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14.0 INITIAL TEST PROGRAM

Chapter 14 was originally written using the present and future tense. In accordance with an NRC letter providing guidance for implementation of 10 CFR 50.71 (D.G. Eisenhut letter dated December 15, 1980) this Section is not updated to incorporate new information. Some editing has been performed to improve clarity and incorporate AEC Question responses not previously incorporated into the FSAR text. [14.0-1]

14.1 SPECIFIC INFORMATION TO BE INCLUDED IN PRELIMINARY SAFETY ANALYSIS REPORT

This section is not applicable to the Quad Cities Station.

14.2 SPECIFIC INFORMATION TO BE INCLUDED IN FINAL SAFETY ANALYSIS REPORT

14.2.1 Summary of Test Program and Objectives

14.2.1.1 Preoperational Test Programs

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 one month of testing. The multiplicity and the sequencing of the preoperational tests dictate the length of the preoperational program. [14.2-1]

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., 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 will become sufficiently radioactive to impose restrictions and time limitations on maintenance work. Because of access limitations during normal operation, some components and systems cannot be observed for proper performance. Therefore, to avoid these difficulties 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 Commonwealth Edison Company (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.

Table 14.2-1 lists the special test equipment used for the preoperational testing. General Electric Company (GE) is responsible for its installation and removal. [14.2-2]

The test program will be conducted on systems and equipment to discover and permit correction of design, manufacturing, or installation errors and to demonstrate that the systems function per design and plant requirements. This program will produce data that will demonstrate the plant is ready for fuel loading and initial startup. Prerequisites for these tests are the completion of construction testing and availability of results and vendor equipment performance data (pump curves, etc.). [14.2-3]

A surveillance testing program is being established to assure timely, periodic testing of structures, components, and systems affecting safety features incorporated into the plant. [14.2-4] Written procedures for such testing will be prepared to assure proper conduct of the tests and appropriate review of test results. [14.2-4]

To facilitate administrative control, a master surveillance testing schedule is being established and will be maintained. Prior to initial plant startup, all startup and valve check lists for systems required to be operational will be completed.

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 during this phase of the unit startup 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 and control rods are calculated with methods which are continuously compared with results of experiments in the Vallecitos Atomic Laboratory's critical facilities, including measurements of similar or identical components. In addition, startup tests and operating data from other boiling water reactors in commercial operation and other measurements throughout the nuclear industry are used to confirm the applicability of the analytical methods. [14.2-5]

The tests listed in Sections 14.2.12.2.1, 14.2.12.2.2 and 14.2.12.2.3 will be conducted on Quad Cities Unit 1 and the results will be considered in preparing the specific tests to be performed in Unit 2.

Tests which are unnecessary for Unit 2 are: 14.2.12.2.1.F, Control Rod Sequence; and 14.2.12.2.3.S, Calibration of Rods. Tests which will be modified depending on the Unit 1 results, to collect a limited amount of data are: 14.2.12.2.1.C, Radiation Measurements; 14.2.12.2.1.G, SRM Performance; 14.2.12.2.3.G, Recirculation Jet Pumps; and 14.2.12.2.3.T, Axial Power Distribution.

Since the Quad Cities Unit 1 design is essentially the same as Dresden Units 2 and 3, it is not necessary to perform the reactor stability check on Quad Cities; however, the same test described in Dresden 2 FSAR Amendments 9 and 10 will be run on the Quad Cities plant. [14.2-6]

In addition, Quad Cities will run tests on all expected normal operational conditions of plant operation. A quarter decay ratio criterion is applied to process variables response in the assessment of reactor stability. At abnormal, but possible operational conditions, such as natural circulation conditions resulting after two recirculation pump trips from the 75% and 100% power levels, the quarter decay ratio criterion does not apply. At these natural circulation conditions, tests will be made to demonstrate that the reactor variables satisfy the ultimate performance criteria of a decay ratio of less than unity.

14.2.2 Organization and Staffing

14.2.2.1 General Responsibilities [14.2-7]

General Electric will develop the written test/startup documentation.

General Electric will develop the preoperational test procedures for the systems which it has prime design responsibility.

General Electric will provide startup personnel and technical specialists for the overall direction of the preoperational and startup testing.

Sargent & Lundy (S&L) will develop the preoperational test procedures for those systems for which it has prime design responsibility. In addition, S&L will provide whatever necessary technical backup is required during the test and startup program for those systems for which it has prime design responsibility. Sargent & Lundy will prepare detailed flushing/cleaning diagrams and procedures for all balance of plant piping systems.

Test Directors will be GE or United Engineers and Constructors (UE&C) startup personnel as designated by the GE Operations Manager.

United Engineers and Constructors will provide startup personnel for the writing, performance and support of the preoperational and startup tests as required.

Commonwealth Edison is responsible for providing a qualified operating staff for system operation during the actual execution of the test and startup program.

Commonwealth Edison Company, in conjunction with performance of the testing operation, will read instruments in the main control room, at local racks, or equipment mounted and enter the data on the preoperational test data sheets. Upon completion of the test, the GE Test Director will make required calculation analyses, and after approval by the GE Operations Manager, transmit them to CECo.

