13.4 PREOPERATIONAL TEST PROGRAM

This section provides a description of the preoperational test program conducted on Browns Ferry prior to initial startup. It has been retained in the FSAR as an historical record of such testing.

13.4.1 Objectives

The purpose of the preoperational test program was four-fold: (1) confirm that construction is complete to the extent that the equipment and systems that have been installed can be put into use during completion of construction on other systems or equipment, (2) adjust and calibrate the equipment to the extent possible in the "cold" plant, (3) assure that all process and safety equipment is operational, and in compliance with license requirements, to the extent possible and necessary to proceed into initial fuel loading and the startup program, and (4) provide baseline data to assist in the evaluation of subsequent periodic tests.

An extensive preoperational test program was planned for the reactor unit being started. This program started approximately 11 months before initial fuel loading. The actual duration of each test was short, relative to the entire 11-month program; the longest test, the Reactor Protection System checkout, took approximately 9 weeks.

Key systems were 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 resulted in an early requirement for electrical systems, demineralized water makeup, and cooling water systems.

After nuclear fuel is loaded in the reactor, all interconnected auxiliary systems are treated as potentially radioactive. In time, many of these systems become sufficiently radioactive to impose restrictions and time limitations on maintenance work. During normal plant operations, some components and systems cannot be observed for proper performance. To avoid these limitations during the preoperational tests, all of the nuclear steam supply system and its auxiliary systems are normally tested before fuel loading.

The preoperational test period is an important phase in the training of the nuclear system operators. Experience and understanding of plant systems and components is gained with a minimum of risk to the equipment or personnel. Minimal restrictions are imposed on either the operators or the testing, except those restrictions required by work in progress on other units. This gives maximum opportunity to evaluate and train individual operators and to troubleshoot plan 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, and to adjust and calibrate the equipment.

Acceptance criteria for each preoperational test will be established by the designer and included in the preoperational test specifications and instructions. These documents will be prepared prior to the start of the preoperational test program.

Preoperational test results were reviewed and evaluated to assure compliance with all acceptance criteria. The approval or modification of any test in which the results were affected were reviewed by TVA with technical assistance from General Electric site representatives.

13.4.2 Preoperational Test Schedule Considerations

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, control air 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 unrelated systems and areas.

c. Stricter controls of plant operations and maintenance work are required following fuel loading. Preoperational testing is performed before fuel loading on all systems that could consequently be exposed to radioactive contamination, to minimize possible contamination problems.

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

e. Temporary construction power is sometimes required for initial tests at the beginning of the preoperational test program. However, unnecessary use of temporary power and improvised setups is to be avoided because of the possibility of costly errors and inconsistency with the ultimate objective of providing the final installation.

f. Electrical jumpers are used to facilitate preoperational testing in some instances, but their use is minimized and controlled by proper identification of such jumpers, by tags on the equipment jumpered, and by log book records. All jumpers are removed before fuel loading, unless required by special procedures.

g. When a unit is ready for fuel loading, construction workers are excluded from that portion of the reactor building and the drywell, and strict control is enforced over access to the control room, electrical equipment rooms, and the radioactive waste treatment building. Construction work will proceed on later units under the access limitations of the operating unit (see Appendix F).

h. Tennessee Valley Authority operations personnel operate the plant and equipment (operation of the nuclear system will be under the technical direction of General Electric) during preoperational testing. However, some testing requirements actually precede the preoperational test program. These are categorized as Construction Tests and are performed by TVA construction forces or by subcontractors, with technical direction available from General Electric (see paragraph 13.4.3).

i. Detailed test procedures are prepared by General Electric or Tennessee Valley Authority depending upon system design responsibility. These procedures are specific regarding intent, method, and operating requirements for completing the test and will include detailed blank data sheets to be completed during the test.

j. In general, tests are performed using permanently installed instrumentation for the required data. Where it is not possible to run pumps or similar equipment for a period of time prior to the system preoperational tests, it is necessary to install test thermometers, vibration meters, stroboscopes, or other test instrumentation to ensure safe operation of the equipment. Special instrumentation is specified in the preoperational test procedure.

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

l. Typical test sequencing for the preoperational test phase is presented in Figure 13.4-1.

13.4.3 Construction Test

a. Initial containment leak rate testing.

b. System hydrostatic test.

c. Chemical cleaning and flushing.

d. Wiring continuity checks.

e. Megger and high potential test.

f. Electrical system tests to and including energizing (e.g., checking grounding, relay checks, checking circuit-breaker operation and controls, phasing check, and energizing of buses).

g. Initial adjustment and "bumping" of motors.

h. Check control and interlock functions of instruments, relays and control devices, except as described in i. below.

i. Calibrate instruments and recheck or set initial trip set points, except as described in paragraph 13.4.2.

j. Clean the control and service air system lines and pneumatically test the systems.

k. Adjustments such as alignment, greasing, and bolt tightening.

l. Surveillance of proper equipment operation during preoperational tests, as required. The primary intent of this item is to cover those instances where measurements such as the above are required to ensure proper operation, but are not obtainable until the entire system is operated during preoperational tests (e.g., measuring motor current and voltage; bearing, lubricating oil, cooling water and seal temperatures; vibration; torque; rpm). These measurements are primarily of importance for protection of equipment, troubleshooting, or supplementing installed instrumentation.

m. Observe the readiness of relief and safety valves.

n. Complete tests of motor-operated valves, including adjusting limit torque switches and limit switches, checking all interlocks and controls, measuring

motor current and operating speed, and checking leaktightness of stem packing and valve seat where required during hydrotests.

o. 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 where required during hydrotest, checking leak tightness of pneumatic operators, and checking for proper operation of controllers, pilot solenoids, etc.

p. Reactor vessel and reactor coolant system hydrotest.

13.4.4 Summary of Preoperational Test Content

The prerequisites listed below for each preoperational test are typical. Certain portions of each test may be conducted without having completed all prerequisites.

13.4.4.1 Condenser Circulating Water System Interunit Crossties (TVA-1)*

13.4.4.1.1 Prerequisites

a. The Unit 1 condensers, intake and discharge tunnels filled with water and the discharge structure stoplog removed.

b. Limit switches on the condenser outlet valves set to stop the valves in the partially closed position for throttling the pump in order to obtain sufficient head for supplying water to Units 2 and 3 were the condensers for these units in service.

c. Electric power available from the emergency generator system for operation of pumps, valves, control system, and annunciation.

d. Preoperational test for diesel generators (see paragraph 13.4.3.46) should be coordinated with this test.

e. Construction checks on the vacuum priming and cooling water systems completed. These systems shall be operable.

f. The traveling screens should not be operated during this test.

13.4.4.1.2 Test Summary

The feature demonstrated by this test is not required until Unit 2 is in operation; therefore, demonstration of this capability is not required for licensing of Unit 1.

However, this test may be performed during preoperational testing of Unit 1 to avoid interference with subsequent operation of Unit 1. A Unit 1 pump represents the worst condition; therefore, repetition of this test for a Unit 2 or 3 pump is not required. If either the Unit 2 of Unit 3 condensers (or both) are unavailable for use during this test, their presence may be simulated.

a. Verify that capability of any one Unit 1 pump and the crosstie piping and valving to supply the minimum flow required by all three units during a system blackout.

b. Throttle the discharge from the condenser until all of the tubes in the tube bank are filled. This operation will require the use of the mechanical vacuum pumps to keep the condenser tubes filled with water.

13.4.4.2 Condensate Storage and Transfer to the NSSS (TVA-2)

13.4.4.2.1 Prerequisites

a. Condensate storage tanks, 24-inch and 20-inch supply headers cleaned and ready for operation.

b. Chemical cleaning and flushing completed on all systems related to this test.

c. Main condensate pumps tested and checklists completed.

d. Condensate booster pumps tested and checklists completed.

e. All valves cross connecting the aluminum and steel headers locked closed.

f. Standpipes installed in condensate storage tanks.

g. Auxiliary boilers cleaned, tested, and ready for operation.

h. Condensate transfer pumps test and checklists completed.

i. HPCI main pump tested and checklist completed.

j. HPCI booster pump tested and checklist completed.

k. At least one condensate filter demineralizer tested and ready for operation.

l. Reactor vessel head removed, dryer and separator removed, and vessel filled with condensate.

m. Permanently installed instrumentation calibrated and checklist completed.

n. All motor-operated valves tested and checklist completed.

o. Strainers installed in pump suction lines as required.

