storage pool:

1. Install fuel pool gates and fill pool with water.

2. Check fuel preparation machine with dummy fuel assembly. This will also check auxiliary tools such as channel handling tool and channel bolt wrench.

3. Set up inspection scope and check with dummy fuel assembly.

4. Check fixed lights and moveable underwater lights to assure adequate visibility for fuel and blade handling and transfer operations.

5. Check underwater vacuum cleaner.

6. Operate refueling platform over the fuel storage pool. Check all equipment on the refueling platform. Transfer fuel assemblies and control blades between storage racks with the grapple. Check all grapple controls and interlocks.

7. Use jib crane to transport dummy fuel assemblies from storage racks to fuel preparation machine work areas.

B. Tests over the reactor vessel:

1. Set service platform assembly on vessel flange. Mount jib crane on service platform and use for installing, removing, or shuffling dummy fuel assemblies, control blades, and poison curtains.

2. Raise water level in reactor well and check leak-tightness of vessel to drywell seal and drywell to fuel pool seal. Lower water level and check ability of fuel pool cooling system to drain these seals or associated low points.

3. Verify best procedural methods and tools for the following:

   a. Removal and replacement of steam dryer;

   b. Removal and replacement of steam separator head;

   c. Removal of poison curtains (most expeditious method of placing poison curtains may be adopted since the job need not be done under high radiation exposure rates);

   d. Removal and replacement of fuel support castings and control rod blades;

   e. Removal and replacement of incore local power range monitor (LPRM) strings; and

   f. Removal and replacement of jet pump nozzles and risers.

   All of the above tests should recognize the shielding requirements of doing the job "hot" and should attempt to simulate normal operating conditions.

4. Transfer dummy fuel assemblies and control blades between the fuel storage pool and the reactor vessel, simulating a refueling operation.

5. Check installation and removal of support plugs in the designated peripheral positions.

14.2.4.1.21 Control Rod Drive

Control rod hydraulic system and manual (electrical) control system tests shall be completed before beginning tests of individual CRD mechanisms. All internals must be in the reactor, including guide tubes and thermal sleeves. Install blades and dummy fuel assemblies.

The following tests are required on individual drives:

A. Insertion - continuous and by notch;

B. Withdrawal - continuous and by notch;

C. Stroke timing;

D. Friction measurements;

E. Scram time measurements;

F. Multiple scram time measurements;

G. Check proper position indication and in/out limit lights;

H. Repeat those tests in the CRD hydraulic system and reactor manual control system which are required to verify total system performance;

I. Recheck rod control interlocks; and

J. Test RPS circuit in conjunction with control rod system to verify scram signals and rod withdrawal interlocks from all safety circuit sensors.

There will be no initial testing of the control rod drive housing supports prior to power operation of the plant because:

A. The CRD housing supports are designed according to acceptable structural engineering practices.

B. The CRD housing supports are conservatively designed by using a design impact factor of 3 based on a 1-inch gap between the CRD housing flange and the support structure rather than a reduced impact factor based on a 1/4-inch gap; and by using a reactor pressure vessel design pressure of 1250 psig rather than the operating pressure of 1000 psig for computation of jet force.

C. Quality control inspection is provided to assure that the CRD housing supports are fabricated according to the design.

14.2.4.1.22 Cleanup Demineralizer System

The system may be flushed, cleaned, and initially checked out while the reactor vessel is empty for the installation of drive mechanisms by supplying it with condensate and routing the discharge either to radwaste or to the hotwell. However, the system cannot be completely checked during the preoperational phase because full temperature and pressure conditions are required in the reactor for normal system operation to complete the tests.

Prerequisites:

A. 480-Vac auxiliary power;

B. 4160-Vac auxiliary power;

C. 115-Vac or 120-Vdc control power;

D. Reactor must be available to supply auxiliary cleanup pump suction; and

E. Instrument air.

Test summary:

A. Check operation of auxiliary cleanup pump.

B. Check operation of pressure control station with simulated pressure input signals.

C. Check operation of main cleanup pumps by pumping first to the hotwell or radwaste and then to the reactor. Do not pump to reactor until filters and demineralizer are fully checked out to prevent injecting poor quality water into the reactor.

D. Check operation of filters and all associated equipment. Perform all required operations such as precoating, normal operation, standby recirculation, filter aid addition, and backwashing. Be sure that system is set up so that filter break through will not dump impurities into the reactor (preferably routed to radwaste for initial filter operation).

E. Simulate pumping of sludge to radwaste system (pump non-radioactive sludge water generated during preoperational testing program).

F. Check operation of demineralizer and all associated equipment:

   1. Check transfer to and from condensate demineralizer system - first without, then with resins, and

   2. Check dumping of resins to resin storage tank.

G. Check operation of all valve and pump interlocks by simulated signals to appropriate instrumentation.

H. Check calibration and alarm or trip (interlock) setpoints of all instrumentation.

I. Check operation of surge tank by interrupting flow to main pumps with pressure control valve or isolation valve for a short period of time.

J. After system is proven to be operational in all modes of operation which are possible to demonstrate without pressure or temperature in the reactor, charge resins and place the system in normal service when water is in the reactor during preoperational testing.

14.2.4.1.23 Isolation Condenser System

This system cannot be tested for performance adequacy until the reactor is operated at rated temperature and pressure. However, all components and instruments must be verified to be operating properly during the preoperational period.

Prerequisites:

A. 480-Vac auxiliary power,

B. 115-Vac and 120-Vdc control power, and

C. Condensate transfer system.

Test summary:

A. Check operation of all valves.

B. Verify proper setpoint of reactor pressure instrumentation.

C. Verify automatic actuation of system from test signal pressure simulating high reactor pressure.

D. Drain some water from shell side of condenser and verify proper operation of level alarms and makeup system.

E. Verify availability of backup water supply. (Do not put this low purity water into the condenser.)

F. Verify automatic closure of system isolation valves following a high elbow differential pressure (high steam flow or high condensate return flow) signal.

14.2.4.1.24 Shutdown Cooling System

Test requires water in reactor vessel. System may not be sufficiently complete at the time of reactor vessel hydrotest to do preoperational test, but performance tests on the pumps will be accomplished at that time.

Test summary:

A. Calibrate all instrumentation and check setpoints;

B. Check operation of all motor-operated valves;

C. Check interlocks in valve and pump control circuits;

D. Measure system pressures where possible and determine flowrates from pump characteristic curve;

E. Measure closing time of isolation valves;

F. Add steam to heat exchangers, from plant heating boiler, and raise reactor water temperatures to approximately 180°F; and

G. After the expansion tests outlined in Item F, cool the reactor down again to ambient temperatures. During both of these tests, record temperatures of reactor water, cooling water, and the reactor pressure vessel.

The reactor head cooling system should be tested at the same time (Section 14.2.4.1.26).

14.2.4.1.25 Standby Liquid Control System

All portions of this test, except the actual pumping rate into the reactor (Item E below), may be done at any time regardless of the status of the reactor vessel (full or empty, head on or off).

Test summary:

A. Calibrate instruments and check all setpoints.

B. Fill the main poison tank with demineralized water and operate the poison injection pumps, recirculating to the main poison tank.

C. Check the setpoint of the pump discharge relief valves.

D. Check the control circuits for poison injection valves thoroughly before connecting to the valves. (Use a dummy resistance to stimulate the valve.)

E. Fire the injection valves and measure pumping rates into the reactor. Replace the firing cartridge.

F. Check interlocks with the reactor water cleanup system that ensure isolation when the poison system is actuated.

G. Check operation of poison tank temperature controls and air sparger.

H. Fill the test tank with demineralized water and operate the poison injection pumps in simulated test mode, recirculating to the test tank.

I. After the system has been demonstrated by the foregoing tests, add the required poison to the poison tank. Mix and sample. This should be done very shortly before fuel loading.

14.2.4.1.26 Reactor Head Cooling System

Prerequisites:

Reactor vessel must be available to receive water and head must be installed. This test should be coordinated with the primary system expansion test (Section 14.2.4.1.29).

Test summary:

A. Calibrate instrumentation

1. Reactor vessel high range level indication and

2. Head cooling flow control and indication.

B. Verify capability of head cooling operation with one control rod hydraulic supply pump simultaneous with the use of the other pump for control rod operation or cooling.

14.2.4.1.27 Reactor Vessel Components

These items may be more appropriately covered in other tests:

A. Calibrate and test reactor vessel O-ring leak detection instrumentation;

B. Set reactor vessel stabilizers;

C. Check all reactor vessel thermocouples; and

D. Check stud tensioner operation.

14.2.4.1.28 Reactor Vessel Instrumentation

This test will include reactor temperature detectors; flange leak detection; stabilizer adjustments; and pressure, level, and flow instrumentation not included in the RPS circuit tests.

Test summary:

A. Calibrate all instrumentation;

B. Check response of thermocouples with temperature baths;

C. Check proper installation of reactor vessel stabilizers; and

D. Observe response of thermocouples during reactor heatup for primary system expansion tests (Section 14.2.4.1.29).

14.2.4.1.29 Primary System Expansion

This test is either done as a preoperational test using an auxiliary means of heatup or may be performed during nuclear heatup.

Prerequisites:

A. Reactor vessel head and insulation in place;

B. Shutdown cooling, reactor water cleanup, and recirculation systems operational; and

C. Condensate and feedwater systems available for fill and makeup to the reactor.

Test summary:

A. Heat the reactor vessel and recirculation loops to approximately 200°F by supplying steam to the shutdown cooling heat exchangers. Continue heating to operating temperature using the two variable speed recirculation pumps.

B. Record and monitor reactor vessel, recirculation pump, and water temperatures. Measure system and vessel heating and cooling rates.

C. Monitor reactor vessel stabilizers.

D. Check motion of reactor vessel, recirculation loops, and major piping connected to the vessel.

E. Check all piping hangers and supports for proper setting.

F. Check motion at all drywell bellows penetrations and verify that forces or motion are not excessive.

14.2.4.1.30 Reactor Vessel Safety and Relief Valves

Test summary:

A. Safety valves will be installed as received from the factory, where setpoints were adjusted, verified, and indicated on the valve;

B. Verify proper operation of solenoid/piston-operated valves from main control room;

C. Calibrate reactor pressure sensors and verify proper operation of solenoid/piston-operated valves from test pressure signal to the pressure sensors; and

D. Check operation of vacuum breaker valves on relief valve discharge lines.

14.2.4.1.30.1 Automatic Pressure Relief

The test of the automatic pressure relief subsystem is intended to verify the following:

A. That the automatic pressure relief subsystem will be initiated by simultaneous signals indicating high drywell pressure and low-low reactor water level following a time delay; and

B. That the relief valves will open on indication of high reactor pressure.

Accomplishment of this test will confirm that the automatic pressure relief subsystem will meet the design basis as listed in Chapter 6 of the UFSAR.