14.2.2.2 Organization and Responsibilities

General Electric will coordinate and is responsible for the overall test and startup program. General Electric will provide technical direction for the CECo operating personnel who will operate the systems and equipment during the test and startup program.

Technical direction is defined as the authority to direct, through CECo Supervisory Staff and with their concurrence, the operation of the station during the startup and testing period as may be necessary for the safe and efficient execution of the program.

United Engineers & Constructors will provide supervisory personnel to participate in the testing of those systems designated by the GE Operations Manager.

Commonwealth Edison Company will make available a sufficient number of operating personnel for a period commencing at least 6 months prior to scheduled date of fuel loading to assist in the Preoperational Test Program, and to carry out the fuel loading, test and startup operations. The normal CECo Operating Force will be in place prior to fuel loading. The GE Shift Supervisor will be assigned to take his shift at the same time and will be phased out at the end of the 100-hour warranty run. Figure 14.2-1 presents the normal CECo Station operating organization. [14.2-8]

The startup organization and interrelationships between CECo and GE are shown in Figure 14.2-2. Sargent & Lundy and UE&C are not part of the startup organization. However, one UE&C engineer will function as Radioactive Waste Disposal Supervisor. [14.2-10]

14.2.2.2.1 General Electric Project Manager

The GE Project Manager has overall responsibility for all work on the project. [14.2-11]

14.2.2.2.2 General Electric Construction Manager

The GE Construction Manager has responsibility for all construction operations at the site.

14.2.2.2.3 General Electric 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 plant by CECo. He is responsible to project management for completion of the project and responsible to Field Engineering management for safety of the plant during the test program.

14.2.2.2.4 General Electric Preoperational Test Engineer

The GE Preoperational Test Engineer is responsible to the GE Operations Manager for the technical content, planning, and achievement of the Preoperational Test Program. He is responsible for the preparation of any supplements necessary for the Preoperational Test procedures. He is responsible for making assignments and coordinating the efforts of those personnel assigned as Test Directors. He is responsible for checking that all prerequisites for the performance of each Preoperational Test have been satisfactorily checked out, including checking out the necessity for special test equipment and the instruction of all personnel involved in the particular Preoperational Test procedure. He is responsible for the actual performance of the Preoperational Test and the evaluation of the test results. He recommends to the GE Operations Manager the approval and acceptance of the Preoperational Test or defines the need for further testing.

Although reporting directly to the GE Operations Manager, he also assists the GE Operations Superintendent by providing operating and technical support as required. He is to provide on-shift support for GE Shift Supervisors during critical phases of the Fuel Loading and Sequence Test/Startup Programs. In the absence of the Operations Superintendent, the Preoperational Test Engineer is delegated his responsibilities.

14.2.2.2.5 Test Directors

Each preoperational test will have a Test Director assigned to be responsible for the timely and satisfactory performance of that test. One individual will probably have this responsibility for several tests. The Test Director will be knowledgeable in necessary details of the system to be tested and the proposed test procedure. He will aid construction personnel in completing construction of a system and accomplishing the construction testing and accepting it for preoperational testing.

Test Directors for the preoperational testing program will be selected according to their background and experience. They may be UE&C or GE personnel. In general, the Test Directors will be selected from available site personnel as the site status phases from construction to ready-for-test. Assignments for this function will be made by the Operations Manager.

14.2.2.2.6 General Electric 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 startup activities. 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 and initiates corrective action as required. He directs the activities of and issues instructions to the GE Shift Supervisors to implement the preceding functions.

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

14.2.2.2.7 General Electric Day Shift Supervisor

The Day Shift Supervisor will aid the Operations Superintendent in accomplishing the startup program. The Day Shift Supervisor will perform special tasks and assignments as the need occurs during the startup in addition to relieving the Shift Supervisors and acting for the Operations Superintendent when required.

14.2.2.2.8 General Electric Shift Supervisors

Around-the-clock shift coverage will commence several weeks prior to loading fuel and during certain Preoperational Test periods. When this around-the-clock shift coverage is started, the assigned Shift Supervisor will be responsible for all activities related to plant operation and safety on his shift. No work or activity on any system will be conducted without the expressed approval of the assigned GE Shift Supervisor. The Shift Supervisor is to provide supervision and technical direction on all activities on this 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 primary contact will be with the CECo Shift Engineer.

His duties and responsibilities include:

A. Knowing the work in progress and the status of systems and equipment;

B. Controlling access to all operational areas of the plant;

C. Approving any work or activities related to plant operation or safety;

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

E. Maintenance of the shift log book documenting activities during his shift;

F. Assisting with preparation and execution of preoperational test procedures and serving as test director if required; and

G. Operating the entire plant during his shift with the commencement of around-the-clock shift activities.

14.2.2.2.9 General Electric Lead Test Design and Analysis Engineer

The Lead Test Design and Analysis Engineer is responsible for planning and detailing the Startup Test Program beginning with fuel loading, including coordination and supervision of the Startup Test Preparation. He is responsible for directing the activities of engineers assigned to him and for providing technical direction as required to safely and efficiently accomplish startup testing. He is responsible for evaluation of or having test data evaluated, specifying further testing, or recommending approval of test results to the Operations Manager.