13.4.4.2.2 Test Summary

a. Verify capacity of the system to supply required volume of condensate to fill the balance of reactor vessel, the dryer separator pit, and the reactor well (refueling pool) within about 3 hours.

b. Verify capacity of the system to supply 5000 gpm from the 24-inch header and to return this flow rate to the 20-inch header during the HPCI tests.

(For other testing of the condensate and feedwater system see paragraph 13.4.4.20 and 13.4.4.48.)

13.4.4.3 RHR Service Water System 1 (TVA-3)

13.4.4.3.1 Prerequisites

a. Construction testing and instrumentation calibration completed.

b. Control air supply available.

c. Electrical power available from emergency diesel bus.

d. Electrical AC and DC power available for system control.

e. Electrical AC power available for pump and valve action.

f. System hydrostatic test performed and system flush completed.

g. Raw Cooling Water System operable for unit under test.

h. EECW piping complete.

13.4.4.3.2 Test Summary

a. Verify capability of the RHRSW system to supply an adequate quantity of raw river water to the secondary side of the RHR heat exchangers under normal conditions.

b. Verify that the associated instrumentation and control systems are functioning correctly.

c. For Units 1 and 2 only, verify the capability of the RHRSW system to supply an adequate quantity of raw river water to the secondary side of the RHR heat exchangers under conditions simulating a breach of Wheeler Dam.

13.4.4.4 Emergency Equipment Cooling Water System (TVA-4)

13.4.4.4.1 Prerequisites

a. Construction testing and instrumentation calibration completed.

b. Electrical power available from the emergency diesel bus.

c. Electrical AC and DC power available for the control system.

d. Electrical AC power available for pump and valve operation.

e. Hydrostatic test performed and system flush completed.

f. RCW system operable for unit under test.

g. RHRSW system operable for unit under test.

13.4.4.4.2 Test Summary

a. Verify capability of the system to automatically supply raw river water to the assigned receivers upon initiation by an accident signal or by signals from the assigned receivers.

   Demonstrate capability both with each pump individually assigned to EECW and with one pump fully assigned to EECW and one pump on floating backup.

b. Demonstrate operation of the sectionalizing valves.

c. Verify capability of the system to automatically supply the priority receivers of the RCW system upon initiation by a RCW low-pressure signal.

d. Verify ability of the EECW system to block service to certain of the RCW priority receivers in the event of low pressure in the section of header to which the line leading to those receivers is attached.

e. Verify proper operation of the automatic strainers.

13.4.4.5 Heating and Ventilation (H&V): Reactor Building and Control Bay (TVA-5)

13.4.4.5.1 Prerequisites

a. Electrical power available to operate equipment and control systems.

b. Electrical power available from the emergency diesel bus for designated equipment located in the control bay and shutdown board rooms.

c. Correct control air pressure available to operate pneumatically operated damper motors.

d. EECW system or RCW system cooling water available for operating control bay and shutdown room air-conditioning equipment.

e. Mechanical and electrical equipment checked and balancing of air flow quantities for each air supply, return, and exhaust system completed.

f. Standby Gas Treatment System available for service.

13.4.4.5.2 Test Summary for Reactor Building

a. With the building under normal H&V operating conditions demonstrate proper functioning of the control interlocks on the Air-Supply Systems and the Air-Exhaust Systems.

b. Demonstrate automatic actuation, where provided, of standby redundant components (fans and dampers) or trains on simulated failure of the initially operating component or train.

c. With the building under normal H&V operating conditions, demonstrate that the TIP room, the steam and feedwater valve room and rooms containing reactor water cleanup system components are maintained at a negative pressure with respect to the surrounding portions of the reactor zone. (Maintenance of this condition is an operational consideration and serves no essential safety function.)

13.4.4.5.3 Test Summary for Control Bay

a. Demonstrate capability of control room emergency pressuring unit to pressurize the floor at El. 617.0 feet.

b. Demonstrate automatic actuation, where provided, of standby redundant components (fans and dampers) or trains on simulated failure of the initially operating component or train.

c. Demonstrate operation of the emergency cooling units for the battery and board rooms during simulated loss of normal supply or exhaust as well as during conditions simulating those which would result from a fire in the main control room.

d. Demonstrate operation of the emergency battery-and-board-room exhaust fan.

e. Demonstrate operation of the emergency relay-room-cooling crosstie.

f. Demonstrate operation of the main-control-room coolers during simulated loss of normal supply and exhaust.

g. On those air-handling units which are so equipped, demonstrate operation of the direct-expansion cooling coils and associated equipment during simulated failure of the normal cooling coils and associated equipment.

h. Demonstrate capability of operating with the control bay under positive pressure using (1) the normal supply fans, and (2) the standby supply fans which are equipped with HEPA filter assemblies.

i. Demonstrate control bay Pressure-Relief Vent System.

j. Demonstrate ability of the smoke dampers, which are mounted in shutdown board room ventilation supply and exhaust ducts routed between rooms and through control bay wall, to automatically close upon indication of smoke.

k. Verify operation of all annunciators provided to signal the malfunction of Heating, Ventilating, and Air-Conditioning System equipment, or abnormal air temperature conditions.

13.4.4.6 Heating and Ventilation (H&V): Reactor, Offgas Treatment, and Radwaste Evaporator Buildings and Recombiner Room (TVA-19, including Supplements 1through 3)

13.4.4.6.1 Prerequisites

a. Electrical power available to operate equipment and controls.

b. Cooling water available from raw water system.

c. Cooling coils and piping system hydrostatic test and system flush completed.

d. Control air pressure available to operate pneumatic damper motors.

e. Air filters inspected for cleanliness, ducts cleaned and new filters installed where needed.

f. Balancing of air and water flow quantities for each system completed according to TVA DED guide, "Testing and Balancing of Heating, Ventilating, and Air-Conditioning Systems."

g. All instrumentation installed, tested, calibrated, and operational.

13.4.4.6.2 Test Summary

a. Verify the acceptable operation of the ventilation, cooling, and air-conditioning systems, where applicable, for turbine, radwaste, service, offgas treatment, and radwaste evaporator buildings, and offgas recombiner room and dehumidification system. In the service building only the exhaust fan systems equipped with HEPA filters will be tested.

13.4.4.7 Primary Containment Atmospheric Control (TVA-6)

13.4.4.7.1 Prerequisites for Cooling and Ventilation System

a. Construction testing of cooler fan operation, supply and return duct air distribution system, and cooling coil water flow completed.

b. Electric power available from the emergency diesel bus.

c. Control air available to operate pneumatic motor-operated dampers.

d. Cooling water available to cooling coils from the Reactor Building Closed Cooling Water System.

e. Cooling coils and piping system hydrostatic test and system flush completed.

f. Reactor Building Closed Cooling Water (RBCCW) system operational and its preoperational testing completed (see paragraph 13.4.4.25).

13.4.4.7.2 Test Summary for Cooling and Ventilation System

a. Demonstrate proper operation of the system control logic and components (dampers and fans).

b. Confirm capability of using the system control logic and components to provide additional cooling capacity during a scram.

c. Perform preliminary air flow rate measurements.

13.4.4.7.3 Prerequisites for Inerting System

a. Containment Inerting System including Oxygen Analyzer System.

b. Auxiliary Boiler System.

c. Primary Containment System (to the extent necessary to contain the inerting nitrogen gas).

d. Service and Control Air System.

e. Drywell Control Air System.

f. Drywell Cooling System.

13.4.4.7.4 Test Summary for Inerting System

a. Demonstrate capability of the system to supply nitrogen gas at a sufficient flow rate so that, if continued, the design objectives would be met.

b. Demonstrate automatic control features of the Inerting Control System.

13.4.4.8 Containment Air Dilution (CAD) System (TVA-27)

13.4.4.8.1 Prerequisites

a. Nitrogen supply tank installed and tested.

b. Piping and valves from nitrogen supply tanks to pressure suppression chamber and drywell of unit under test installed and operational.

c. Instrumentation tested and calibrated as necessary.

d. Adequate quantity of liquid nitrogen in each supply tank.