Deviations from expected accident conditions:

A. Only one relief valve will be tested at a time to prevent rapid depressurization of the reactor vessel and

B. The test duration will not equal that of accident conditions because of the undesirability of having the reactor vessel rapidly depressurized.

14.2.4.1.31 Reactor Recirculation System

This test will determine recirculation loop (recirculation pumps and jet pumps) characteristics to the degree possible with cold water conditions.

Prerequisites:

A. 4160-Vac electrical,

B. 480-Vac electrical,

C. Reactor hydrotest and chemical cleaning, and

D. Water in the vessel during pump tests.

Test summary:

A. Operate all recirculation loop valves and verify that seat leakage is small enough to permit pump maintenance work;

B. Calibrate loop instrumentation and check controls and interlocks;

C. Operate recirculation pumps and M-G sets at reduced speed;

D. Check flow control transient operation within the range permitted by cold water and atmospheric pressure in reactor; and

E. Using special instrumentation, determine jet pump characteristics under both normal and abnormal conditions.

14.2.4.1.32 Core Spray System

The test of the core spray subsystems is intended to verify the following:

A. That the core spray subsystems will be initiated by either a high drywell pressure signal or a low-low reactor water level and low reactor pressure signal;

B. That the core spray pumps are properly sequenced onto the emergency buses;

C. That the motor-operated admission valves open at the preselected low reactor pressure when core spray initiation signal is present; and

D. That the design flow and pressure requirements are met when water is taken from the suppression chamber and injected into the reactor vessel through the spray nozzles.

Accomplishing the foregoing test will confirm that the core spray subsystems will meet the design bases for the core spray system as listed in Chapter 6.

Prerequisites:

A. Drywell-to-reactor-cavity seal pressure test completed and

B. Reactor vessel available to receive water, with vessel head and shroud head removed for observation.

Test summary:

A. Calibrate all instrumentation.

B. Check alarms, controls, and interlocks including complete verification of automatic system starting controls.

C. Operate pumps by recirculating to the torus in the test mode. Verify pump and system performance from manufacturers head-flow curves and measured system pressures.

D. Check operation of all motor-operated valves.

E. With valves closed and locked out of service, initiate system automatically and verify pump start.

F. With pumps locked out of service, initiate system automatically and verify that valves open. Repeat for system in test configuration.

G. Isolate pump suction from torus and route to receive pump supply directly from condensate storage tank. Spray into reactor vessel. Verify proper flowrate and observe spray pattern. This will also be repeated with suction from torus.

H. Simulate an accident and observe proper sequential operation of system pumps and valves. This test is run concurrently with the containment cooling system automatic operation test (Section 14.2.4.1.34.F) and the diesel generator automatic starting test (Section 14.2.4.1.39.E).

I. Simulate component failures by locking a selected pump out of service and initiating the system. Verify that the simulated failure condition is detached and the redundant pump is automatically started.

Deviations from expected accident conditions:

A. The suppression chamber water temperature will be cool compared with the high temperature following an accident.

B. No containment pressure is present during test.

C. Reactor vessel will have no pressure during test. However, a reactor vessel pressure can be simulated by adjusting discharge valving to provide a system resistance equal to the output pressure of the pumps.

D. The pressure signal for opening the admission valves is not a true reactor pressure signal but rather a simulated pressure signal.

E. The initiation signals will be simulated.

F. The test duration will not equal that of an accident situation, but the test will be of a duration of insure proper operation of all components including verification of pump characteristic curve.

G. Condensate storage tank water will also be injected into the reactor vessel.

14.2.4.1.33 High Pressure Coolant Injection System

The high pressure coolant injection (HPCI) turbine was designed using the most advanced methods of turbine design with particular emphasis being placed on ability of the turbine to:

A. Undergo fast startup from a cold condition, and

B. Sustain operation with a large percentage of moisture carryover in the driving steam.

Following construction of the HPCI turbine, the manufacturer conducted tests on the turbine which are summarized below:

A. Verification of proper hydraulic operation of the turbine control system, i.e., line orificing, pressure ranges, trip and reset capabilities;

B. Turning gear operational checkout;

C. Controlled startup (using 600 psig steam) to full speed in 200 rpm increments, recording vibration conditions;

D. Operation at full speed, no load for 1 hour, verifying satisfactory vibration levels;

E. Setting the low speed and high speed stops on both the motor speed changer and the motor gear unit; and

F. Setting the overspeed trip point and verifying satisfactory oil trip capability.

The test of the HPCI subsystem is intended to verify the following:

A. That the HPCI subsystem will be initiated by either a high drywell pressure signal or a low-low reactor water level signal;

B. That the valves supplying steam to the turbine and water to the reactor open as required to admit HPCI flow into the vessel; and

C. That the design flow requirement is met over the design pressure range when water is pumped from the condensate storage tank or the suppression pool into the reactor vessel.

Accomplishing this test will confirm that the HPCI subsystem will meet the design basis for the HPCI subsystem as listed in Chapter 6.

Criteria:

A. Level 1 - The required starting time from actuating signal to design flow is 25 seconds. The HPCI turbine must not trip off during startup.

B. Level 2 - With pump discharge pressure at 1165 psig, the flow should be at least 5600 gal/min.

Prerequisites:

A. Station heating boiler available to supply steam to the HPCI turbine. The turbine checks will be conducted using steam from the heating boiler. If full rated flow output of the HPCI pumps cannot be achieved using this steam source, it will be verified during the startup test program prior to going to full power on the reactor.

B. Reactor vessel available to receive water through the feedwater piping.

C. Torus filled to normal level with demineralized water.

Test summary:

A. Verify that all instrumentation, alarms, and relief valves have been calibrated and all setpoints are correct;

B. Check all controls and interlocks including a verification of all automatic initiation sequences;

C. Check operation of all motor-operated valves;

D. Check operation of pumps, turbine, and turbine auxiliaries; and

E. Verify flow characteristics for the following flow paths:

   1. Torus to torus using minimum flow line,

   2. Condensate storage tank to condensate storage tank, and

   3. Condensate storage tank to reactor vessel.

Deviations from expected accident conditions:

A. Flow will not be injected into the reactor vessel from the torus. Flow will, however, be directed from the torus back to the torus and from the condensate storage tank to the reactor vessel. This is done to assure that only the highest quality water is injected into the reactor vessel.

B. The initiation signals will be simulated.

C. The test duration will not equal that which could occur in an accident situation, but the test will be of a duration to ensure proper operation of all components.

14.2.4.1.34 <u>Low Pressure Coolant Injection/Containment Cooling System</u>

The test of the low pressure coolant injection (LPCI)/containment spray subsystem is intended to verify the following:

A. That the LPCI subsystem will be initiated by either a high drywell pressure signal or a low-low reactor water level and low reactor pressure signal;

B. That the LPCI pumps are properly sequenced onto the emergency buses;

C. That the break detection logic properly identifies the break if the break should occur in a recirculation loop;

D. That the motor-operated admission valves open at the preselected low reactor pressure when LPCI initiation signal is present;

E. That the design flow and pressure requirements are met when water is taken from the suppression chamber and injected into the reactor vessel through the recirculation loop and jet pumps;

F. That the interlock functions to prevent diversion of LPCI flow to the containment spray until the reactor vessel refills to approximately two-thirds of the core height;

G. That the manual transfer of the LPCI flow to containment spray and suppression chamber spray can be made, and the required flow for containment cooling is obtained;

H. That the containment pressure interlock which prevents the containment spray from opening when the containment pressure is low functions correctly; and

I. That the containment cooling service water system functions as designed.

Accomplishing the foregoing tests will confirm that the LPCI/containment cooling subsystem will meet the design bases for the LPCI/containment cooling subsystem as listed in Chapter 6.

Prerequisites:

A. Torus filled to normal level with demineralized water and

B. Reactor vessel available to receive water through the recirculation piping.

Test summary:

A. Verify that all instrumentation, alarms, and relief valves have been calibrated and all setpoints are correct.

B. Check all controls and interlocks including a verification of all automatic initiation sequences.

C. Check operation of all motor-operated valves.

D. Check operation of all pumps.

E. Verify flow characteristics of both system loops for the following flow paths:

1. Torus to torus using full flow test line,

2. Torus to torus using torus spray line,

3. Condensate storage tank to torus using full flow test line, and

4. Condensate storage tank to reactor vessel.

F. Flow test several containment spray nozzles using a test stand to determine nozzle flowrates.

G. Air test the containment spray header to verify that the nozzles are installed correctly and free from constriction.

H. Check that the DELTA--P control across the containment cooling heat exchangers will maintain the service water pressure greater than the LPCI system pressure.

I. Simulate an accident condition simultaneously with a loss of normal power and verify proper sequential operation of the system. This test should be conducted concurrently with the system tests of the core spray system (Section 14.2.4.1.32) and the emergency diesel (Section 14.2.4.1.39).

Deviations from expected accident conditions:

A. As specified in the test procedure referenced above, condensate storage tank water will be injected into the reactor vessel instead of suppression chamber water. This is done to assure that only the highest quality water is injected into the reactor vessel.

B. The suppression chamber will be at a lower temperature than when an accident occurs.

C. No containment pressure will be present during the test.

D. The reactor vessel will have no pressure during the test, however, a reactor pressure can be simulated by adjusting the discharge valving to obtain a system resistance nearly equal to the maximum pump head.

E. The various signals required to initiate the system, open the admission valves, select the unbroken recirculation loop, and perform the interlocking functions will be simulated.

F. The test duration will not equal that of an accident situation, but the test will be of a duration to insure proper operation of all components (including verification of pump characteristic curves).

G. The testing of the containment spray system will not be accomplished due to the undesirability of spraying the containment. A test of the drywell spray headers will be made using air instead of water.

14.2.4.1.35 Radioactive Waste Disposal System

After fuel is loaded into the reactor, all drains from the reactor, fuel pool, or interconnecting auxiliary systems must be considered to be potentially radioactive. Therefore, most of the liquid radioactive waste disposal system must be tested and operational before fuel loading. The solid waste handling system and waste concentrator need not be operational before fuel loading.

Liquid waste disposal test summary:

A. Calibrate instrumentation.

B. Check all controls and interlocks.

C. Recheck all air-operated valves.

D. Pumps and tanks:

1. Clean tanks mechanically;

2. Fill with demineralized water;

3. Check pump operation in recirculation, wherever possible; and

4. Simulate operations associated with the particular tank, such as draining or filling, recirculating, sampling, and processing to a filter, demineralizer, another tank, or overboard discharge.