14.2.2.2.10 General Electric Test Design and Analysis Engineer

A GE Test Design and Analysis Engineer will be assigned to each shift so that full shift coverage is provided during the test and startup operations. He will be technically responsible to and will receive his instructions from the Lead Test Design and Analysis Engineer; however, while on shift duty he will report directly to the GE Shift Supervisor. He will analyze test results as soon as possible as the test is being performed so that the GE Shift Supervisor can be advised as to the adequacy of the test being performed.

14.2.2.2.11 General Electric Specialists

General Electric specialists such as radiochemists, physicists, et al, will be utilized as required for special duties or unusual problems. For example, a GE radiochemist will probably spend three to four weeks at the site during the initial startup operations to

check out primary water chemistry conformance. Additional personnel may be assigned to work on the various test/startup operations to acquire training.

14.2.2.2.12 United Engineers & Constructors

United Engineers & Constructors will furnish supervisory personnel as required to supervise the testing and startup equipment within the scope of UE&C's responsibility. United Engineers & Constructors personnel will function as test directors in accordance with assignments determined by the GE Preoperational Test Engineer and the UE&C Lead Startup Engineer.

United Engineers & Constructors will also accomplish the required installation/construction testing.

14.2.2.2.13 Commonwealth Edison Company

From the time that equipment and systems are transferred to CECo, CECo personnel will operate all equipment as required.

The CECo operating organization will function as nearly as possible in the manner intended after plant acceptance.

As indicated previously, CECo personnel will perform work with technical direction from GE as required.

Activities utilizing CECo personnel include:

A. Flushing operations;

B. Preoperational testing of the plant;

C. Initial reactor fuel loading and low level and criticality testing;

D. Bringing the plant up to rated power;

E. Testing of the plant prior to plant acceptance; and

F. Calibration of nuclear instrumentation.

It is expected that CECo operating personnel will perform routine minor maintenance on equipment after satisfactory completion of preoperational testing. This is not intended to apply to the correction of contractor or vendor deficiencies, but it may include new problems which develop during equipment operation after test completion. Examples of such maintenance are lubrication, packing adjustment and simple trouble shooting. Major repair or correction work will be accomplished by returning the equipment to UE&C.

Appropriate records will be kept of all maintenance and equipment operating history.

Maintenance and calibration of nuclear instrumentation will be performed by CECo.

Commonwealth Edison Company will provide radiation protection services as required for personnel involved in the startup of the plant.

14.2.3 Test Procedures

Changes or revisions to the test procedures will be developed by the organization which has prime design responsibility for that system. Changes are reviewed by the System Engineer and the Technical Staff Supervisor who forward recommendations regarding approval to the CECo Station Superintendent or System Mechanical and Structural Engineer as applicable. When the test results indicate that a system modification is required to accomplish system design objectives, approval of the test results and final acceptance of the test procedure is withheld pending resolution of the system deficiency. Formal approval of required preoperational tests is a prerequisite to fuel loading, and formal approval of all startup tests is a prerequisite to acceptance of the unit. [14.2-11]

14.2.3.1 Preoperational Test Procedures

All preoperational testing will be conducted in accordance with an approved formal test procedure. The initial versions of these procedures are reviewed by GE and CECo site and engineering personnel. The procedures are revised based on review comments. Signatures of CECo engineering and site management are obtained, and the approved procedures are issued. If required, minor changes may be made to clarify a procedure or in some way facilitate the execution of a given test. These types of changes to an approved formal test procedure must be detailed in writing and approved by the GE Operations Manager and concurred with by the CECo Station Superintendent. [14.2-12]

If significant changes in technical content are required because of design changes or oversight, a revised procedure or an addendum will be issued prior to conducting the test. Such revised procedures or addenda will be reviewed in the same manner as the original test procedure.

14.2.3.2 Startup Test Procedures

The startup test procedures are prepared by GE engineers assigned to the Test Design and Analysis Unit. Final review and approval of the procedures prior to implementation is made by the site startup organization consisting of the GE Operations Manager and the Principal Test Design and Analysis Engineer, along with their CECo counterparts. They have the authority to revise the procedures, as necessary, provided the initial Test Specifications are not compromised.