13.4.4.8.2 Test Summary

a. Demonstrate the ability to continuously supply gaseous nitrogen at 50°F or above and at 6000 scfh over a two-hour period to the drywell or pressure suppression chamber of the unit being tested.

b. Calibrate and verify the performance of the monitoring systems for hydrogen and oxygen.

c. Adjust HCV-84-37 and HCV-84-38 to deliver 6000 scfh of gaseous nitrogen.

d. Verify that valves FCV-64-31 and FCV-64-34 can be opened with Hs-84-35, and that valves FCV-64-29 and FCV-64-32 can be opened with HS-84-36.

e. Verify that the drywell and pressure suppression chamber can be vented properly.

13.4.4.9 CS and RHR Pump Compartment Coolers (TVA-7)

13.4.4.9.1 Prerequisites

a. Construction testing of cooler fan operation, air supply duct distribution system, and cooling coil water flow completed.

b. Electrical power available from the emergency diesel bus.

c. Correct electrical power for operating fan motor and control circuits available.

d. Cooling water available from emergency equipment cooling water systems and/or raw water system.

e. Cooling coil and piping system hydrostatic test and system flush completed.

f. Fan motors lubricated and fan belts checked.

g. RHR and core spray pumps operational.

13.4.4.9.2 Test Summary

a. Demonstrate automatic start of each RHR pump-compartment cooler when its associated RHR pump starts.

b. Demonstrate automatic start of each CS pump-compartment cooler when either associated CS pump starts.

c. Demonstrate automatic start of each pump-compartment cooler when its associated temperature sensor is exposed to temperature greater than approximately 100°F.

13.4.4.10 161-kV Electrical System (TVA-8)

13.4.4.10.1 Prerequisites

a. All construction checks for this system completed and documented.

b. All relay setting sheets completed and signed.

13.4.4.10.2 Test Summary

a. Confirm independence of the 161-kV sources of power to the 4160-V auxiliary power system by the simulation of faults on the Trinity and Athens 161-kV line sections and also lines terminating at the Trinity and Athens substations. (Where possible, standard transmission line protective relay tests will be used to demonstrate that one 161-kV line and one common transformer group are available for faults on either the Athens or Trinity 161-kV line sections.)

b. Simulate failure of PCB 924 to trip for a line fault to demonstrate action of the backup relay protection to isolate the fault.

13.4.4.11 4.16-kV Electrical System--Normal Auxiliary Power System (TVA-9)

13.4.4.11.1 Prerequisites

a. The 161-kV yard available to energize both common station service transformers and both cooling tower transformers.

b. Main generator links disconnected and unit station service transformer energized from 500-kV yard.

c. All system construction checks completed and documented as outlined in the applicable Browns Ferry Nuclear Plan construction procedures.

13.4.4.11.2 Test Summary

The equipment involved in this test will be the common station service transformers, cooling tower transformers, circuit breakers 1412, 1414, 1516, and 1518 (except as they apply to tests performed in preoperational testing of the 161-kV electrical system), the 4-kV unit boards 1A and 1B (2A, 2B, 3A, and 3B will be tested before operation of their respective units), the Unit 1 station service transformer (unit station service transformers 2 and 3 will be tested before operation of their respective units, 4-kV cooling tower switchgear and 4-kV bus tie board. The limit of the test will be the load side of the unit board breakers 1126 and 1132 and the load side of breakers 1642, 1742, 1632, and 1732 to the shutdown bus. No other unit board load is involved in these tests.

a. Demonstrate search and transfer operations of the system in seeking a normal power supply before invoking diesel generator operation.

b. Confirm loading and voltage regulation design objectives under design criteria loading (i.e., under the most degraded conditions).

c. Verify short-circuit and inverse-time protection of all 4-kV circuit breakers supplying power to Class 1 boards.

13.4.4.12 480-V Electrical System--Normal (TVA-10)

13.4.4.12.1 Prerequisites

a. Insulation tests of control and power cables completed for equipment to be tested.

b. Power and control cable checklists completed.

c. Insulation tests for switchgear and panelboard equipment completed and satisfactory.

d. High potential tests on 5-kV cables completed and satisfactory.

e. Cable installation and documentation completed and satisfactory.

f. Bus installation completed and satisfactory.

g. Inspection and testing of 480-V AC power circuit breakers completed and documented.

h. Switchboard instruments calibrated and protective relays set according to appropriate setting sheets.

i. Power transformer, current transformer, and potential transformers associated with equipment under tests completed and satisfactory.

j. Wiring and continuity checks completed on equipment under test.

13.4.4.12.2 Test Summary

With two exceptions the components of this system serve no essential safety functions; therefore, the balance of this system will be tested and documented using accepted power plant practices. The two exceptions are 480-V control bay ventilation board A and 480-V control bay ventilation board B. These two boards are exceptions since they are the only components serving essential safety functions which have ties back to the standby auxiliary power system. The 480-V condensate demineralizer boards are also tied back; but these boards serve no essential safety functions.

a. Demonstrate that for a loss of power to either 4-kV common board A or B, all of 480-V common boards 1 and 3 will remain energized through automatic operation of bus feed and bus tie breakers.

b. Demonstrate that the 480-V control bay vent boards will preferentially seek their 480-V common board supplies in lieu of their 480-V common board supplies in lieu of their 480-V shutdown board supplies.

c. In addition to these automatic transfer tests, the trip setting for the 480-V common board breakers feeding the control bay vent boards will be confirmed

by tests and the test results included in the final documentation. (Acceptance should be based on meeting manufacturer's stated accuracy.)

d. Verify short-circuit and inverse-time protection of all branch circuits from any Class 1 boards.

13.4.4.13 AC Supply--Plant Preferred and I&C (TVA-11)

13.4.4.13.1 Prerequisites

All system construction checks completed and documented as outlined in the applicable Browns Ferry construction procedures.

13.4.4.13.2 Test Summary

No loads having essential safety functions are supplied from the Plant Preferred System. Therefore, this system will be tested and documented using accepted power plant practices. The Instrument and Control Power System (I&C) is a Class 1E system subject to interruptions for a duration of up to 10 sec during transfer of the 480-V shutdown boards from normal to diesel power. This system will be tested to prove three major design characteristics as described below.

a. Demonstrate independence of the redundant channels.
b. Demonstrate full-load capabilities of the system.
c. Demonstrate current coordination of the system.

This preoperational test will cover the 480-V shutdown board breakers supplying power to the I&C transformers, the Battery Board Distribution System, and the Panel 9-9 Distribution System. It will include the load breakers but will not include tests on any of the I&C loads. The loads having essential safety functions will be tested in specific system preoperational tests. Loads having no essential safety functions will be tested using accepted power plant practices.

13.4.4.14 Plant Communication System (TVA-12)

13.4.4.14.1 Prerequisites

a. Installation verified to agree with latest reference drawings.

b. All system construction tests completed.

13.4.4.14.2 Test Summary

This test is limited to demonstrating capability of those portions of the system which are independent of a power source and which have signaling capability. Therefore,

the testing will be conducted only on the Backup Control Center System and on the Health Physics System. The balance of the Plant Communication System serves no essential safety function and will be tested using accepted power plant practices.

a. Verify ability to signal using magneto howlers and to acknowledge using sound-powered equipment.

b. Test backup control center system to determine maximum number of jacks into which handsets can be plugged without overloading system.

13.4.4.15 Evacuation Signal (TVA-16)

13.4.4.15.1 Prerequisites

a. Installation verified to agree with latest reference drawings.

b. All system construction tests completed.

13.4.4.15.2 Test Summary

In general, this test is designed to verify that the system functions properly and provides adequate coverage through out the plant. Specific objectives of the test are described below.

a. Demonstrate that the system can be activated at the electrical control room console and the Unit 3 control room console under both normal and abnormal conditions.

b. Verify and document the proper performance of each siren in the system, both quantitatively and qualitatively.

c. Demonstrate that failures within the system, should they occur, are annunciated and are properly identified.

d. Determine that the power distribution network performs properly.

13.4.4.16 Fire Protection System--Water and CO_2 (TVA-13)

13.4.4.16.1 Prerequisites

a. Construction tests and instrumentation calibration completed for high-pressure water fire-protection system.

b. Construction tests of CO_2 fire-protection system completed for the storage unit and the piping and instrumentation serving the diesel generator building

hazard areas. Flooding and concentration tests for the diesel generator building hazard areas, which are done using accepted power plant practices, shall be recorded as part of these preoperational tests.

c. Electrical power available for controls, CO_2 refrigeration unit and fire pump operation.

d. Electrical power available from emergency diesel generator bus to demonstrate that fire pumps may be operated manually in case of an accident signal and loss of normal auxiliary power.