E. Filters (waste collector, fuel pool, and floor drain);

1. Check operation of filter components without precoat material, using demineralized water only, until system operation is acceptable;

2. Perform all required operations such as precoating, normal operation, recirculation, filter aid addition, and backwashing; and

3. Add diatomaceous earth or Solkafloc precoat and repeat the operations in step E.2.

F. Waste concentrator;

1. Simulate the waste concentration operation by pumping demineralized (or relatively clean) water from the waste neutralizer tank to the concentrator. Check all modes of operation: startup, equilibrium, shutting down, condensate collection, and sludge transfer to the concentrate waste tank.

2. Pump from the concentrated waste tank to the concrete mixer.

G. Sumps (drywell, reactor building, turbine building, and radwaste building);

1. Fill sumps with water;

2. Check operation of sump pumps and proper functioning of level controls, including isolation valves on containment; and

3. Verify discharge to proper collection tank in radwaste with no backflow or leakage enroute.

H. Waste neutralizer system;

1. Pump to waste neutralizer tanks from condensate demineralizer regenerant collection tank. Verify proper operation of interlocks with condensate demineralizer system and with conductivity.

2. Test chemical addition equipment with demineralized water initially, then add chemicals and demonstrate the neutralizing operation.

3. Demonstrate all pumping operations with demineralized water only: recirculation, sampling, and transfer to floor drain filter.

I. Spent resin system;

1. Simulate transfer to resins from the fuel pool, waste, condensate, and cleanup demineralizers to the spent resin tank.

2. Verify cleanup and condensate resin transfer capability by actual transfer of resins (perform near end of test program with little or no radioactivity present, or devise means for catching and reclaiming resins).

3. Verify capability to pump spent resins to centrifuge. This may be the best means for reclaiming the resins used in item I.2, but this operation should be performed first with water only.

J. Filter sludge processing;

1. Simulate transfer of sludge from waste, floor drain, and fuel pool filters to sludge storage tank using water only;

2. Repeat sludge transfer with actual filter and material;

3. Pump filter sludge to centrifuge; and

4. Pump cleanup filter sludge to centrifuge.

K. Solid waste handling, storage, and disposal;

1. Check loading operations from mixer and centrifuge hoppers.

2. Check drum handling, loading, capping and transfer to storage. Use sand, drying material and filter aid material to represent solid wastes.

3. Check drum removal for offsite shipment.

4. Check baler.

14.2.4.1.36 Neutron and Radiation Monitoring Instrumentation Systems

This includes the following systems:

A. SRM/intermediate range monitor (IRM) chamber drives;

B. SRM system;

C. IRM systems;

D. Average power range monitoring (APRM) system;

E. LPRM systems;

F. Traversing incore probe system (TIP);

G. Area radiation monitoring (ARM) system;

H. Environs station monitors; and

I. Process, off-gas, and air ejector monitors.

The following types of preliminary testing are required (where applicable) prior to fuel loading:

A. Install dummy incore string in several positions in the core.

B. Check continuity and resistance to ground of signal and power cable.

C. Check response and calibration of all channels with simulated input signals.

D. Check alarm and trip setpoints.

E. Check chamber response to bugging sources.

F. Check all interlocks with the RPS circuit and control rod electrical control system.

G. Check operation and position indication of all SRM/IRM chamber drives.

H. Using dummy TIP chamber, insert calibration probe in all incore string tubes. Verify capability to insert more than one calibration probe in a particular incore string.

I. Install all incore SRM and IRM chambers and verify final system operability.

J. Install, calibrate, and bug temporary neutron monitoring instrumentation.

14.2.4.1.37 <u>Reactor Protection System</u>

The test of the RPS is for the purpose of demonstrating that all components of the system operate correctly and that the integrated system functions as intended. Specific tests will be performed for the following:

A. Power - The purpose of this test is to demonstrate the availability, reliability, control, and regulation of the RPS power supply.

B. Relay testing - The purpose of this test is to demonstrate the proper operation of all relays on voltage and frequency.

C. Sensor logic to scram relay actuation - The purpose of this test is to demonstrate the proper operation of the RPS relays and that proper combination of sensor trips deenergizes the proper relays to produce a scram. This test will also demonstrate the proper operation of the annunciating system as applicable. The following trips will be verified:

    1. Neutron monitoring system:

        a. IRM channel inoperative trip;

        b. Bypass switch check;

    c. Reactor mode switch check;

    d. IRM upscale (high flux) trip;

    e. APRM downscale, upscale, and inoperative trips;

    f. Annunciator check; and

    g. Refueling instrument trips.

2. Reactor vessel pressure:

    a. High pressure trip and

    b. Annunciator check.

3. Reactor vessel water level:

    a. Low water level trip and

    b. Annunciator and indicator check.

4. Scram discharge volume water level:

    a. Scram discharge volume chamber high level trip;

    b. Bypass switch check;

    c. Reactor mode switch check; and

    d. Annunciator check.

5. Drywell pressure:

    a. High pressure trip and

    b. Annunciator check.

6. Condenser vacuum:

    a. Low vacuum trip;

    b. Reactor pressure bypass check;

    c. Reactor mode switch check; and

    d. Annunciator check.

7. Main steam line radiation:

    a. High radiation trip and

    b. Annunciator trip.

8. Main steam line isolation valve closure:

    a. Any two valves not fully open;

    b. Reactor pressure bypass check;

    c. Reactor mode switch check; and

    d. Annunciator check.

9. Reactor manual scram:

    a. Manual scram switch check;

    b. Reactor mode switch check; and

    c. Annunciator check.

10. Turbine generator load rejection:

    a. Turbine control valve closure (fast-acting solenoid);

    b. Turbine first stage pressure bypass; and

    c. Annunciator check.

11. Turbine stop valve closure:

    a. Any two valves not fully open;

    b. Turbine first stage pressure bypass;

    c. Annunciator.

D. RPS scram relay test - The above tests demonstrated proper circuit continuity from the sensors to the relays through deenergization of the scram relays. The purpose of this test is to demonstrate that by deenergizing the scram relays in the proper logic sequence, the reactor will be scrammed.

The function of the reactor scram relays is threefold:

1. Open the power supply circuit to the pilot scram valve solenoids and cause them to deenergize. This test verifies that all pilot scram valve solenoids operate properly and that on a scram signal, the pilot solenoids will deenergize and open the scram inlet and outlet valves.

2. Energize the backup scram valves. This test verifies that the backup scram valves energize and vent on a scram signal from the scram relays.

3. Isolate the scram discharge volume. This test verifies that the power supply to the scram discharge volume vent and drain valve pilot solenoids is interrupted which in turn vents the air supply to the

vent and drain valves causing their closure and isolation of the discharge volume on a scram signal from the scram relays.

E. RPS auxiliary functions - The RPS has several auxiliary functions which it performs in addition to scramming the reactor. These auxiliary functions include containment and system isolation, tripping of the recirculation pumps, and the initiation of the emergency core cooling systems.

Tests are conducted to demonstrate the proper operation of annunciators, relays, indicator lights, valves, etc., due to the following:

1. Reactor low-low water level,
2. Steam line tunnel high temperature,
3. Main steam line low pressure,
4. Main steam line high flow,
5. Main steam line high radiation,
6. Drywell high pressure,
7. Reactor low water level,
8. Isolation condenser steam line break/condensate return line break,
10. Reactor vessel high pressure,
11. HPCI steam line break, and
12. HPCI steam line space high temperature.

F. Sensor calibration - Prior to and during the RPS preoperational test, a preliminary calibration of all sensors is adequate. However, prior to fuel loading, all sensors must be calibrated accurately and meet specification. A permanent record of each sensor calibration is made and includes the following:

1. Actual measured trip setpoint,
2. Actual measured reset point,
3. Date of calibration,
4. Signature of person making the calibration,
5. Sensor identification, and
6. Trip setpoint specified (required).

After each sensor is calibrated, the repeatability of the trip point will be checked by tripping the sensor a minimum of two additional times and recording the trip and reset points.

G. RPS response time - After the above tests have been completed and the CRD hydraulic system preoperational tests (Sections 14.2.4.1.17 and 14.2.1.21) have been completed, several full system scrams must be made. The purpose of these tests are to measure the system response time from sensor trip to rods 10%, 50%, and 90% inserted. In addition to the total elapsed time, the elapsed times from sensor trip to each of the following events are measured:

1. Sensor relay deenergized;

2. Reactor scram relays deenergized;

3. Pilot solenoid valves deenergized;

4. Scram valves open; and

5. Control rods 10%, 50%, and 90% inserted.

The full system scrams are coordinated with the control rod drive system preoperational tests and include scrams made by:

1. Main steam isolation, stop, and control valve closure,

2. Scram discharge volume high water level,

3. Manual scram, and

4. Neutron monitoring system.

Accomplishing the foregoing test will confirm that the reactor protection system will meet the design basis for the reactor protection and primary containment isolation as listed in Chapter 7.

Prerequisites:

1. All safety system sensors installed and calibrated and

2. All wiring installed and checked for continuity.

Test summary:

1. Operate RPS M-G sets with a resistance load to check capacity and regulation.

2. Energize buses; check controls and power source transfer.

3. Check relay operation; pick up and drop out voltages.

4. Check each safety sensor for operation of proper relay.

5. Using test signals, verify scram setpoints. Recheck or perform the reactor level check with water in the reactor vessel measuring the actual water level against a suitable reference point such as the vessel flange.

6. Check all positions of the reactor mode switch for proper interlocks and bypass functions.

7. Check all control rod permissive interlocks for proper function.

8. Check automatic closing of containment isolation valves from proper signal.

9. Check automatic initiation of core spray, LPCI, isolation condenser, and emergency ventilation (standby gas treatment) systems by the proper signals.

Deviations from expected accident conditions are that operating conditions for sensor trip actuation will be simulated by the use of conventional test and calibration equipment and techniques. All RPS sensors will be checked for proper installation. Prior to fuel loading, all instrument piping will be checked for proper installation and connection arrangement. All lines will have been checked to see that they are clear, hydrotested, flushed, filled or drained, and otherwise made ready for plant operation.

14.2.4.1.38 Rod Worth Minimizer

After the control rod drive system is operational, withdraw control rods in various sequences to expose the rod worth minimizer to simulated operational conditions. These withdrawal patterns should simulate the conditions required for the following operations:

A. Check all programmed normal rod withdrawal sequences for satisfactory performance.

B. Check different short-term sequences within the sequenced rod groups for satisfactory performance.

C. Attempt improper rod withdrawal and insertion at various points in the withdrawal sequence, and verify that the action is blocked.

D. Determine capability to insert drive mechanisms out of sequence to the extent permitted by the rod worth minimizer. Insertion of two rods out of sequence should be possible.