The startup procedures will be written, with individual detailed subsections. [14.2-13]

14.2.4 Conduct of Test Program

The preoperational test procedures are performed on an individual system by system basis to verify operation; while during operation systems will have to interface with each other. These differences are factored into our startup test program for testing and verification of the design basis and operability of the overall plant. [14.2-14]

After completion of the formal preoperational test on a system or subsystem, the system or subsystem is turned over to GE and CECo for operation by UE&C. A blue tag to indicate turnover is affixed to system valves, electrical breakers, etc., to prevent unauthorized maintenance or modification. Any such maintenance or modification must be done with the concurrence of GE and CECo and the system turned back to UE&C for the duration of the maintenance or modification period. Afterwards the system is turned back to GE and CECo for operating after a successful demonstration of functional operability. [14.2-15]

14.2.5 Review, Evaluation, and Approval of Test Results

The completed tests will be signed by the people designated on the test cover sheet. These signatures indicate that a system is operable, subject to resolution of exception items noted. The data will be evaluated by the test director and preoperational test engineer (with appropriate technical assistance) with specification for further testing or recommendation of approval. The signed copy of the test procedure, including the approved test data, will be reissued as the approved preoperational test report. Resolution of preoperational test exceptions must be approved by the GE Operations Manager, the CECo Station Superintendent, the system mechanical and structural engineer, and a final cover sheet must be approved. Each test will be the responsibility of a test director. Designated test directors will be either GE or UE&C startup personnel. System-equipment operation and data recording will be by CECo personnel. [14.2-16]

For the startup tests, the results are evaluated by the responsible GE and CECo personnel.

All data from the preoperational and startup tests will be evaluated by the test director and preoperational test engineer to verify that results meet the specification and procedure requirements before acceptance of test. Resolution of test exceptions must be approved by the GE Operations Manager, the CECo Station Superintendent and the system mechanical and structural engineer. [14.2-17]

Commonwealth Edison Company's system for evaluating test results from preoperational and startup testing is as follows. [14.2-18]

Each formal approved preoperational and startup test is witnessed by a CECo Technical Staff Engineer who has been designated as System Engineer for the system which is being tested. System assignments are made in advance so that the System Engineer can

participate in the review and comment of the test procedure. He is responsible for following system construction and the supervision of data recording when the test is actually performed. Test results are evaluated by the System Engineer and the Technical Staff Supervisor who then makes a recommendation to the CECo Station Superintendent regarding final acceptance of the test.

14.2.6 Test Records

General Electric Company will prepare and maintain the test reports for the construction, preoperational and startup tests until the plant is turned over to CECo. [14.2-19]

Commonwealth Edison Company will prepare and maintain the test records after the plant has been turned over.

14.2.7 Conformance of Test Programs with Regulatory Guides

The initial test program information originally submitted to the Atomic Energy Commission (AEC) did not address this topic.

14.2.8 Utilization of Reactor Operating and Testing Experiences in Development of Test Program

The initial test program information originally submitted to the AEC did not address this topic.

14.2.9 Trial Use of Plant Operating and Emergency Procedures

The initial test program information originally submitted to the AEC did not address this topic.

14.2.10 Initial Fuel Loading and Initial Criticality

Refer to Section 14.2.1.2 for a discussion of the startup and power testing program including fuel loading and initial criticality. Refer to Sections 14.2.12.2.1 and 14.2.12.2.2 for a listing of tests performed during the fuel loading and initial criticality phases.

14.2.11 Test Program Schedule

The following key points were considered in developing the sequence and schedule of preoperational tests: [14.2-19]

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, 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 still in progress on non-critical systems and areas.

C. Stricter controls of plant operation and maintenance work will be required following fuel loading. Preoperational 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 set-ups 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 log book 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, service building, and the radioactive waste treatment building.

H. Commonwealth Edison will operate the plant and equipment (under the technical supervision of GE) during the 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 includes but is not limited to the following examples:

   1. Containment final leak rate testing.

   2. Cleaning and flushing.

3. System hydrostatic tests.

4. Wiring continuity checks.

5. Megger and high potential tests.

6. Electrical system tests up to and including energizing e.g. checking grounding, relay checks, checking circuit breaker operation and controls, continuity checks, megger tests, phasing check, high potential measurements, and energizing of buses.

7. Initial adjustment and bumping of motors.

8. Check control and interlock functions of instruments, relays and control devices.

9. Calibrate instruments and check or set initial trip set points.

10. Pneumatic test of instrument and service air system and blow out 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 purpose of this item is to cover those instances where measurements such as the above 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 seal temperatures; vibration; torque; rpm; etc. These measurements are primarily of importance for protection of equipment, troubleshooting, or supplementing installed instrumentation.

13. Check and adjust relief and safety valves.

14. Complete tests of motor-operated valves including adjusting limitorque 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 for proper operation of controllers pilot solenoids, etc.

I. Specialized electronic equipment manufactured by General Electric NID will be checked and preoperationally tested by representatives of NID assisted by CECo personnel.

J. Detailed test writeups will be prepared by GE or S&L depending upon system design responsibility. These writeups 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.

14.2.12 Individual Test Descriptions

14.2.12.1 Summary of Preoperational Test Content and Sequence [14.2-22]

The schedule showing the general sequence in which tests are generally conducted is shown in Figures 14.2-3, 14.2-4, and 14.2-5. This schedule is intended to be a guide only. Deviation from it to facilitate the completion of the testing program will be at the discretion of the General Electric Operations Manager. See Table 14.2-2 for a list of the preoperational tests.