13.4.4.16.2 Test Summary

a. Demonstrate that fire-pump loads are automatically rejected by emergency-equipment logic as long as an accident signal exists coincident with a signal that normal auxiliary power is not available.

b. Demonstrate that individual control switches in the main control room can be used to override the load rejection at any time.

c. Demonstrate automatic start of these pumps under nonaccident conditions.

d. Demonstrate that CO_2 alarm horns for each hazard area in the diesel generator building sound when the timer is actuated, and that discharge into the hazard area does not occur until 20 sec after the horns have started sounding.

e. Demonstrate that CO_2 system is capable of discharging the correct concentration into each hazard area in the diesel generator building. These hazard areas are the diesel generator rooms, the fuel oil transfer pump room, and the electrical board rooms. The balance of the CO_2 Fire Protection System will be tested using accepted power plant practices.

13.4.4.17 Control Air System and Drywell Control Air System (TVA-14)

Testing of the Control Air system and Drywell Control Air System is primarily limited to those portions which serve an essential safety function and for which accumulators or receivers have been provided. Each of these portions extends from the device actuated back to the check valve which is used to isolate that portion from the balance of system on loss of system pressure. An accumulator or receiver is located between the device and the check valve. The devices which are served in this manner by the Drywell Control Air System are six of the main steamline relief valves and four inboard main streamline isolation valves. The devices which are served in this manner by the Control Air System are four outboard main steam isolation valves and the pneumatic door seats for the large equipment lock.

13.4.4.17.1 Prerequisites

a. Installation of all air lines completed from the compressors through the devices to be tested.

b. All air lines cleaned and the pressure and leak tests completed on applicable lines.

c. Air compressors, auxiliaries and receivers, and instrumentation and controls checked out and ready for operation.

d. Electrical AC and DC power available as required.

13.4.4.17.2 Test Summary

a. Verify capability of the Control Air System to shut off supply to the Service Air System on low pressure.

b. Measure leakage rate from pneumatic seats, air receiver, and associated piping and check valve with the piping upstream of the check valve depressurized.

c. Demonstrate that the capacity of the air receiver and associated piping is sufficient for full inflation of seals the design number of cycles and that the equivalent of about one week of leakage could occur without makeup and without loss of sealing capability.

d. Demonstrate that the capacity of each isolation-valve accumulator and associated piping is sufficient to allow the valves to be closed the design number of cycles with the piping upstream of the check valve depressurized.

e. Demonstrate that the capacity of each relief-valve accumulator and associated piping is sufficient to allow the valves to be cycled the design number of cycles with the piping upstream of the check valve depressurized.

13.4.4.18 Offgas System Including SJAE (TVA-15)

13.4.4.18.1 Prerequisites

a. Auxiliary boiler system, offgas system including installation of HEPA filters, and offgas stack dilution system completed, tested, and ready for operation.

b. Turbogenerators and condensers completed and condensers filled to normal operating level.

c. Condensate system and condensate demineralized system completed and ready for operation.

13.4.4.18.2 Test Summary

a. Using steam from the auxiliary boiler, this test will confirm ability of the system to: (1) automatically start the standby SJAE on low condenser vacuum, and (2) automatically isolate the system on high pressure, on high temperature, and on low-low condenser vacuum. It will also determine the steady-state leakage rate through the seals of the condenser. (Incidental to this test the functioning of the Turbine Seal System will be demonstrated.)

b. Demonstrate proper operation of the dilution fan and mechanical vacuum pump control logic.

c. Demonstrate satisfactory efficiency of HEPA filters.

13.4.4.19 Turbine Electrohydraulic Control (EHC) System Including IPR's and Remote Controls (TVA-17)

13.4.4.19.1 Prerequisites

a. Turbine lube oil system completed, tested, and ready for operation.

b. Turbine hydraulic fluids system completed, tested, and ready for operation.

c. Normal turbine protective systems (hydraulic, mechanical, electric, and electronic) all installed, tested, and ready for zero speed operation. The conventional turbine trips should have been previously checked out, and should produce the required turbine trip through energizing the master trip relay. Since these trips serve no essential safety function, it is enough to demonstrate that a turbine trip from the master trip relay will trip close all turbine valves to initiate a reactor scram.

d. Turbine EHC system installed, properly aligned, and completely checked and tested and ready for zero speed operation.

e. Reactor protection system completed, tested, and determined to be ready for operation through the "Autoscram" channels.

f. Control room annunciation and sequential events systems installed, tested, and ready for operation.

g. Sufficient control room instrumentation in service so as to monitor performance of all necessary turbogenerator auxiliaries.

h. Appropriate electrical supply (power and control, AC and DC) available for items a through f, plus cooling water as required for turbogenerator auxiliaries, heat exchangers, etc.

13.4.4.19.2 Test Summary

The conventional turbine tests performed on this system involve features which serve no essential safety functions; therefore, that portion of the testing will be conducted and documented using accepted power plant practices.

a. Verify under simulated conditions the initiation of reactor scram signals on turbine-control-valve closure, and low EHC oil pressure with the turbine first stage pressure greater than 30 percent of the rated value.

b. Verify under simulated conditions the performance of the Bypass-Valve System and its response to control valve closure.

c. Verify under simulated conditions the capability of various turbine trip initiating conditions to trip the turbine. Sequence-of-event printout capability should be available during this portion of the test.

d. Demonstrate under simulated conditions bypass-valve closure and feedwater turbine trip on insufficient condenser vacuum in addition to main turbine trip.

13.4.4.20 Secondary Containment Leak Rate Test (Including Standby Gas Treatment System--SGTS, Vacuum Relief System, and Primary Containment Purge to the SGTS), (TVA-20)

13.4.4.20.1 Prerequisites

a. Electrical power available to operate equipment and control systems.

b. Electrical power available from emergency diesel boards A and B for designated SGTS equipment.

c. Control air available for pneumatically operated dampers.

d. Air supply, return, exhaust, dampers, and ductwork of the reactor building ventilating system available for service.

e. Doors and seats for personnel and equipment locks in place and operational.

f. Completion of all secondary containment penetrations to the zone or zones to be leak tested.

g. Architectural siding on refueling floor has passed quality leak rate tests.

h. Relief panels at main steam penetrations and between zones installed.

i. SGTS suction piping and ductwork cleaned to remove all foreign debris that might poison the charcoal.

j. Static pressure limiters are installed, tested, and operative.

k. Vacuum relief units installed, tested, calibrated, and operative.

l. SGTS instrumentation installed, tested, calibrated, and operational.

m. SGTS exhaust piping and stack exhaust vent and piping available for use.

13.4.4.20.2 Test Summary

a. Demonstrate that all three of standby redundant components (dampers) or trains start initially. NOTE: The remaining test requirements must be met with the refueling zone alone isolated and with both the refueling zone and the reactor zone isolated.

b. Demonstrate that any two out of three SGTS blowers can produce the design flow rate.

c. Demonstrate operation and leak tightness of the isolation dampers. The modulating capability of the Vacuum Relief System will be checked. The containment leakage rate will be determined by comparison between the inflow through the SGTS.

d. The operating range of the vacuum relief dampers will be compared with the physical limits.

e. Demonstrate that test conditions do not result in requiring excessive force to open any doors. In addition, demonstrate that the door closers can maintain closure of other doors.

f. Determine the differential pressure between specified locations in any isolated zone and specified locations in adjacent zones or on the building exterior.

13.4.4.21 Leak Test of Drywell to Pressure Suppression Chamber Vacuum Breakers (TVA-24)

13.4.4.21.1 Prerequisites

a. Preoperational Test GE-14A, Integrated Primary Containment Leak Rate Test, completed and primary containment integrity established.

13.4.4.21.2 Test Summary

a. Establish the leakage rate between the drywell and the pressure suppression chamber with the vacuum breakers closed.

b. Detect flow path between the drywell and pressure suppression chamber whose total capacity is equal to or greater than the capacity of a 1-inch diameter orifice.

c. To verify, by superimposing a known flow, the accuracy of the leak rate test.

13.4.4.22 Reactor Building Crane (TVA-21)

13.4.4.22.1 Prerequisites

a. Crane construction testing completed and permanent power available.

b. The crane emergency stop stations along north wall checked for proper operation.