E. Check all alarms by simulated or actual error conditions:

   1. Low power alarm,

   2. Printing,

3. Computer error,

4. Input/output error,

5. Select error,

6. Select block,

7. Insert block, and

8. Withdraw block.

F. Check all controls:

1. Sequence A mode,

2. Sequence B mode,

3. Shutdown margin mode,

4. Scan exit,

5. Print log, and

6. Error clean.

G. Check all displays and information printout:

1. Group identification,

2. Withdrawal error readout,

3. Insertion error readout, and

4. Print out rod position from scan and from memory for several rod withdrawal patterns.

14.2.4.1.39 Diesel Generator

One diesel generator must be operational before fuel is loaded in the reactor, to provide maximum reliability of power supply.

The test of the emergency power system is intended to verify the following:

A. That on a loss of power, high drywell pressure or low-low reactor water level, the diesel generators will start. That the breaker supplying power to the emergency bus from the diesel generator will close upon loss of power to the normal feed to the emergency bus (and providing the unit has had an accident as indicated by high drywell pressure or low-low reactor water level).

B. That the two LPCI pumps and core spray pump are properly sequenced onto each emergency bus.

C. That the diesel generator will carry the load required over an extended period of time.

Accomplishment of the foregoing test will confirm that the emergency power system will meet its design basis as listed in Chapter 8.

Test summary:

A. Megger and high potential tests.

B. Calibration of instrumentation.

C. Check operation of diesel generator auxiliaries.

D. Check automatic start of the diesel generator, closing of the output breaker, and load pickup.

E. Simulate design basis accident and demonstrate capability of diesel generator to pick up core spray, LPCI, emergency ventilation (standby gas treatment), and associated loads in sequence.

   Perform a simulation of power failure with normal reactor shutdown and demonstrate capability of the diesel generator to pick up normal shutdown loads.

F. Operate the diesel generator at full rated load for 4 hours to demonstrate load carrying capability. Operate for 2 hours at 10% overload (110% of rated).

Deviations from expected accident conditions are as follows:

A. The drywell pressure signal and the reactor water level signal will be simulated, and

B. The test duration will not equal that which could occur in an accident condition, but the test will be of duration to ensure proper operation of all components.

14.2.4.1.40 Drywell Ventilation

Test summary:

A. Calibrate all thermocouples and temperature alarms;

B. Operate all cooler fans;

C. Check proper flow distribution under normal conditions, i.e., four coolers in operation and drywell closed;

D. Verify adequate cooling of the recirculation pump motors to the extent possible under pump cold water speed limitations; and

E. Verify adequacy of drywell ventilation system during system expansion tests with primary system at rated temperature and both recirculation pumps in operation.

14.2.4.1.41 <u>Emergency Ventilation (Standby Gas Treatment) and Reactor Building Leak Rate Test</u>

Prerequisites:

A. All building entrance airlocks complete and operational and

B. Emergency ventilation equipment operational.

Test summary:

A. Calibrate instrumentation. Check all controls and interlocks.

B. Check operation of preheater equipment.

C. Operate blowers and verify design flow capability.

D. Operate blowers until equilibrium negative pressure is achieved inside the reactor building. Evaluate building leak-tightness from air volume flowrate and measured pressures and temperatures. All other ventilation equipment should be out of service during these tests.

E. Determine efficiency of charcoal adsorbers by injecting freon into the flow stream and sampling the adsorber effluent.

14.2.4.1.42 <u>Balance of Plant - Auxiliary Systems</u>

In general, conventional performance tests will be utilized for acceptance testing of these systems. These tests will be formalized and documented to a greater extent than might be done in a conventional power plant to provide the necessary control and assurance of equipment or system operability before radioactive contamination or radiation exposure becomes a potential problem.

While most of the preoperational tests in this category will be primarily individual component tests, instrument calibration, or checking of controls and interlocks, the following systems will require somewhat more extensive simulation of normal operation conditions or more attention to detail in performance of the component tests in order to minimize later difficulties. The performance of extensive preoperational tests on the nuclear steam supply systems provides additional time in a coordinated construction schedule which must be used to advantage in prechecking turbine generator and associated auxiliary systems.

14.2.4.1.42.1 Circulating Water System

Test summary:

A. Check operation of pump discharge and flow reversing butterfly valves;

B. Check operation of circulating water pumps verifying that design flow is obtained;

C. Operate condenser vacuum priming and backwash valves; and

D. Calibrate all remote instruments.

14.2.4.1.42.2 Condensate and Feedwater Systems

These systems are not required for initial fuel loading, but certain phases of other preoperational tests require these systems for completion. Filling the reactor vessel and refueling well is easier if the condensate and feedwater systems are used.

Test summary:

A. Calibrate instrumentation.

B. Check all controls, alarms, and interlocks.

C. Operate all remote operated valves.

D. Check performance of condensate and feedwater pumps recirculating to the hotwell through the 8-inch connection downstream from high pressure feedwater heaters. Initial operation should bypass the condensate demineralizers and flow to the reactor should be blocked.

E. Check operation of minimum flow recirculation valves and controls.

F. Check hotwell high level reject and low level makeup controls and valves.

G. Check operation of feedwater flow control valves. If an actual level signal is not available from the reactor vessel, use simulated signals.

14.2.4.1.42.3 Feedwater Heater Instrumentation

This test is not required before fuel loading. Access to key valves and instrumentation will be restricted after nuclear steam is available, so that these components must be tested before power operation.

Test summary:

A. Calibrate instrumentation;

B. Check response of level instruments with supply of demineralized water to the heaters and flash tanks;

C. Check all controls, alarms, and interlocks; and

D. Check proper operation of valves from level and turbine trip signals.

14.2.4.1.42.4 Off-Gas System

Gases from nuclear steam will restrict access to off-gas equipment, so that these tests must be done before power operation.

Test summary:

A. Calibrate instrumentation;

B. Check controls, alarms, and interlocks;

C. Check operation of valves from manual control switches and automatic trip signals; and

D. Check proper operation of mechanical equipment in off-gas and stack sampling and monitoring system.

14.2.4.1.43 Turbine Generator and Auxiliaries

Turbine generator and auxiliary systems' preoperational tests will consist essentially of individual component tests. In most cases, coordinated system tests are prevented by the lack of steam flow or associated sustained sources of pressure, temperature, energy, or other effects of normal system operation. The objective of preoperational tests on these turbine generator auxiliary systems is to obtain preliminary indication of acceptable system performance before radiation makes test observation or performance cumbersome and before radioactive contamination makes maintenance or delivery correction difficult.

Systems listed below are covered in this category. Test procedures will be prepared by S&L based on requirements and instructions obtained from GE LSTG.

A. Turbine oil system,

B. Lube oil purification,

C. Moisture separator and drain tank valves and drains,

D. Steam seal,

E. Gland exhaust,

F. Hydrogen and carbon dioxide for main generator,

G. Stator cooling,

H. Turbine control system including control valves,

I. Generator seal oil system, and

J. Main and spare exciters.

14.2.4.1.44 Reactor Building, Radwaste Building, and Turbine Building Ventilation

Proper operation of supply and exhaust fans, dampers, and controls is required in the reactor building and radwaste buildings before fuel loading. Balancing of air flows must be checked to confirm that contamination control requirements are met. Ventilation systems in other buildings may be checked after fuel loading.

14.2.4.2 Description of Startup Tests

14.2.4.2.1 Fuel Loading and Tests at Atmospheric Pressure

The initial fuel loading and critical testing are performed at near-zero power and at atmospheric pressure, with the reactor pressure vessel open. The following tests are performed during this phase of the startup program:

A. Chemical and radiochemical tests are conducted to establish water conditions prior to initial operation and to maintain these throughout the test program. Chemical and radiochemical checks are made at primary coolant, off-gas exhaust, radwaste, and auxiliary system sample locations. Base or background radioactivity levels are determined at this time for use in fuel assembly failure detection and long-range activity buildup studies.

B. Control rod drive system tests are performed on all drives prior to fuel loading to assure proper operability and to measure and adjust operating speeds. Drive line friction and scram times are determined for all drives at zero reactor pressure. Functional testing of each drive is performed with dummy fuel just prior to and then following the fuel loading in each cell.

C. Radiation measurements are made prior to nuclear operation to establish base levels in the plant and the nearby environment.

D. Vibration measurements at cold flow conditions are performed to determine the vibrational characteristics of the pressure vessel internals. The results of extensive vibration measurements made at other BWR installations will be considered in selecting the components to be tested such as the control rod guide tubes, fuel channels, jet pumps, and recirculation loops.

E. Fuel loading is then begun, according to detailed, step-by-step written procedures. The core is assembled, with control curtains in place, to the full sized core.

F. Shutdown margin will be demonstrated periodically during fuel loading that the reactor is subcritical by more than a specified amount with the strongest single control rod withdrawn. The shutdown margin requirement is a limitation on the amount of reactivity which can be loaded into the core. The magnitude of the margin is chosen with consideration for credible reactivity changes after the test, and for the accuracy of measurement. The test has three parts:

   1. The analytical determination of the strongest control rod;

   2. The calibration of an adjacent control rod, experimentally or analytically; and

   3. The demonstration of subcriticality with the strongest rod fully withdrawn and the second at a position equal to the margin.

   This demonstration will be made for the fully loaded core and with selected smaller core loadings.

G. The specified control rod sequences are evaluated to verify that the stated criteria of safety, simplicity, and operating requirements are met during routine cold startups. The reactor is made critical by withdrawing control rods in a specified sequence, and reactivity addition rates are measured near critical. The preselected sequence may be modified if necessary to meet criteria. A small number of nonstandard arrays will be utilized to check out the operation of the rod worth minimizer.

H. The performance of the SRMs will be evaluated based on data taken with the installed source range monitoring instrumentation and installed operational sources. The SRM system will be calibrated to reactor power and its performance will be compared to stated criteria on noise, signal-to-noise ratio, and response to change in core reactivity.

I. Calibration of the IRMs is performed to provide a power level calibration for the IRMs adequate for this phase of the test program.

J. As plant process variable signals become available to the process computer, verifications will be made of these signals and of the computerized systems performance calculations.

14.2.4.2.2 Heatup from Ambient to Rated Temperature and Pressure

Following satisfactory completion of the core loading and low power test program, the core components are visually verified for proper installation, and the additional in-vessel hardware is installed. This includes special monitoring instrumentation and the steam separator and dryer assemblies. The reactor head is installed, followed by a hydrostatic test to assure satisfactory sealing of the vessel head. The drywell head is installed and shield plugs placed over it. A sequence of tests is performed to confirm a number of the nuclear steam supply system characteristics, as the temperature and pressure are increased. Sufficient tests are performed at each incremental step increase in power or change in pressure, and the tests and operating procedures are evaluated to assure that the succeeding change in operating conditions can be made safely. The following tests are conducted during this phase of the startup:

A. IRM calibration is improved by using data obtained from heatup rates observed during nuclear heating.

B. SRM performance is determined in the power overlap region with the IRM system. The SRM system is recalibrated by comparison to the IRM system readings in the region.