14.2.12.1.1 Electrical Systems

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 the customer. [14.2-22]

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 will be in the nature of construction tests on wiring and individual components such as the following:

A. Continuity and phasing checks,

B. Megger test 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.

Preoperational Test D-24, "Electrical Auxiliary Power Systems" covers testing the emergency systems offsite ac auxiliary power supply. The plant dc power systems are also covered in preoperational test D-24 as follows: [14.2-23]

Part V:	250 Vdc system
Part VI:	125 Vdc system
Part VII:	48/24 Vdc system

14.2.12.1.2 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. [14.2-24]

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.

14.2.12.1.3 Service Water System

One or two service water pumps will be placed into service to provide cooling for the reactor and turbine building cooling water systems. Instrumentation will be calibrated and placed in service. During initial operation of the pumps, they will be monitored for proper motor current, temperatures, and vibration and will be checked to verify delivery of the appropriate flow by using the manufacturers' curves and installed system instrumentation. [14.2-25]

14.2.12.1.4 Turbine Building 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 service air compressors and then for various system pumps which will be used during cleaning and flushing. [14.2-26]

14.2.12.1.5 Fire Protection System

Test summary: [14.2-27]

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

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

14.2.12.1.6 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 isolating block valves. Tests on compressors and dryers should be completed as soon thereafter as possible, without waiting for all air piping to be installed. [14.2-28]

Test summary:

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

B. Measure capacity of each compressor.

C. Check dryer performance.

14.2.12.1.7 Condensate Demineralizer System

This test will cover the demineralizers, precoat and body feed equipment, and holding 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. [14.2-29]

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 filter aid operations with water flow, but without resin.

F. Simulate all phases of recharging with actual water and air flow, but without resin.

G. Simulate backwash of resins from demineralizers.

H. Pump precoat slurry and mixed power resins to demineralizers and backwash, if required (at least one charge should be cycled even if not required).

14.2.12.1.8 Plant Heating Boiler

Standard acceptance tests will be performed to verify that the boiler capacity and heat rate meets specifications and that all auxiliary equipment and controls are working properly. [14.2-30]

14.2.12.1.9 Reactor Building Cooling Water System

This system is required before operation and testing can begin on the variable speed 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 cleaning and flushing. [14.2-31]

Test summary:

A. After hydrotest and flushing, fill system with demineralized water.

B. Operate pumps to verify proper performance.

C. Check operation of surge tank level controls and alarms.

D. Check 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.

14.2.12.1.10 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 mechanisms and reactor internals. [14.2-32]

Test Summary:

A. Hydrotest reactor, main steam lines, and recirculation loops.

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

14.2.12.1.11 Control Rod Hydraulic System

Test summary: [14.2-33]

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.

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. Backup pilot valves,

   3. Scram dump volume drain 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 return to reactor,

4. System pressures, and

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

14.2.12.1.12 Drywell-Suppression System Leak Rate Measurement and Isolation Valves

Test summary: [14.2-34]

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

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

C. Leak test electrical penetrations at 56 psig.

D. Measure leak rate of drywell and suppression chamber simultaneously at 56 psig.

14.2.12.1.13 Fuel Pool Cooling

Test summary: [14.2-35]

A. Calibrate all instrumentation.

B. Check alarms, controls and interlocks.

C. Fill pool with demineralized water.

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

E. Check operation of filter-demineralizer valves, and precoat pumps.

F. Simulate resin sluicing operation to and from filter-demineralizer, using demineralized water only (and air as required). After satisfactory simulation and when general cleanliness of fuel pool and reactor building warrants, charge resins and place filter-demineralizer into routine service, verify system flow rates from pump head-flow characteristic.

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

14.2.12.1.14 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. [14.2-36

Test summary:

A. Tests in the storage pool involve:

1. Installation of fuel pool gates, filling pool with water, and checking gates for leakage.

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

3. Setting up inspection scope and checking with dummy fuel assembly.

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

5. Checking the underwater vacuum cleaner.

6. Operating the refueling platform over storage pool. Checking all equipment on the refueling platform. Transferring fuel assemblies and control blades between storage racks with the grapple. Checking all grapple controls and interlocks.

7. Using the jib crane to transport dummy fuel assemblies from new fuel storage pool.

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 dummy fuel assemblies and control blades.

2. Raise water level in reactor well and check leak-tightness of vessel to drywell seal and drywell to 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:

   a. Removal and replacement of steam dryer,

   b. Removal and replacement of steam separator head,

   c. Removal and replacement of fuel support castings and control rod blades,

   d. Removal and replacement of in-core flux monitor strings, and

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

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

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

14.2.12.1.15 Control Rod Drive

Control rod hydraulic system and manual (electrical) control system tests shall be completed before beginning tests of individual control rod drive mechanisms. All internals must be in reactor, including guide tubes and thermal sleeves. Install blades and dummy fuel assemblies. The following tests are required on individual drives. [14.2-37]

Test summary:

A. Insertion — continuous and by notch.

B. Withdraw — 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 hydraulic system and manual control system which are required to verify total system performance.