13.4.4.22.2 Test Summary

a. Verify that the 125-ton Reactor Building crane will operate in good mechanical and electrical condition and that it handles its rated capacity.

b. Perform inspection of mechanical and electrical equipment.

13.4.4.23 Miscellaneous Gaseous Radiation Monitoring Systems (TVA-22)

This testing includes the following systems:

a. Plant Ventilation Exhaust Radiation Monitoring System.

b. Drywell Leak Detection Air Sampling System.

c. Area Radiation Monitoring System, Air Particulate Monitoring Subsystem.

13.4.4.23.1 Prerequisites

a. Systems listed in Sections 13.4.4.13.a, .b, and .c above completed and construction checks completed.

b. Instrumentation calibrated.

c. Applicable alarm set points calculated.

13.4.4.23.2 Test Summary

The following types of testing are required prior to fuel loading:

a. Check continuity and resistance to ground of all signal and power cables.

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

c. Check alarm and trip set point.

d. Check chamber response to bugging sources.

e. Functionally check sampling and recording equipment including failure alarms.

13.4.4.24 Environs Monitoring (TVA-23)

13.4.4.24 Prerequisites

Monitors functioning and capable of telemetering data to the logarithmic recorder installed in the Unit 1 control room.

13.4.4.24.2 Test Summary

a. Verify and document capability of local and perimeter radiation monitors to perform their design function.

b. Verify calibration, signal transmission, main control room recording, and malfunction alarm performance.

13.4.4.25 Feedwater System (TVA-25)

13.4.4.25.1 Prerequisities

a. Condensate-feedwater systems completed, tested, and ready for operation.

b. Condensers completed and filled, along with the condensate-feedwater system, to normal operating level.

13.4.4.25.2 Test Summary

a. Demonstrate that condensate booster pumps operating in series with condensate (hotwell) pumps are capable of pressurizing the reactor to approximately 385 psig.

b. Verify that condensate (hotwell) pumps, when operating alone can supply at least 35 psig pressure to the reactor feed pump suction valve to permit operation at low flows for emergency service. For other testing of the condensate and feedwater system see paragraphs 13.4.4.2 and 13.4.4.28.

13.4.4.26.2 Test Summary

Demonstrate capability of the system to take water from the pressure suppression pool and pump it to Auxiliary Boiler "A." Water from the upper portion of the upper

drum will be returned to the pressure suppression pool. Auxiliary Boiler "A" shall be isolated from the other boilers and from the heating system during this test.

13.4.4.27 Raw Cooling Water System (TVA-32)

13.4.4.27.1 Prerequisites

a. System construction testing and instrumentation calibration completed.

b. Electrical power available for system control and for system pump operation.

c. Preoperational testing for the EECW System completed.

d. Individual unit condenser-circulating-water pumping system operable.

e. Condenser circulating water diffusers capable of receiving RCW discharge as follows: Unit 1 RCW - Unit 2 CCW, Unit 2 RCW - Unit 3 CCW, Unit 3 RCW - Unit 1 CCW.

f. Vacuum priming system operable.

g. RHR pumps available for operation.

13.4.4.27.2 Test Summary

a. Demonstrate capability of supplying the RHR-pump seal heat exchangers and the RHR-compartment coolers.

b. Demonstrate that one RCW pump per unit can be supplied from the intake conduit with no condenser circulating water pumps operating for that unit. (This capability is not essential to safe shutdown.)

13.4.4.28 Evaporator for Radioactive Waste System (TVA-34)

13.4.4.28.1 Prerequisites

a. All construction tests, preliminary equipment test, and instrument checks must be completed prior to this test.

b. Entire evaporator system operable.

c. Auxiliary boiler steam supply and condensate return available.

d. Raw cooling water available.

e. Demineralized water or seal water available.

f. All tanks cleaned.

g. All sumps cleaned and limit switches set.

13.4.4.28.2 Test Summary

a. Verify the functions of all controls and interlocks.

b. Verify the operation of all air operated valves.

c. Verify the operation of all pumps by checking pump operation in recirculation mode and simulating all other operations.

d. Check tanks by draining or filling, recirculating, sampling, and processing to other tanks.

e. Check sumps by filling with water, operating sump pumps to verify functioning of level controls, and checking discharge to proper collection tank in radwaste for no back flow or leakage en route.

f. Check evaporator by demonstrating the ability of the system to remove water and increase the concentration of a sodium sulfate solution to 25 percent by weight.

13.4.4.29 Radioactive Waste Solidification System (TVA-35)

13.4.4.29.1 Prerequisites

a. All construction tests, preliminary equipment test, and instrument checks completed.

b. Entire solidification system operable.

c. Applicable portions of the system completely flushed with demineralized water.

13.4.4.29.2 Test Summary

a. Verify ability of the system to solidify mixtures of Tiger Lock (urea-formaldehyde) and waste solution in the ratio of 1 to 3, respectively.

b. Verify ability of system to solidify mixtures of water, sodium sulfate, and concentrated floor drainwastes of the lowest possible radioactivity level.

c. After solidification check container for free standing water and the homogeneity of the solidified mass.

13.4.4.30 Solid Radwaste System (TVA-18)

13.4.4.30.1 Prerequisites

a. Liquid radwaste preoperational testing complete (see paragraph 13.4.4.54).

b. One phase separator filled with a minimum of settled sludge from both powder demineralizer and solkafloc filters.

c. Spent resin tank contains one charge of depleted head resins.

d. Portable tank available to be used as a simulated waste package. The tank must have an open top to observe dewatering procedure.

13.4.4.30.2 Test Summary

a. Verify ability of the transfer and compacting equipment to take wet solids from phase separator tanks and to prepare these solids for shipment.

b. Verify ability of the bailing equipment to package dry solid wastes.

13.4.4.31 Condensate Demineralizer System Test (GE-17)

13.4.4.31.1 Prerequisites

a. System completed and cleaned.
b. Condenser hotwell and condensate pumps operational.
c. Condensate system cleaned and flushed.

13.4.4.31.2 Test Summary

a. Initiate precoat system and precoat demineralizer with resins.

b. Check instruments and controls.

c. Operate filter demineralizers. Obtain clean pressure drop data for each unit.

d. Check system instrumentation and controls for proper operation.

e. Check operation of filter aid body coat system.

f. Verify that effluent water meets proper water quality specifications.

13.4.4.32 Reactor Building Closed Cooling Water System Test 1GE-15)

13.4.4.32.1 Prerequisites

a. Supply of demineralized water available.

b. Air available for operation of air-operated valves.

c. Chemical injection system operational for injecting corrosion inhibitor.

d. AC and DC control power available.

13.4.4.32.2 Test Summary

a. Fill system with water and inhibitor--check surge tank level indication and alarms.

b. Check operation of reactor building cooling water pumps.

c. Check division of cooling water flow to heat exchangers.

d. Check all system instruments.

e. Check all automatic actions, such as pump start or partial system isolation if necessary.

13.4.4.33 Control Rod Drive Hydraulic System Test (GE-10)

13.4.4.33.1 Prerequisites

a. All CRD piping and wiring installed and connected.

b. System flushed and cleaned.

c. System filled and demineralized water available in demineralized water reservoir.

d. CRD hydraulic supply pumps operations.

e. Control air available.

f. AC and DC power available.

g. Power available through reactor safety circuit to energize scram valves.

13.4.4.33.2 Test Summary

a. Calibrate instruments.

b. Check alarms, controls, and interlocks.

c. Obtain pump performance data (e.g., head, flow, suction pressure, bearing, and cooling water temperatures, motor current, and RPM). NOTE: The above portion of the Preoperational Test may be performed much earlier than the remainder of the test because the pumps are used for the flushing listed in item (b) of the prerequisites.

d. Adjust flow control valves.

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

    1. Scram valves and scram solenoid pilot valves.

    2. Scram backup pilot valves.

    3. Scram volume dump and vent valves.

    4. Drive selection valves, withdraw and insert control.

f. After drives and rods 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.

5. Transient response of system during insert and withdraw operations, or following scrams, including checking the scram dump volume level instrumentation and drain and vent valves.

The above control rod drive hydraulic system and control system tests are completed before beginning tests of individual control rod drive mechanisms. All internals are in 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. Check proper position indication and in/out lights.

g. Repeat those tests in the hydraulic system and manual control system which are required to verify total system performance.

h. Recheck rod control interlocks.