C. Reactor vessel temperatures will be monitored during heatup and cooldown to determine that temperature differences are not excessive.

D. System expansion checks are made during heatup to verify freedom of major equipment and piping to move.

E. CRD system tests will be made by measuring scram times on a selected number of drives at two intermediate pressures, scram times and drive line friction tests on a representative set of drives at rated reactor pressure, and on a selected number of drives without accumulators at rated reactor pressure.

F. Control rod sequence to be used during the heatup will be checked periodically for satisfactory performance.

G. Radiation measurements will be made periodically during nuclear heating and a complete survey will be made at rated temperature.

H. Chemical and radiochemical checks will be made during the heatup.

I. Main steam line isolation valve functional tests will be made at rated pressure.

J. Core performance evaluations are made at or near rated temperature and pressure. This includes a reactor heat balance at rated temperature.

K. Steam separator/dryer efficiency measurements are made in preparation for increasing reactor power level.

14.2.4.2.3 From Rated Temperature to 100% Power

Reactor power will be increased to 100% power in increments of approximately 10% with major testing at 50%, 75%, and 100% power. The turbine will be placed in service and tested during this phase. The test program will include the following, but not necessarily at each increment of power.

A. Chemical and radiochemical tests are continued.

B. Radiation measurements of limited extent are made at 25% of rated power and complete surveys are made at 50%, 75%, and 100% power.

C. Vibration measurements are made of selected core components as reactor power is increased.

D. System expansion tests are continued on a limited basis as reactor power is increased.

E. Main steam isolation valve functional and operational tests will be made as reactor power is increased.

F. Isolation condenser tests to determine the system performance in regard to heat removal rate and leak-tightness will be made at a low power level.

G. HPCI system will be made to demonstrate proper performance of the system including the steam turbine driven pumping system.

H. Recirculation pump trips and their effects on the jet pumps and the reactor will be tested periodically during power increase.

I. Feedwater and recirculation flow control capabilities will be determined at specified power levels.

J. Turbine trip tests will be made to determine the effects of turbine trips on the reactor and the auxiliaries of the unit.

K. Generator trip tests will be performed to determine speed and reactor response.

L. Pressure regulator tests will be made to determine the response of the reactor and the turbine governor system. Regulator settings will be optimized using data from this test.

M. Bypass valve measurements will be performed by opening a turbine bypass valve and recording the resulting reactor transients. Final adjustments to the bypass valves will be made.

N. Feedwater pumps will be used to change reactor subcooling and the resulting transients will be measured to determine system response.

O. Flux response to rods will be determined in both equilibrium and transient conditions. Steady-state noise will be measured as will the flux response to control rod motion. Power void loop stability will be verified from this data.

P. LPRM calibrations which include use of the TIP system, will be made at 50%, 75%, and 100% of rated power. Each local power range monitor will be calibrated to read in terms of local fuel rod surface heat flux.

Q. APRM calibrations will be performed after making significant power level changes. Reactor heat balances will form the bases of these calibrations of the average power range monitors.

R. Core performance evaluations will be made periodically to assure that the core is operating within allowable limits on maximum local surface heat flux and minimum critical heat flux ratio. This test includes reactor heat balance determinations.

S. Calibration of rods will be performed to obtain reference relationships between control rod motion and reactor power and steam flow in the specified control rod sequence.

T. Axial power distribution measurements will be made with the traversing incore probe system after significant changes in power, control rod pattern, or flowrate. The TIP system will supply data for core performance evaluations and LPRM calibrations.

U. Rod pattern exchanges will be demonstrated from one specified sequence to the other at the highest practical reactor power.

V. Steam separator/dryer measurements of carryover and carryunder will be made as a function of reactor water level and power level.

W. Process computer functions will be verified as sensed variables come into range during the ascension to and at rated power.

14.2.4.2.4 Testing to Demonstrate Conformance to the Ultimate Performance Limit Criteria

Certain transients during the startup and power testing of Unit 2 were specifically tailored to demonstrate conformance to the ultimate performance limit criteria (See Section 4.3.2.3.3). These tests were outlined and described in the Unit 2 "Startup Test Procedures" document available at the Dresden site. These tests were as follows:

A. Test 17 - Flow control,

B. Test 20 - Pressure regulators,

C. Test 21 - Bypass valves,

D. Test 22 - Feedwater pumps, and

E. Test 23 - Flux response to rods.

The test procedures document included the objectives of each test, the primary measured parameters, and the method of data analysis.

Acceptance criteria for each test was also included. It is extremely important to realize that there were two levels of criteria for determining the success of each test, identified as Level 1 and Level 2. For the tests related to stability, the Level 1 criteria was the same as the ultimate performance limit criteria used in stability analyses.

In the forward to the Unit 2 "Startup Test Procedures" document, the significant distinctions between Level 1, Level 2, and safety limit criteria are defined as follows:

A. Level 1 - The values of process variables assigned in the design of the plant and equipment are included in this category. If a Level 1 criterion is not satisfied, the plant will be put in a hold condition (which is satisfactory) until a resolution is made. Tests compatible with this hold condition may be continued. Following resolution applicable tests must be repeated to verify that the requirements of the Level 1 criterion are satisfied.

B. Level 2 - The limits considered in this category are associated with expectations in regard to the performance of the system. If a Level 2 criterion is not satisfied, operating and testing plans would not necessarily be altered. Investigations of the measurements and of the analytical techniques used for the predictions would be started.

C. Safety limit - This category of limit is specified in the Technical Specifications of the plant and is associated with levels of process variables which if exceeded will result in required shutdown of the plant. This limit is not included in the Criteria section of the Startup Test Procedures since there are no planned operations of testing at the associated levels.

The ultimate performance limit criteria used in the stability analyses and also applied to startup and power testing of BWR plants is clearly a Level-1-type criteria and not a safety-limit-type which would have required shutdown of the plant if the criterion were not satisfied.

The design guide limit criteria used in stability analyses could not be applied directly in the startup and power testing of any plant as it is based upon response to a pure step function. These pure step functions are not realizable in actual testing situations. Therefore the stability related tests utilized what has been called "near" step disturbances. As examples, consider pressure setpoint changes and rod notches. Pressure setpoint changes on the Dresden units are normally made at a rate of about 1 psi/s but can be made with a special test function at a rate of about 10 psi/s. Normal notching of a rod first requires an unlatching, temporarily moving the rod in the direction opposite to position finally desired. It also requires about 2 seconds for a rod to move from one notch to the next. Noise on signals also complicates any intended precise measurement of decay ratio.

The Level 2 criteria applied to the startup and power testing was used strictly to assess operational excellence and did not in any way limit the operation of the plant nor necessarily alter the control settings.

The method of data analysis and interpretation used during the startup and power test was quite similar to that used in the stability prediction analyses as described in Section 4.3.2.3.4. The Level 2 criterion applied was that underdamped oscillatory response modes of recorded transient variables, if there were any observable, had to have a relative damping or decay ratio of less than or equal to 0.25. This Level 2 criterion applied only between the lower and upper limits of the flow control range. At core recirculation flow values below the flow control range, only the Level 1 criterion applied.

No attempt was made to estimate the decay ratio of variables which did not have any observable oscillatory mode of response.

Although the response of all recorded variables was observed for oscillatory response, the response of neutron flux was the most closely observed during the tests. When no underdamped oscillatory response modes were observed then it was so noted on the data sheets for the test being made.

During the startup and power testing period, the data listed in Table 14.2-1 was collected, analyzed, and evaluated in regard to stability as described in Section 14.2.4.2.4.2. In general this testing established stability results which could be compared with analytical predictions of stability. For decay ratios above 0.25, the testing established specific numbers; for decay ratios below 0.25, the testing established only that the decay ratios were below 0.25.

14.2.4.2.4.1 Stability-Related Startup Tests

An outline of each test, including the objectives of the test, the primary parameters measured, the method of data analysis and interpretation, and acceptance criteria, is provided below for each of the small perturbation, stability-oriented startup tests. In addition, a description of data analysis and acceptance criteria is provided in Section 14.2.4.2.4.2. Tables 14.2-1 and 14.2-2 indicate the signals recorded for each test on high speed oscillograph recording channels. Table 14.2-3 and Figure 14.2-2 indicate the sequence of test conditions during the startup test program.

14.2.4.2.4.1.1 Flow Control (Stability Considerations Only)

A. Outline of Test

1. Recirculation flow and, hence, the core flow, is changed by changing the recirculation pump motor speeds through the fluid coupled M-G sets. The test perturbation is introduced by a rapid setpoint disturbance to the flow controller.

2. The flow changes will be performed in the following manner by manual flow control:

a. A 10% flow decrease then increase at the following tabulated conditions (these correspond to nominal startup test conditions):

Percent Power	12	31	50	42	52	75	58	70	100
Percent Flow	24	57	100	37	56	100	37	55	100

b. A ramp decrease in power of 30% of rated power per minute (760 MWt/min) from full power to 1770 MWt and a similar increase in power to 1895 MWt.

B. Objectives of Test

Determine the plant response to changes in the recirculation flow and confirm plant and core stability.

C. Primary Measured Parameters

The signals recorded for the flow control test are listed in Tables 14.2-1 and 14.2-2.

D. Method of Data Analysis and Interpretation

See Section 14.2.4.2.4.2.

E. <u>Acceptance Criteria</u>

1. Level 1 - The decay ratio must be less than 1.0 for each process variable that exhibits oscillatory response to flow control changes.

2. Level 2 - The decay ratio is expected to be less than or equal to 0.25 for each process variable that exhibits damped oscillatory response to flow control changes when the plant is operating above the lower limit setting of the master flow controller.

3. See Section 14.2.4.2.4.2 for definitions of decay ratio and criteria Levels 1 and 2.

14.2.4.2.4.1.2 <u>Pressure Regulator (Stability Considerations Only)</u>

A. Outline of Test

The pressure regulator is tested by making step changes in the operating pressure regulator setpoint and recording the resulting transients in power level, steam pressure, steam flow, control, and bypass valve position, etc.

B. Objectives of Test

1. Determine the reactor and turbine system responses to pressure regulator setpoint changes.

2. Demonstrate the stability of the power-void feedback loop to pressure perturbations.

C. Primary Measured Parameters

The signals recorded for the pressure regulator test are listed in Tables 14.2-1 and 14.2-2.