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

14.2.12.1.16 Reactor 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. [14.2-38]

Test summary (not necessarily in chronological order):

A. Check operation of cleanup recirculation pumps by pumping first to the hotwell or radwaste. Do not pump to reactor until filter-demineralizers are fully checked out to prevent injecting poor quality water into the reactor.

B. Check operation of filter-demineralizers 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).

C. Check sluicing of sludge and resins to radwaste system.

D. Check operation of filter-demineralizer and all associated equipment.

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

F. Check calibration and alarm or trip interlock set points of all instrumentation.

G. 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 filter-demineralizers and place the system in normal service when water is in the reactor during preoperational testing.

14.2.12.1.17 Residual Heat Removal System

Test requires water in the reactor vessel. System may not be sufficiently complete at the time of reactor vessel hydrotest to do preoperational test at that time, but performance tests on the pumps will be accomplished at that time. [14.2-39]

Test summary:

A. Calibrate all instrumentation and check set points.

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 flow rates from pump characteristics curve for various modes of operation; shutdown cooling, LPCI containment spray, test and vessel head cooling.

14.2.12.1.18 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). [14.2-40]

Test summary:

A. Calibrate instruments and check set points.

B. Fill the neutron absorber tank with demineralized water and operate the injection pumps, recirculating to the neutron absorber tank.

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

D. Check the control circuits for neutron absorber injection valves thoroughly before connecting to the valves (use a dummy resistance to simulate the valve).

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

F. Check interlocks with the cleanup filter-demineralizer system; this ensures isolation when the standby liquid control system is actuated.

G. Check operation of neutron absorber tank temperature controls and air sparger.

H. Fill the test tank with demineralized water and operate the neutron absorber 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 amount of neutron absorber material to the neutron absorber tank. Mix and sample. This should be done very shortly before fuel loading.

14.2.12.1.19 Reactor Vessel Components

These items may be tested more appropriately during the performance of other tests. [14.2-41]

Test summary:

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

B. Set reactor vessel stabilizers.

C. Check all reactor vessel thermocouples.

D. Check stud tensioner operation.

14.2.12.1.20 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 safety circuit tests. [14.2-42]

Test summary:

A. Calibrate all instrumentation.

B. Check response of thermocouples with temperature baths.

C. Check proper installation of reactor vessel stabilizers.

14.2.12.1.21 Reactor Vessel Safety and Relief Valves

Test summary: [14.2-43]

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

B. Calibrate reactor pressure sensors and verify proper operation of air-operated valves from test pressure signal to the pressure sensors.

C. Check operation of vacuum breaker valves.

14.2.12.1.22 Reactor Recirculation System

This test will determine recirculation loop (recirculation pumps and jet pumps) characteristics to the degree possible with cold water conditions. [14.2-44]

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.

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

14.2.12.1.23 Core Spray System

Test summary: [14.2-45]

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 suppression chamber in the test mode. Verify pump and system performance from manufacturer's 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 flow rate and observe spray pattern. This will also be repeated with suction from suppression chamber.

H. 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 (Section 14.2.12.1.23, item F) and the diesel generator automatic starting test (Section 14.2.12.1.29, item E).

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

14.2.12.1.24 High Pressure Coolant Injection and Reactor Core Isolation Cooling Systems

These tests will test the functional capability of all portions of the systems to operate under simulated accident conditions and under various failure modes. Final full capacity testing of the HPCI and RCIC systems may be deferred until adequate steam supply is available. [14.2-46]

14.2.12.1.25 Radioactive Waste Disposal System

After fuel is loaded in the reactor, all drains from the reactor, fuel pool or interconnecting auxiliary system must be considered to be potentially radioactive. Therefore, most of the Radioactive Waste Disposal System must be tested and operational before fuel loading. The solid waste handling system need not be operational before fuel loading. [14.2-47]

Test summary:

A. Calibrate instrumentation.

B. Check all controls and interlocks.

C. Check all air-operated valves.

D. Check pumps and tanks, including:

    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 discharge to the river.

E. Check Filter-demineralizer and fuel pool including:

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

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

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

F. Check Demineralizers including:

    1. Transfer fluids from waste collector to waste sample tank through filter and demineralizer;

    2. Check operation of all components including bypass circuit; and

    3. Check instrument and level gage indications.

G. Check Spent Resin System including:

    1. Simulate transfer of sludge and resins from the fuel pool, waste, condensate, and cleanup demineralizers to the waste sludge tank and phase separator tanks;

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

    3. Verify capability to pump spent sludge resin mixture to centrifuge; and

    4. Verify capability of centrifuges to operate at design capacity and fill hoppers.

H. Check Sumps, (Drywell, Reactor, Turbine, and Radwaste Buildings) including:

    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 back flow or leakage enroute.