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

13.4.4.34 Primary Containment Leak Rate Measurement Test (GE-14)

13.4.4.34.1 Prerequisites

a. All piping and electrical penetrations of the primary containment in place.

b. Testing described in items 1 through 3, below, need not be performed in sequence; however, the remaining items are performed in sequence, i.e.:

1. Individual penetration leak rate measurements.

2. Isolation valve operating test.

3. Valve seat leakage measurements.

4. Overpressure test.

5. Design pressure tests (may precede 2 and 3).

6. Combined leak rate measurement.

c. All isolation valves fully operable.

d. Containment spray and core spray systems completed and operable.

e. During the combined leak rate measurement at design pressure, no equipment shall be operating within the containment and no heat sources shall be energized or hot or cold fluids circulating.

f. A complete survey made to locate and remove any instrumentation, light bulbs, etc., which could be damaged by external pressure.

13.4.4.34.2 Test Summary

a. Check individually testable penetrations by applying air pressure and checking with soap bubbles.

b. Stroke all containment isolation valves and leave in closed position.

c. Pressurize to 5 psig and check with soap bubbles all penetration welds made subsequent to design pressure test.

d. Pressurize to 49 psig and conduct leak rate measurement using absolute method.

e. Repeat the test at 25 psig in order to establish an appropriate relationship between leakage rate and containment pressure.

13.4.4.35 Fuel Pool Cooling and Cleanup System Test (GE-18)

13.4.4.35.1 Prerequisites

a. All piping installed and thoroughly cleaned.

b. Electrical supply complete to this system.

c. Instrumentation installed and calibrated.

d. Fuel pool thoroughly cleaned and filled with demineralized water.

e. Proper air supply available.

13.4.4.35.2 Test Summary

a. Check alarms, controls, and interlocks.

b. Recirculate pool water through heat exchangers, bypassing filter demineralizer.

c. Check operation of filter valves, precoat pumps and filter air pumps.

d. Simulate resin precoating and backwashing operation of filter demineralizer, using demineralized water only (and air as required). After satisfactory simulation and when general cleanliness of fuel pool and refueling floor area warrants, charge resins and place filter demineralizer in routine service. Verify system flow rates from pump headflow characteristics.

e. Check level alarms in pool and surge tanks against actual changes in level.

13.4.4.36 Fuel Handling Equipment Test (GE-11)

Equipment covered in this category will be tested with a load equivalent to 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.

13.4.4.36.1 Prerequisites

a. Refueling platform installed.

b. Fuel preparation machine installed.

c. Fuel racks installed.

d. Electrical Services operational.

e. Control circuits checked and available for service.

f. Pumps and motor properly lubricated, pump shaft packing installed, motors recently meggered and tested to ensure correct rotation, motor ventilation not blocked. All items pertaining to initial start and operation of pumps and motors completed.

g. Refueling platform air complete.

13.4.4.36.2 Test Summary (not necessarily in chronological order)

a. Tests in the storage pool.

    1. Install fuel pool gates and fill pool with water. Pressurize seals if necessary. Inspect for leakage.

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

    3. Check fixed overhead lights and movable underwater lights to assure adequate visibility for fuel and blade handling and transfer operations.

    4. Check underwater vacuum cleaner.

    5. Operate refueling platform over 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.

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

b. Tests over reactor vessel.

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

2. Verify procedural methods and tools for:

(a) Removal and replacement of steam dryer assembly.

(b) Removal and replacement of shroud head steam separator assembly.

(c) Removal and replacement of control rod blades, fuel support pieces, and control rod guide tubes.

(d) Removal and replacement of incore flux monitor strings.

(e) Removal and replacement of jet pump nozzles and risers.

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

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

4. Obtain representative values of the time required to do all operations normally in the critical path of a refueling outage.

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

13.4.4.37 Control Rod Drive Manual Control Tests (GE-9)

13.4.4.37.1 Prerequisites

a. Construction completed on CRD position indicating system.

b. Construction completed on reactor manual control system.

c. It is not necessary that drives be installed or the hydraulic system functioning. However, if drives are installed or hydraulic system is operating, the isolation valves to each drive should be closed on the hydraulic control module.

d. The hydraulic control units must be installed and wiring complete and checked.

13.4.4.37.2 Test Summary

a. Verify all rod blocks.

b. Check that rod position information system functions properly.

c. Check for proper timing sequence of CRD control circuit.

d. Verify proper operation of CRD select circuit.

13.4.4.38 Rod Sequence Control System (RSCS)(GE-29)

13.4.4.38.1 Prerequisites

a. Reactor Manual Control System (ge-9) tested and operational.

b. Rod Worth Minimizer System (GE-24) tested and operational.

c. Control Rod Drive Hydraulic System (GE-10) tested and operational.

d. RSCS electrical cables and panel wiring tested.

e. RSCS power supplies adjusted.

f. RSCS self test feature tested and operational.

g. All control rods initially in.

13.4.4.38.2 Test Summary

a. Check power supplies for proper voltage.

b. Check Rod Group push button illuminate properly.

c. Check the system for group verification, full in bypass tests, fence tests, full out bypass tests, group select blocks, insert blocks, sequence tests and notch control tests.

d. Check the systems for proper push button illumination in the tests.

e. Test the system for annunciation of actual or simulated deviations from the normal sequencing.

13.4.4.39 Reactor Water Cleanup System Test (GE-2)

13.4.4.39.1 Prerequisites

a. AC power from 480-V shutdown board available.

b. AC and DC control power available.

c. Condensate or demineralized water available to supply cleanup pump suction.

d. Control and service air supply available.

e. RBCCW system operational.

f. Condensate storage and supply system operational.

g. Liquid radwaste system functional to receive discharge fluids.

h. Solid radwaste system operational.

i. A supply of ion exchange resins available.

j. Strainers installed upstream of the reactor water cleanup recirculation pump.

The system is flushed, cleaned, and initially checked out while the reactor vessel is empty for the installation of drive mechanisms, by supplying it with demineralized water 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. The filter demineralizer may be operated only when precoated; otherwise, it must be bypassed.

13.4.4.39.2 Test Summary

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

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

c. Check operation of filter demineralizers, holding pumps, precoat equipment and all associated equipment. Perform all required operations, such as precoating, normal operation, standby recirculation, and backwashing. Be sure that system is set up so that filter breakthrough will not dump impurities into the reactor (route to radwaste for initial operation).

d. Simulate pumping of spent resin to radwaste system (pump nonradioactive sludge water generated during preoperational testing program).

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

f. Check calibration, alarm, and/or trip (interlock) set points of all instrumentation.

g. After system is proven to be operational in all modes of operation possible to demonstrate without pressure or temperature in the reactor, charge filter demineralizers. Place the system in normal service when water is in the reactor during later preoperational testing.

13.4.4.40 Offgas Recombiner and Charcoal System (GE-34)

13.4.4.40.1 Prerequisites

a. Required functional testing and quality assurance documentation on all electrical and mechanical components is complete.

b. AC and DC control power is available.

c. Proper air supply available.

d. Preliminary and final cleaning complete by construction.

e. Helium leak tests completed on all valves and components.

f. Filter media installed in the pre- and after-filters.

g. Recombiner catalyst installed.

h. Required quantity of activated charcoal installed in the absorber vessels.

i. Refrigeration machines placed in service and proper operation of the glycol circulating pumps verified.

j. Vault air-conditioning units placed in service and verification obtained that units can maintain the desired vault temperature, pressure, and relative humidity throughout a given test period.

k. Steam available at 350 lbs/hr and between 180 to 250 psi.

l. Condensate supply available.

The system cannot be completely checked during the preoperational phase because operating temperature and pressure conditions are required in the main condenser for "normal" system operation in order to complete the testing. If steam supply is not available, flow testing of the system must be deferred until nuclear steam is available. The hydrogen analyzers will not be functionally tested until the system is placed in "normal" operation. In all cases where redundant components exist, the "B" component flow path will be isolated and only the "A" flow path will be used.