D. Method of Data Analysis and Interpretation

See Section 14.2.4.2.4.2.

E. Acceptance Criteria

1. Level 1 - The decay ratio must be less than 1.0 for each power variable that exhibits oscillatory response to pressure regulator changes.

2. Level 2 - The decay ratio is expected to be less than or equal to 0.25 for each process variable that exhibits oscillatory response to pressure regulator changes when the plant is operating above the lower limit setting of the master flow controller.

3. See Section 14.2.4.2.4.2 for definitions of decay ratio and criteria Levels 1 and 2.

14.2.4.2.4.1.3 <u>Bypass Valves (Stability Considerations Only)</u>

A. Outline of Test

One of the turbine bypass valves will be cycled using a test switch. The bypass valve to be tested is selected by the bypass valve test select switch. The test bypass valve pushbutton switch initiates valve movement. Reactor transient performance will be measured during the opening and closing strokes of the test bypass valve. Results of this test will be factored into the final adjustment of the pressure regulators for optimum performance. The test will be performed at the following conditions (where pump speeds are not included, they are inconsequential and the importance is placed on percent flow):

Percent Recirculation Pump Speed	20	-	-	20	-	-
Percent Flow	35	100	100	37	55	100
Percent Power	25	50	75	58	70	100

Bypass valve opening time will be adjusted to be as short as possible in order to approximate a step input. The recirculation control system will be in the local manual mode for the 25% rated power level and in the master manual mode for all the subsequent test levels.

B. Objectives of Test

Demonstrate the stability of the power-void feedback loop to pressure disturbances.

C. Primary Measured Parameters

The signals recorded for the bypass valve test are listed in Tables 14.2-1 and 14.2-2.

D. Method of Data Analysis and Interpretation

See Section 14.2.4.2.4.2.

E. Acceptance Criteria

1. Level 1 - The decay ratio must be less than 1.0 for each process variable that exhibits oscillatory response to bypass valve changes.

2. Level 2 - The decay ratio is expected to be less than or equal to 0.25 for each process variable that exhibits oscillatory response to bypass valve changes when the plant is operating above the lower limit setting of the master flow controller.

3. See Section 14.2.4.2.4.2 attached for definitions of decay ratio and criteria levels 1 and 2.

14.2.4.2.4.1.4 Feedwater Pumps (Stability Considerations Only)

A. Outline of Test

Feedwater transients are initiated by making changes in setting of reactor water level reference point. This action causes a rapid change in feedwater flow. The portion of the test accomplished by setpoint changes is performed at the following conditions (where pump speeds are not included, they are inconsequential and the importance is placed on percent flow):

Percent Recirculation Pump Speed	20	-	-	20	-	-
Percent Flow	35	100	100	37	55	100
Percent Power	25	50	75	58	70	100

B. Objectives of Test

Demonstrate that reactor responses to changes in subcooling are stable at all power levels.

C. Primary Measured Parameters

The signals recorded for the feedwater pumps test are listed in Tables 14.2-1 and 14.2-2.

D. Method of Data Analysis and Interpretation

See Section 14.2.4.2.4.2.

E. Acceptance Criteria

1. Level 1 - The decay ratio must be less than 1.0 for each process variable that exhibits oscillatory response to feedwater system changes.

2. Level 2 - The decay ratio is expected to be less than or equal to 0.25 for each process variable that exhibits oscillatory response to feedwater system changes when the plant is operating above the lower limit setting of the master flow controller.

3. See Section 14.2.4.2.4.2 for definitions of decay ratio and criteria levels 1 and 2.

14.2.4.2.4.1.5 Flux Response to Rods (Stability Considerations Only)

A. Outline of Test

1. Rod movement tests will be made at chosen power levels to demonstrate that the transient response of the reactor to a reactivity perturbation is stable for the full range of reactor power. The reactivity effect can be considered as input and power as output. A centrally located rod will be moved one or two notches, and the neutron flux signal from a nearby LPRM chamber will be measured and evaluated to determine the dynamic effects of rod movement.

2. The second characteristic measured in this test is the steady-state signal-to-noise ratio at progressively higher power levels. This ratio can be interpreted as a qualitative measure of the stability of the power-reactivity feedback loop in the core. A plot of this ratio as a function of power level, when extrapolated to zero at some higher power level, indicates the approximate power conditions at which the power-reactivity feedback loop would be unstable. The output from a centrally located LPRM chamber will be used to measure neutron flux and noise. The extrapolation is expected to yield very high power levels as the threshold of instability and will therefore be applied only when appropriate as a guide to stepwise increases in power level.

3. The test will be performed at the following conditions (where pump speeds are not included, they are inconsequential and the importance is placed on percent flow):

Percent Recirculation Pump Speed	20	-	20	-	0	20	-	-	0
Percent Power	25	50	42	75	39	58	70	100	54
Percent Flow	35	100	37	100	NC	37	55	100	NC

B. Objectives of Test

1. Demonstrate the relative stability of the power-reactivity feedback loop to small perturbations in reactivity caused by rod movement with increasing reactor power.

2. As power level is increased, determine the increase in noise in the reactor from steady-state LPRM signals, and demonstrate that there is no tendency toward instability in the power-reactivity loop.

3. Predict the signal-to-noise ratio and hence stability at the next higher power level where extrapolation is in a reasonable range.

C. Primary Measured Parameters

The signals recorded for the flux response to rods test are listed on Tables 14.2-1 and 14.2-2

D. Method of Data Analysis and Interpretation

1. See Section 14.2.4.2.4.2 for analysis of decay ratios.

2. Calculate the ratio (neutron flux/flux noise) from selected ARM and LPRM readings and plot as a function of core thermal power, and extrapolate to higher power levels. The next power level at which this measurement is to be made should be below the core power at which this ratio extrapolates to zero.

E. Acceptance Criteria

1. Level 1 - The decay ratio must be less than 1.0 for each process that exhibits oscillatory response to control rod movement.

2. Level 2 - The decay ratio is expected to be less than or equal to 0.25 for each process variable that exhibits oscillatory response to reactivity changes introduced by control rod movement.

   The LPRM signal-to-noise ratio must be equal to or greater than zero when plotted against core thermal power and extrapolated to the next higher operating thermal power.

3. See Section 14.2.4.2.4.2 for definitions of decay ratio and criteria Levels 1 and 2.

14.2.4.2.4.2 Data Analysis and Acceptance Criteria

A. Decay Ratio

Perturbation of a single process variable such as core recirculation flow, steam flow, reactor pressure, core inlet temperature, or neutron flux induces changes in other process variables. The character of the induced response of a process variable is either oscillatory or nonoscillatory.

Each oscillatory variable was analyzed by applying the decay ratio test which required the ratios of successive maximum amplitudes of the same polarity to be less than or equal to 0.25.

$$\text{Decay ratio} = \frac{x_{n+2}}{x_n} \leq 25$$

A base line was drawn through the inflection points of the trace as in Figure 4.3-44 to establish a reference line from which the maximum amplitude x_n of the nth peak could be determined. For traces with many peaks, the decay ratio was determined by averaging the ratios of both polarities (x_2/x_0, x_3/x_1, x_4/x_2, etc.).

Each oscillatory variable was subjected to the decay ratio test independent of whether it was induced by the primary perturbation or by a secondary effect.

The decay ratio for a limit cycle is 1.0. Special attention was given to differentiate between inherent system limit cycles and small, acceptable limit cycles which are always present even in the most stable reactors. The latter are caused by physical nonlinearities such as deadband or friction in real control systems and are not representative of hydrodynamics or reactivity instabilities in the reactor.

B. Acceptance Criteria

The acceptance criteria that were used for each test were listed in two categories, Level 1 and Level 2, defined as follows:

1. Level 1 - The values of process variables (as listed in Table 14.2-1) assigned in the design of the plant and equipment are included in this category. If a Level 1 criterion is not satisfied for discernible response of each variable the plant will be put in a hold condition, which is satisfactory, until a resolution is made. Tests compatible with this hold condition may be continued. Following resolution applicable tests must be repeated to verify that the requirements of the Level 1 criterion are satisfied.

2. Level 2 - The limits considered in this category are associated with expectations in regard to the performance of the system. If a Level 2 criterion for discernible response of each variable is not satisfied, operating and testing plans would not necessarily be altered. Investigations of the measurements and of the analytical techniques used for the predictions would be started. Note that the Level 2 criterion for decay ratio 0.25 is to be applied only above the lower

limit of the master flow controller. It is to be expected that the decay ratio of low recirculation flows, for example at natural circulation, may be 0.25 but well below 1.0. Natural circulation decay ratios will be determined and evaluated against the criterion of Level 1.

C. Additional Evaluation Information

1. A third category of criteria is labeled safety limit. This category of limit is specified in the Technical Specifications of the plant and is associated with levels of process variables which if exceeded will result in deliberate shutdown of the plant. This limit is not included in the Criteria section of the Startup Test Procedures since there are no planned operations of testing at the associated levels.

2. A graphic presentation of the test conditions for each startup stability test is included in Table 14.2-2 and Figure 14.2-2 for convenience.

3. The use of the signal-to-noise ratio as an indicator of stability is a supporting technique to the principle technique of decay ratios. The prior use of the signal-to-noise ratio technique is reported in GE Topical Report APED-5698.

14.2.4.2.5 Testing to Confirm Parameters Used in the Accident Analysis

An expanded outline of the startup tests is presented in "Startup Test Instructions," Specification 22A2207, May 1968. A detailed step-by-step description of the startup tests is presented in "Startup Test Procedure," Procedure 22A2150, September 1968. These documents are available at the Dresden site for review.

Some of the tests to be performed which will confirm some of the parameters used in the accident analysis of Chapter 15 are summarized in CECo's response to AEC Question V.G, contained in Amendment 9/10 of the FSAR. The remaining parameters not covered in the above tests are covered in the tests summarized below:

A. Shutdown margin,

B. Control rod sequence,

C. Flux response to rods, and

D. Core thermal and hydraulic performance.

14.2.4.2.5.1 Shutdown Margin

A. Purpose

Demonstrate that the reactor is adequately subcritical with the strongest single control rod fully withdrawn.

B. Description

The basic criterion for reactivity control is that the core in its maximum reactivity condition be subcritical with the strongest control rod fully withdrawn and all other rods fully inserted. This will be implemented by requiring that the core be limited to that which can be made subcritical by at least (R + 0.25% DELTA--k) in the most reactive condition at the start of the cycle, with the strongest control rod fully withdrawn and all other rods fully inserted. The value R is the amount by which the core reactivity, at any time in the operating cycle, is calculated to be greater than at the time of the check.