I. Check Solid Waste Handling, storage and disposal including:

    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; and

    4. Check baler.

14.2.12.1.26 NID Instrumentation Systems

This includes the following systems: [14.2-48]

A. Source range monitor(SRM)/intermediate range monitor(IRM) Chamber Drives.

B. Source range monitoring system.

C. Intermediate range monitoring systems.

D. Average power range monitoring system.

E. Local power range monitoring systems.

F. Incore flux monitor calibration.

G. Area radiation monitoring system.

H. Environs station monitors.

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

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

Test summary:

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 set points.

E. Check chamber response to bugging sources.

F. Check all interlocks with the reactor safety 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.

K. The environs monitoring stations have been in service for 12 months collecting background radiation data and will remain in service continuously. The plant area radiation monitoring system will be in service prior to power operation. Radiation levels will be observed from the beginning of fuel loading until completion of 100% power testing. A comprehensive radiation survey will be conducted in the plant prior to loading and at various steps in the power ascension program as required by the startup test program.

14.2.12.1.27 Reactor Protection System

Test summary: [14.2-49]

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

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

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

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

E. 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.

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

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

H. Check automatic closing of all isolation valves from proper signal.

I. Check initiation of core spray, containment spray, RCIC, and emergency ventilation systems by the proper signals.

14.2.12.1.28 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: [14.2-50]

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 displays and information printout including:

1. Group identification,

2. Withdrawal error readout,

3. Insertion error readout, and

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

14.2.12.1.29 Diesel-Generator

One diesel generator must be operational before fuel is loaded in the reactor, to provide maximum reliability of power supply. [14.2-51]

Test summary:

A. Conduct megger and high potential tests.

B. Calibrate instrumentation.

C. Check operation of diesel-generator auxiliaries.

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

E. Simulate design basis accident and demonstrate capability of diesel-generator to pick up core spray, containment spray, emergency ventilation and associated loads in sequence.

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

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

14.2.12.1.30 Drywell Ventilation

Test summary: [14.2-52]

A. Calibrate all thermocouples and temperature alarms.

B. Operate all cooler fans.

C. Check proper flow distribution under normal conditions, i.e. seven 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.

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

14.2.12.1.31 Emergency Ventilation and Reactor Building Leak Rate Test

Test summary: [14.2-53]

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 flow rate and measured pressures and temperatures. All other ventilation equipment should be out of service during these tests.

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

14.2.12.1.32 Balance of Plant Auxiliary Systems

In general, conventional performance tests will be utilized for 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. [14.2-54]

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 pre-checking the turbine-generator and associated auxiliary systems.

14.2.12.1.32.1 Circulating Water System

Test summary:

A. Check operation of butterfly valves.

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

C. Operate condenser vacuum priming and backwash valves.

D. Calibrate all remote instruments.

14.2.12.1.32.2 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 system is used.

Test summary:

A. Calibrate instrumentation.

B. Check all controls, alarms, and interlocks.

C. Operate all remotely-operated valves.

D. Check performance of condensate and feedwater pumps recirculating to the hotwell through the 6-inch connection downstream from high pressure feedwater heaters. Initial operation should bypass the condensate filter-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.

14.2.12.1.32.3 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 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.

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

14.2.12.1.32.4 Off-Gas System

Gases from nuclear steam will restrict access to off-gas equipment, so 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.

D. Check proper operation of mechanical equipment in off-gas and 310-foot chimney sampling and monitoring system.

14.2.12.1.33 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. Test procedures will be prepared by S&L based on requirements and instructions obtained from GE Large Steam Turbine Generator(LSTG) Department. Systems in the following list are covered in this category. [14.5-55]

A. Turbine oil system,

B. Lube oil purification,

C. Steam seal,

D. Gland exhaust,

E. Hydrogen and carbon dioxide,

F. Stator cooling,

G. Turbine control system including control valves,

H. Generator seal oil system, and

I. Main and spare exciters.

14.2.12.1.34 Ventilation: Reactor, Radwaste, and Turbine Buildings

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. [14.2-56]

14.2.12.2 Startup Tests

The Quad Cities Station startup test program is summarized on Table 14.2-3 and Figure 14.2-6. All of the startup tests to be performed along with the corresponding test conditions are listed on Table 14.2-3. Figure 14.2-6 is a power-flow map which also defines the test conditions as listed on Table 14.2-3. It should be noted that Phase I consists of the preoperational tests which can be performed prior to fuel loading. [14.2-57]

14.2.12.2.1 Fuel Loading and Tests at Atmospheric Pressure

The initial fuel loading and the following tests are performed at atmospheric pressure, with the reactor pressure vessel open: [14.2-58]

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, waste 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 environs.

D. Fuel Loading is then begun, according to detailed, step-by-step written procedures. The core is assembled in sections to the full-sized core.

E. Shutdown margin will be demonstrated periodically during fuel loading to insure 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: the analytical determination of the strongest control rod, the calibration of an adjacent control rod, experimentally or analytically, and 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.

F. 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 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.

G. The performance of the source range monitors 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.

H. Calibration of the intermediate range monitors is performed to provide a power level calibration for the intermediate range monitors adequate for this phase of the test program.