13.4.4.40.2 Test Summary

a. Calibrate all instruments and check all alarms and set points.

b. Verify that the sensors and associated instrumentation perform the proper function.

c. Verify that all valves operate properly by functionally testing them.

d. Check all components of the system including the pre- and after-filters.

e. Verify that both of the level controllers in the offgas condenser will maintain proper level control.

f. Verify the proper logic on all primary and secondary valves.

g. Verify that the pre- and after-filters perform efficiently by inplace DOP testing with an air flow equivalent to the nominal rated operating flow.

h. After the system is proven to be operational in all modes of operation the RECHAR system should be lined up for operation in accordance with station operating instructions. Test apparatus should be secured and the system made leak tight and otherwise ready for service.

13.4.4.41 Standby Liquid Control System Test (GE-3)

13.4.4.41.1 Prerequisites

a. Construction completed on entire system including electrical and mechanical.

b. Normal air supply available.

c. Demineralized water supply available.

d. Instrumentation checked out and calibrated.

13.4.4.41.2 Test Summary

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).

a. Calibrate instruments and check all alarm and set points.

b. Fill standby liquid control solution tank with demineralized water and operate the injection pumps, recirculating to the tank.

c. Check set point of the pump discharge relief valves.

d. Check control circuits for the explosive injection valves thoroughly before connecting to the valves. Use a dummy resistance to simulate the valve during the circuit checkout.

e. Turn the keylock switch to each channel to fire the explosive valve and start the injection pump. Measure pumping rates into the reactor.

f. Check the interlock with the reactor water cleanup system to ensure isolation when the standby liquid control system is actuated.

g. Check operation of the standby liquid control solution temperature controls and air sparger.

h. Fill test tank with demineralized water and operate the injection pumps in simulated test mode, recirculating to test tank. Stop all leakage from the pump packings.

i. After the system has been demonstrated by the foregoing tests, replace the valve explosive cartridges. Add the required boron chemical to the standby liquid control solution tank. Mix and sample. This should be done very shortly before fuel loading. Recheck that the pump packings are not leaking.

13.4.4.42 Core Spray System Test (GE-12)

13.4.4.42.1 Prerequisites

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

b. Pressure suppression chamber filled with water to operating level.

13.4.4.42.2 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 manufacturer's headflow curves and measured system pressures.

d. Check operation of all motor-operated valves.

e. Initiate system automatically and verify that valves open and that pumps start.

f. Isolate pump suction from torus and route to receive pump supply directly from condensate storage tank. Spray into reactor vessel. Verify proper flow rate and observe spray pattern. Pumping capability from the torus will be verified by recirculating through the test line.

g. Simulate the accident condition simultaneously with a power failure and observe proper sequential operation of system pumps and valves. This test is run concurrently with the containment cooling system automatic operation test and the diesel generator automatic starting test.

13.4.4.43 HPCI System Test (GE-13)

13.4.4.43.1 Prerequisites

a. Construction completed on entire system.

b. Torus filled to normal water level.

c. Steam from auxiliary boiler available for HPCI turbine.

d. An adequate quantity of water in the condensate storage tank available.

e. All instrumentation checked and calibrated.

13.4.4.43.2 Test Summary

a. Check out the functional capability of all components needed to operate under simulated accident conditions as far as is practical. Final full capacity testing of the HPCI system may be deferred until adequate steam supply is available.

b. Check all components of the system including the turbine, pumps, valves, and associated instrumentation.

c. Verify that the system satisfies its design objective and also determine reference characteristics such as differential pressures and flow rates that can be used as base points for check measurements in subsequent testing of the system.

13.4.4.44 Residual Heat Removal System Test (GE-5)

All portions of this system are tested during the preoperational testing of the various modes of the RHRS: Containment Spray and LPCI (see paragraph 13.4.4.45) and Shutdown Cooling (see paragraph 13.4.4.46).

13.4.4.45 Containment Spray and LPCI Test (RHR System) (GE-5)

13.4.4.45.1 Prerequisites

a. Torus filled to normal water level with demineralized water.

b. Instrumentation checked and calibrated.

c. Construction complete on system.

d. Electrical AC and DC power available.

13.4.4.45.2 Test Summary

a. Check alarms, controls, and interlocks.

b. Operate RHR pumps by recirculating in the test mode to torus only (not drywell). Verify proper performance by using installed pressure and flow instrumentation.

c. Check flow rate in LPCI mode by pumping from the torus to the reactor vessel.

d. Flow test several drywell spray nozzles before installation on the spray headers. Inspect all nozzles before installation to verify cleanliness and proper opening size.

e. Blow air through drywell spray headers to verify that all nozzles are installed properly.

f. With containment spray valves closed and locked out of service, initiate system automatically and verify proper pump starting for normal power and emergency power modes of operation.

g. Check the RHR crossconnection between units to demonstrate circulation of torus on reactor vessel water from Unit 1 through the A and C RHR loops of Unit 2.

13.4.4.46 Shutdown Cooling Test (RHR System) (GE-5)

13.4.4.46.1 Prerequisites

a. Construction completed.

b. Electrical power available.

c. Vessel water at normal level.

d. All instrumentation installed and calibrated.

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

13.4.4.46.2 Test Summary

a. Check operation of all motor-operated valves.

b. Check interlocks in valve and pump control circuits.

c. Measure system pressures where possible and determine flow rates from pump characteristic curve.

d. Measure closing time of isolation valves.

e. Demonstrate proper functioning of valves in the RPV head spray subsystem. (Demonstration of flow capability may be deferred until after fuel is loaded and the RPV head is installed.)

13.4.4.47 RCIC System Test (GE-6)

13.4.4.47.1 Prerequisites

a. Construction completed on system.

b. Electrical power available.

c. Steam available from the auxiliary boiler for turbine testing.

d. Instrumentation calibration completed.

13.4.4.47.2 Test Summary

a. Verify the operability of system logic and equipment under no-flow conditions.

b. Verify proper integrated system response to manual and automatic controls using the site boiler to supply steam to the turbine.

13.4.4.48 Nuclear System Safety and Relief Valve Test (GE-4)

13.4.4.48.1 Prerequisites

a. Electrical power available.

b. All valves properly installed.

c. Discharge the vacuum breaker valves installed and checked.

d. Instrumentation installed and calibrated.

e. Drywell Control Air System operable.

13.4.4.48.2 Test Summary

a. Safety and relief valves will be installed as received from the factory. (Set points were factory adjusted and verified and are indicated on the valves.)

b. Verify proper operation of remote controlled relief valves from main control room.

c. Check automatic blowdown function of the relief valves with a simulated pressure signal.

d. Check automatic initiation of contacts, relays, and logic.

13.4.4.49 Reactor Protection System Test (GE-21)

13.4.4.49.2 Prerequisites

a. All safety system sensors installed and calibrated.

b. All wiring installed and checked for continuity.

13.4.4.49.2 Test Summary

a. Operate RPS MG sets with a resistive load to check capacity and regulation.

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

c. Check operation, pick up and drop out voltages of the protection system relays.

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

e. Using test signals, verify alarm, interlock and scram set points. Check proper operation of level switches by varying water level in the reactor vessel, measuring the actual water level against a suitable reference point such as the vessel flange.

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

13.4.4.50 Miscellaneous Neutron and Gamma Radiation Instrument Systems Testing (GE-22 A-E, 23, 25, and 26)

This testing includes the following systems:

a. Source range monitoring system.

b. Intermediate range monitoring system.

c. SRM/IRM chamber drives.

d. Average power range monitoring system.

e. Local power range monitoring system.

f. Traversing incore probe system.

g. Area radiation monitoring system.

h. Process liquid and gas monitors.

13.4.4.50.1 Prerequisites

a. Systems (a through h, paragraph 13.4.4.50) completed and construction checks completed.

b. Instrumentation calibrated.

c. Applicable alarm set points calculated.

13.4.4.50.2 Test Summary

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

a. Check continuity and resistance to ground of all signal and power cables.

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

c. Check alarm and trip set points.

d. Check chamber response to bugging sources.

e. Check all interlocks with the reactor manual control system.

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

g. Using dummy TIP chamber, insert calibration probe in all incore calibration tubes. Verify capability to insert more than one calibration probe in the crosscalibration guide tube. Repeat with all five TIP machines operable.

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

13.4.4.51 Process Computer System (Rod Worth Minimizer Function) Test (GE-24)

13.4.4.51.1 Prerequisites

a. Computer installation completed.

b. Electrical power available.

13.4.4.51.2 Test Summary

After control rod drive system is operational, withdraw control rods in various sequences to expose the rod worth minimizer function of the process computer 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 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 function. 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
8. Withdraw block
9. Bypass block

f. Check all controls

1. Sequence A mode
2. Sequence B mode
3. Shutdown margin mode
4. Scan exit
5. Print log
6. Error clean

g. Check all displays and information printout.