Satisfactory completion of the shutdown margin test assures, at the time of loading, that the core can be made subcritical by control rods at any time in the operating cycle even if the strongest rod fails to insert. The 0.25% DELTA--k is provided to account for calculational uncertainties in k_{eff} for the operating cycle and to provide a finite subcritical margin. The most reactive condition is cold and xenon-free. This requirement is designed to limit core loading to match expected operating conditions. The strongest rod, CR1, is defined as that rod which would cause the core k_{eff} to be highest when it is fully withdrawn with all other rods fully inserted and is selected on the basis of calculations.

The shutdown margin test will be performed by fully withdrawing rod CR1 and then withdrawing a second rod such as CR2 to a position N1 which inserts an amount of reactivity at least equal to the required margin. The table of reactivity inserted versus position of the second rod, presented in the Startup Test Instructions for this unit, will be used to determine the appropriate position of the second rod for the fully loaded core. The same test is adequate and conservative for partially loaded cores. The parameters CR1 through CR5, R, and N1 are defined for this plant in Table 14.2-4.

Prior to the withdrawal of each notch of any control rod, subcriticality will be verified from observations of the character of the neutron count rates.

C. Criteria

Level 1 - The fully or partially loaded core must be subcritical by at least (R + 0.25% DELTA-k) with the strongest rod fully withdrawn.

14.2.4.2.5.2 Control Rod Sequence

A. Purpose

The purpose of this test is to verify the acceptability of the specified control rod withdrawal sequences. For each of the two withdrawal sequences, calibrations will be made to give an indication of notch strengths of in-sequence control rods. The rod worth minimizer will be checked periodically for proper operation during rod withdrawals.

B. Description

Two complementary rod withdrawal sequences are specified. These completely specify rod withdrawals from the all-rods-in condition to the rated power configuration. Each sequence will be used to attain cold criticality. Calibrations will be made of selected in-sequence rods to determine typical notch strengths in the upper, middle, and lower regions of the core. Critical patterns will be recorded periodically as the reactor is heated to rated temperature. Movement of rods in a prescribed sequence is monitored by the rod worth minimizer, which will prevent the withdrawal of more than one rod out of sequence. Also, not more than two rods may be inserted out of sequence. This system will be programmed to monitor each sequence from all-rods-in to approximately 10% of rated power.

C. Criteria

The maximum notch strengths of in-sequence rods should not exceed 0.1% DELTA--k per notch.

14.2.4.2.5.3 Flux Response to Rods

A. Purpose

1. Demonstrate the relative stability of the power-reactivity feedback loop to small perturbations in reactivity caused by rod movement with increasing reactor power.

2. As power level is increased, determine the increase in noise in the reactor from steady-state LPRM signals, and demonstrate that there is not tendency toward instability in the power-reactivity loop.

3. Predict the signal-to-noise ratio and hence stability at the next higher power level.

B. Description

1. Basically, this test demonstrates two separate reactor characteristics. Rod movement tests will be made at chosen power levels to demonstrate that the transient response of the reactor to a reactivity perturbation is stable for the full range of reactor power. The void and doppler effect can be considered as input and power as output. A centrally located rod will be moved one or two notches, and the neutron flux signal from a nearby LPRM chamber will be measured and evaluated to determine the dynamic effects of rod movement.

2. The second characteristic measured in this test is the steady-state signal-to-noise ratio at progressively higher power levels. This ratio also indicates the stability of the power-reactivity feedback loop in the core. A plot of this ratio as a function of power level will yield predictions for stability at higher power levels. If the extrapolated plot were to indicate the signal-to-noise ratio going to zero at some

higher power level, this indicates the noise would become infinite, and the power-reactivity feedback loop would be unstable. The output from a centrally located LPRM chamber will be used to measure neutron flux and noise.

3. The test will be performed at power levels of 632 MWt, 1264 MWt, 1895 MWt, and 2527 MWt. In addition the test will be performed at the natural-circulation-associated power levels obtained from all recirculation pumps tripped from power levels of 1895 MWt and 2527 MWt.

C. Criteria

Relative damping of the transient response of neutron flux, reactor pressure, and reactor water level must satisfy the following limits:

1. Level 1 - Relative damping must be less than 1.0.

2. Level 2 - Relative damping must be less than or equal to 0.25, and the LPRM signal-to-noise ratio must be greater than or equal to 0 where plotted against core thermal power and extrapolated to the next higher operating thermal power lead.

14.2.4.2.5.4 Core Thermal and Hydraulic Performance

A. Purpose

The purpose of this test is to evaluate the core thermal and hydraulic performance.

B. Description

1. The core performance evaluation is employed to determine the principal thermal and hydraulic parameters associated with core behavior. These parameters are as follows:

   a. Core flowrate,
   b. Core thermal power level,
   c. Maximum fuel rod surface heat flux, and
   d. Core minimum critical heat flux ratio (MCHFR).

2. The general procedure analysis for GE BWR core performance evaluation including example calculations is presented in GEI-92823 "Nuclear Engineers Manual," dated May 1967. Data, calculated performance quantities, nomographs, and calculation work sheets are presented in GE Document 22A2207, "Dresden 2 Startup Test Instructions," May 1968, Section 7 and Appendix I-6. This report is available at the Dresden site.

   The evaluation procedure includes the use of detailed knowledge of the core and nuclear boiler performance characteristics with measured operating parameters to determine the thermal and hydraulic performance for both normal plant operation and test conditions. The core characteristics required in the evaluation are presented as performance nomograms. The determination of core performance parameters in the manner specified in this procedure permits accurate determination of parameters limited by license and/or warranty.

3. The core performance parameters listed in Paragraph 1 above will be evaluated in the following manner:

    a. Core flowrate will be determined from the summation of the 20 jet pump diffuser pressure drop readings converted into total flow from the two banks of 10 jet pumps, and read on the control room recorder.

    b. Core thermal power will be determined from a detailed reactor heat balance.

    c. The maximum fuel rod surface heat flux will be determined using the LPRM system, axial power distribution information, and calculated fuel assembly local power distribution information.

       The maximum rod surface heat flux will generally occur in the fuel assembly where the gross power distribution is peaked most highly; i.e., where the product of relative assembly power and axial peaking factor is the greatest. The core power distribution, as characterized by the factors r (radial), a (axial), and l (local) can be determined using the LPRM system, the TIP, and calculations of the fuel assembly local power distribution. The peak heat flux location will generally be in that fuel assembly with the highest adjacent LPRM readings, since the readings are calibrated to indicate the average heat flux of the four adjacent fuel rods at the elevation of the LPRM chambers. Since the peak heat flux may occur at any axial location, the determination must include TIP data to construct the axial distribution of heat flux on the highest powered fuel rod.

    d. The MCHFR of a fuel assembly depends upon the fuel assembly flow the axial heat flux distribution and magnitude and the local quality. Similarly, core MCHFR will depend on the gross power and the core flow and power distributions. The core flow and power distributions are interdependent. Thus, since fuel assembly flow decreases with power, the fuel assemblies with the highest power in each orifice zone should be investigated to determine their MCHFR. Since critical heat flux (CHF) is a decreasing function of quality and a fuel assembly of a given power will have a lower MCHFR when the axial power distribution is peaked toward the top of the fuel assembly, the core MCHFR may occur in a fuel assembly with the axial power distribution peaked high but with radial factor less than the core maximum value.

C. Criteria

Reactor power, maximum fuel surface heat flux, and MCHFR must satisfy the following limits:

1. Maximum fuel rod surface heat flux shall not exceed 126.4 W/cm^2 (402,000 Btu/h-ft^2) when evaluated at the operating power level.

2. MCHFR shall not be less than 1.90 when evaluated at the operating power level. The basis for evaluation of MCHFR shall be "Design Basis for Critical Heat Flux Condition in BWRs," APED-5186, July 1966.

3. Normal reactor power shall be limited to 2527 MWt for the steady-state condition.

Table 14.2-1

RECORDER SIGNAL TAPS INDEX

Number	Description
1	Reactor Pressure
2	Total Steam Flow
3	Main Steam Line (Throttle) Pressure
4	Total Feedwater Flow
5	Reactor Water Level
6	Total Recirculation Flow (from Jet Pump Delta-P's)
7	Loop A Recirculation Flow (driving flow)
8	Loop B Recirculation Flow (driving flow)
9	Feedwater Discharge Header Temperature
10	Recirculation Temperature Loop B
11	LPRM Chamber
12	APRM Channel 1
13	APRM Channel 4
14	Bypass Valve Position
15	Control Valve Position
16	Heat Flux ("Hot" LPRM)
17	LPRM Flux Noise
18	Generator Speed Recirculation Loop A
19	Scoop Tube Position Speed Controller Loop A
20	Master Recirculation Flow Controller Output
21	No. 1 Turbine Stop Valve Position
22	Main Steam Line Valve 203-1A Position
23	Main Steam Line Valve 203-1B Position
24	Main Steam Line Valve 203-1C Position
25	Main Steam Line Valve 203-1D Position
26	Main Steam Line Valve 203-2A Position
27	Main Steam Line Valve 203-2B Position
28	Main Steam Line Valve 203-2C Position
29	Main Steam Line Valve 203-2D Position
30	Electro-Hydraulic Pressure Regulator Setpoint
31	Mechanical Pressure Regulator Setpoint
32	Scram Circuit
33	Generator Trip Circuit
34	Turbine Trip Circuit

Table 14.2-1 (Continued)

RECORDER SIGNAL TAPS INDEX

Number	Description
35	Recirculation Loop A Pump Trip
36	Feedwater Pump 3201-2A Trip
37	Feedwater Pump 3201-2B Trip
38	Feedwater Pump 3201-2C Trip
39	Relief Valve 203-3A Position
40	Relief Valve 203-3B Position
41	Relief Valve 203-3C Position
42	Relief Valve 203-3D Position
43	Relief Valve 203-3E Position
44	Isolation Condenser Return Valve 1301-3 Position
45	No. 1 Bypass Valve Position
46	Jet Pump No. 1 Diffuser Delta-P on Loop A Receiver
47	Jet Pump No. 2 Diffuser Delta-P on Loop B Receiver
48	Generator Speed Recirculation Loop B

The signals recorded for each startup test are listed in Table 14.2-2.

Table 14.2-2

SIGNALS RECORDED DURING STARTUP TESTS

	TEST				
VARIABLE	Flow Control	Pressure Regulators	Bypass Valves	Feedwater Pumps	Flux Response to Rods
Reactor Pressure	1	1	1	1	1
Steam Flow	2	2	2	2	2
Steam Line Pressure	3	3	3		
Feedwater Flow	4	4	4	4	
Reactor Water Level	5	5	5	5	
Recirculation Flow	6			6	
Feedwater Temperature	9			9	
Recirculation Temperature	10			10	
LPRM		11			11
APRM	12,13	12,13	12,13	12,13	12,13
Bypass Valve Position		14	45		
Control Valve Position		15	15		
LPRM Heat Flux					
LPRM Flux Noise					17
Recirculation Generator Speed	18,48				
Recirculation Scoop Tube Position	19				
Recirculation Master Controller Output	20				
Turbine Stop Valve Position					
Isolation Valve Position					
Pressure Regulator Setpoint	30	30,31			
Scram Circuit					
Generator Trip Circuit					
Turbine Trip Circuit					
Recirculation Pump Trip (Event)					
Feedwater Pump Trip				36,38	
Relief Valve Position					
Isolation Condenser Return Valves					
Jet Pump Diffuser Delta-P					

The numbers in the columns are the Signal Tap Numbers listed in Table 14.2-1.

Table 14.2-3

STABILITY TESTS DURING STARTUP TEST PROGRAM[1]

Phase	II	III	IV					V
			Percent Rated Power					
Startup Test Title	Open Vessel	Heat-Up	10 %	25%	50%	75%	100%	Warranty 100%
Flow Control					5,6,7	8,9,10	12,13,14	
Pressure Regulators				4	7	10	12,13,14	
Bypass Valves				4	7	10	12,13,14	
Feedwater System: Drop Pump						10		
Feedwater System: Change Setpoint				4	7	10	12,13,14	
Flux Response to Rods				4	7	8,10,11	12,13,14,15	

Notes:

1. The numbers in the table refer to the test conditions in Figure 14.2-2.

Table 14.2-4

PARAMETERS FOR SHUTDOWN MARGIN TEST PROCEDURE

A. Plant: Dresden Units 2 and 3

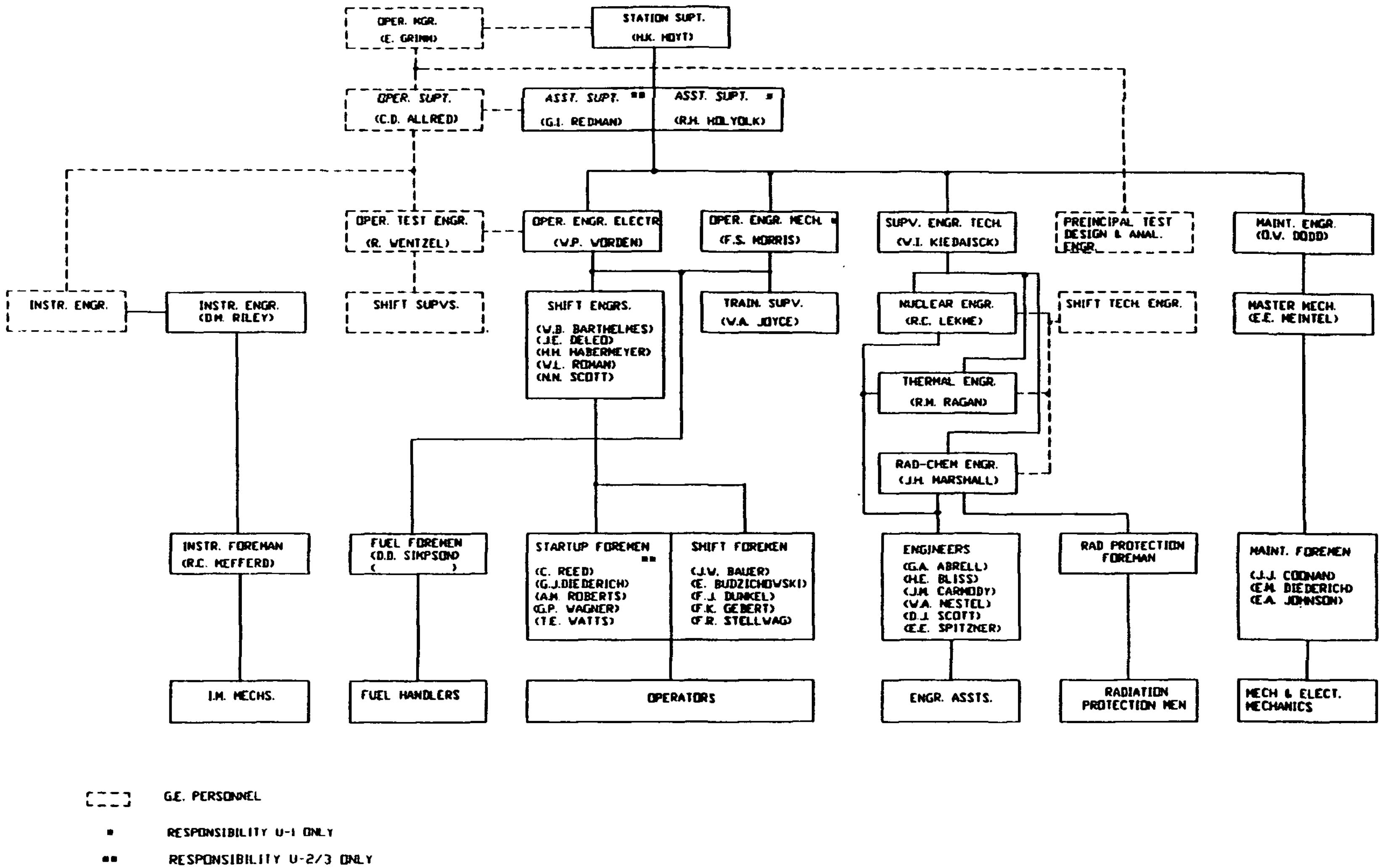
B. R = 0.1% Delta-k

C. Control Rod Designation

Symbol Used in This Procedure	Control Room Indication
CR1	H-8
CR2	H-9
CR3	J-8
CR4	H-7
CR5	G-8

D. Control Position

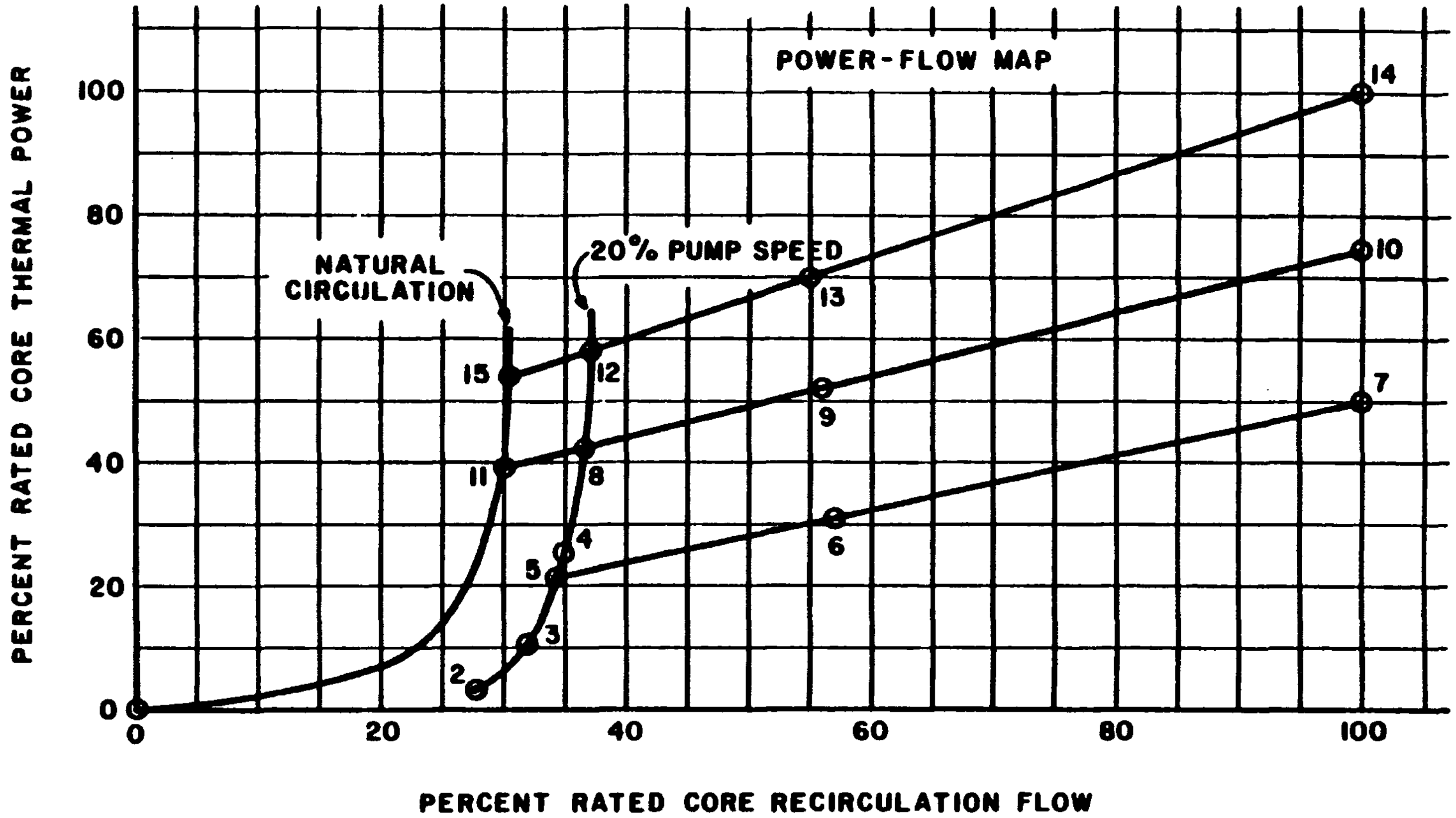
Symbol Used in This Procedure	Control Room Indication
N1	Position 10



DRESDEN STATION
UNITS 2 & 3

UNIT 2 STARTUP ORGANIZATION

FIGURE 14.2-1



TEST CONDITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROD PATTERN	V	V	a	b	c*	c*	c	d*	d*	d	d*	e*	e*	e	e*
% PUMP SPEED	0*	20*	20*	20*	20*	--	--	20*	--	--	0*	20*	--	--	0*
% CORE FLOW	0	V	32	35	34	57	100*	37	56	100*	NC	37	55	100*	NC
% POWER	0*	<5*	10*	25*	21	31	50*	42	52	75*	39	58	70*	100*	54

* INITIAL TEST CONDITIONS, NON-ASTERISKED VALUES ARE ESTIMATES

NC = NATURAL CIRCULATION CONDITION

DRESDEN STATION
UNITS 2 & 3

POWER FLOW MAP AND STARTUP TEST CONDITIONS

FIGURE 14.2-2