1. Group identification
2. Withdrawal error readout
3. Insertion error readout
4. Printout rod position from scan and from memory for several rod withdrawal patterns

13.4.4.52 Reactor Recirculation System Test (GE-8)

13.4.4.52.1 Prerequisites

a. 4160-V electrical power available
b. 440-V electrical power available

c. Reactor hydrotest and cleaning completed
d. Water in the vessel during pump tests

13.4.4.52.2 Test Summary

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

a. Operate all recirculation loop valves. Simulate the automatic operation of these valves following a breach of one of the recirculation loops.

b. Calibrate loop instrumentation and check controls and interlocks.

c. Operate recirculation pumps and MG sets at reduced speed.

d. Check flow control transient operation within the range permitted by cold water and atmospheric pressure in reactor. Optimize controller settings for system linearity and response time requirements.

13.4.4.53 Primary Containment Isolation System Test (GE-30)

13.4.4.53.1 Prerequisites

a. Construction completed.

b. Control air available.

c. Reactor protection system operating.

d. Electrical power available.

13.4.4.53.2 Test Summary

a. Check manual and auto logic control of all isolation valves.

b. Check valve stroke time.

c. Check valve control from backup control centers.

13.4.4.54 Liquid Radioactive Waste Disposal System Test (GE-20)

13.4.4.54.1 Prerequisites

a. Construction completed.

b. Instrumentation installed and calibrated as required.

c. Electrical power available.

d. Proper air supply available.

13.4.4.54.2 Test Summary

After fuel is loaded in 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. (For testing of Solid Radwaste System see paragraph 13.4.4.30.)

a. Check all controls and interlocks.

b. Recheck all air-operated valves.

c. Pumps and tanks.

    1. Clean tanks mechanically.

    2. Fill with demineralized water.

    3. Check pump operation in recirculation mode whenever possible.

    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.

d. Filters (waste collector and floor drain).

    1. Perform all required operations such as precoating, normal operation, recirculation, and backwashing.

    2. Check operation of filter components only after precoating, using demineralized water only, until system operation is acceptable.

e. Sumps (Drywell, Reactor, Standby Gas Treatment, Turbine and Radwaste Buildings).

1. Clean out sumps. Check and set level switches.

2. Fill sumps with water.

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

4. Verify discharge to proper collection tank in radwaste with no back flow or leakage en route.

5. Check valving to heat exchangers where supplied, and operation of temperature controls.

f. Chemical Waste System.

1. Partially fill chemical waste tank with demineralized water.

2. Demonstrate all pumping operations with demineralized water only; recirculation, sampling, and transfer to floor drain collector tank.

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

g. Spent resin system.

1. Simulate transfer of resins from the waste demineralizer to the spent resin tank.

2. Verify 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 reclaiming resins.)

h. Filter sludge processing.

1. Simulate transfer of sludge from the several filters and filter demineralizers to the respective backwash receiver tanks using water only. Simulate transfer from backwash receiver tanks to phase separator.

2. Repeat sludge transfers with actual filter aid material.

13.4.4.55 Standby AC Power System Test (GE-31)

13.4.4.55.1 Prerequisites

a. Electric system tests (see paragraphs 13.4.4.10-.11 and .47) completed prior to this test.

b. Vendor representative for the power source (i.e., emergency diesel generator) present for the test.

c. Devices on the control panels such as controls, interlocks, indicators, push buttons, and annunciators (including their associated circuitry) operative, tested, and adjusted before the preoperational test is started.

13.4.4.55.2 Test Summary

a. Perform load tests to verify diesel generator capacity.

b. Check automatic start of the available diesels upon loss of power.

c. Check automatic sequencing of major motors which occurs during accident conditions.

d. Check automatic redistribution of load after failure of one diesel.

e. Perform an integrated test demonstration operation of all plant safety systems subsequent to a loss of offsite power.

13.4.4.56 DC Power System Test (GE-32)

13.4.4.56.1 Prerequisites

a. Complete all construction testing. Complete all controls, polarity, meggering and alarm checks for battery chargers, batteries, and distribution center.

b. Complete battery installation including initial charge and float control.

c. Complete adequate room ventilation and air exhauster system.

13.4.4.56.2 Test Summary

a. Checkout operation of battery chargers.

b. Check out all system operation actions and alarms.

c. Perform battery service test.

13.4.4.57 Feedwater Control System Test (GE-1)

13.4.4.57.1 Prerequisites

a. System completed.

b. Control air available.

c. Electrical power available.

d. Instrumentation calibrated.

13.4.4.57.2 Test Summary

a. Check proper operation of instruments and controls.

b. Simulate reactor level variations and verify proper response. (For other testing of the condensate and feedwater system see paragraphs 13.4.4.2 and 13.4.4.25.)

13.4.4.58 Unit Preferred Power System Test (GE-33)

13.4.4.58.1 Prerequisites

a. Complete all construction testing for the motor generator sets, transformers and their associated devices.

b. Complete all construction testing for the panelboards and circuits to them (including continuity and phasing checks, dielectric tests and alarms).

c. AC power from 480-V shutdown board available.

d. 250-V DC power available.

13.4.4.58.2 Test Summary

a. Check proper operation of all motor generator sets.

b. Check proper operation of all automatic transfer operations.

c. Checkout all alarm and indication instrumentation.

13.4.4.59 Process Computer Tests (in addition to rod worth minimizer) (GE-28)

13.4.4.59.1 Prerequisites

a. System complete, power available.

b. All systems that provide input to computer completed and connected.

13.4.4.59.2 Test Summary

a. Perform computer self checks.

b. Verify computer operation.

Computer testing will continue during the startup and power test programs.

13.4.4.60 Primary Containment Atmospheric Monitor (GE-35)

13.4.4.60.1 Prerequisites

a. Required testing and quality assurance documentation on all cables for the primary containment atmospheric control (inerting system) complete.

b. Temporary jumpers marked and recorded.

c. Required testing and quality assurance documentation on all electrical equipment for the primary containment control (inerting system) complete.

d. All instruments have been installed and checked.

e. An inspection has been made of the electrical and mechanical equipment installation and a tentative transfer of the system has been made to DPP.

f. The applicable drawings are maintained by the configuration control group in the master file. The drawings are marked to reflect the latest system configuration. These drawings, with the revisions listed, functionally reflect the operability of the system as it will be preoperationally tested.

g. The control air system must be available for service.

h. All calibration gas supplies are connected and operable.

i. Construction of system piping complete.

13.4.4.60.2 Test Summary

a. Verify that the log rad monitors operate properly.

b. Verify that the oxygen analyzers operate properly.

c. Verify that the hydrogen analyzers operate properly.

13.4.4.61 Leak Detection System Test (GE-19)

13.4.4.61 Prerequisites

a. Electrical checks completed and all buses and MCCs supplying motors, solenoids, and instruments energized.

b. Control air system available.

c. Instruments checked and calibration data sheets completed.

d. Drywell floor drain sump pumps and drywell equipment drain sump pumps checked for alignment and rotation. Sump pumps and motors lubricated.

e. Variable-flow makeup water supply available to drywell sumps.

f. Floor areas which are drained to drywell floor drain sump, cleaned and flushed to drain.

g. Drywell sumps drained and mechanically cleaned prior to operation of sump pumps.

h. Startup suction strainer installed on drywell sump pumps.

13.4.4.61.2 Test Summary

a. Verify proper operation of the sensors associated with detection of leaks from the primary system during normal plant operation.

b. Verify logic and active components associated with isolation and annunciation of these leaks.

13.4.4.62 Test of Condenser Circulating Water Pump Operating on Diesel Generator Power (TVA Supplement A to GE-31)

13.4.4.62.1 Prerequisites

The following preoperational testing completed:

a. Condenser circulating water system interunit crossties (see paragraph 13.4.4.1).

b. 4.16-kV electrical system (normal auxiliary power system) (see paragraph 13.4.4.11).

c. Diesel generator system and emergency power system (see paragraph 13.4.4.55).

13.4.4.62.2 Test Summary

a. Demonstrate that two diesel generators can be operated successfully in parallel with each other.

b. Start and operate one condenser circulating water pump on power supplied by these diesel generators.