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

14.2.12.2.2 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 this phase of the startup. [14.2-59]

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. Control rod drive system tests will be made by measuring scram times on a selected number of drives at two intermediate pressures and by performing scram time 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. Temperature coefficient of reactivity tests will be performed.

I. Process computer functions will be verified as more sensed variables come into useful range.

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

14.2.12.2.3 Power Escalation 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): [14.2-60]

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. IRM calibration final adjustments will be made.

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

E. RCIC system tests to determine the system performance in regard to flow rate and leak tightness will be made at a low power level.

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

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

H. Flow-control capabilities will be determined at specified power levels.

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

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

K. 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.

L. 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.

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

This test will be performed at 75% power and 100% core flow. At these conditions, one of the two operating feedwater pumps will be turned off and the standby feedwater pump will be brought to speed automatically to return the system to approximately the same conditions that existed when the transient was initiated.

N. 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.

O. Main steam relief valves will be functionally tested.

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 in-core probe system after significant changes in power, control rod pattern, or flow rate. The TIP system will supply data for core performance evaluations and LPRM calibrations.

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

V. The loss of auxiliary power test as shown on the schedule is test No. 31 as listed on Table 14.2-3. The purpose of this test is to demonstrate proper performance of the reactor, and the plant electrical equipment and systems during the loss of auxiliary power transient. The proper switching of the auxiliary power source from the main generator will be demonstrated at about 10% electrical power. The proper performance of the reactor and the plant electrical systems will be demonstrated for loss of main generator and offsite power with the main generator at 100% electrical power. [14.2-61]

W. The vibration of the various instrumented reactor vessel internal components will be detected by sensors mounted directly on those components. The vibration signals from these sensors will be amplified and displayed by an oscillographic recorder and also recorded on magnetic tape. These tests will be performed as part of the power ascension program at 50, 75, and 100% power. [14.5-62]

Table 14.2-1

STARTUP TEST EQUIPMENT AS SUPPLIED BY
PLANT TEST ENGINEERING

1.	4 each	Proportional counters, Type NA08
2.	4 each	Dunking chambers
3.	-	Control rod blade guides (complete set)
4.	1 each	30-channel event recorder
5.	4 each	Linear displacement transducers
6.	1 each	Portable test pump 0-3000 psi range
7.	1 each	Vibrometer
8.	1 each	Dial test indicator
9.	1 each	Hand tachometer 0 - 800 rpm
10.	1 each	Hand-held direct-reading pyrometer
11.	1 each	Electronic stroboscope

Table 14.2-2

LIST OF PREOPERATIONAL TESTS

A-1	Drywell Leak Rate
A-2	RPV Components
A-3	Safety & Relief Valves
A-5	CRD Hydraulic
A-6	CRD Manual Control
A-7	Recirculation System
A-8	RCIC System
A-9	RHR System
A-10	Reactor Water Cleanup System
A-11	Standby Liquid Control System
A-12	Core Spray System
A-15	Fuel Pool Cooling & Cleanup System
A-16	Refueling & Support Equipment
A-20	HPCI System
B-1	T-G Lube Oil
B-2	T-G EHC System
B-3	T-G, Drains, Extraction & Steam Seal
B-4	Generator Cooling
B-5	Generator Excitation
C-1	Condenser & Aux
C-2	Condensate & Feedwater
C-3	Circulation Water
C-4	Service Water
C-5	Condensate Demineralizer
C-6	Make-Up Water System
C-7	Turbine Building Closed Cooling Water System
C-8	Reactor Building Closed Cooling Water System
C-9	Instrument & Service Air
C-11	Heating Boiler
C-12	Reactor Building Heating & Ventilation System
C-13	Drywell Cooling System
C-16 & C-17	Radwaste Disposal System

Table 14.2-2 (Continued)

LIST OF PREOPERATIONAL TESTS

D-8	Standby Diesel Generator
D-9	Public Address System
D-11	Feedwater Control System
D-12	Reactor Protection System
D-13	Neutron Monitoring System
D-14	T.I.P. Calibration
D-15A	Main Steam, Radiation Mon.
D-15B	Reactor Bldg. Heating & Ventilation Mon.
D-15C	Crane, Mon.
D-15D	Process Liquid, Mon.
D-16	Area Rad. Mon.
D-17A	Stack Gas Mon.
D-17B	Off Gas Mon.
D-17C	Flux Tilt Mon.
D-18	Environs Mon.
D-19	Rod Position Info.
D-22	Rod Worth Minimizer
D-23	Process Computer
D-24	Elect. Aux. Power

Table 14.2-3

STARTUP TEST PROGRAM SUMMARY

	Phase	II	III	IV					V
Test No.	Startup Test Title	Open Vessel	Heatup	Percent Power					Warranty 100%
				10%	25%	50%	75%	100%	
1	Chemical and Radiochemical	1[Note 1]	2	3	4	7	10	14	
2	Radiation Measurements	1	2		4	7		14	14
3	Fuel Loading	1							
4	Shutdown Margin	1							
5	Control Rod Drives	1	2					14	
6	Control Rod Sequences	1	2						
7	Calibration of Rods					7		14	
8	(Not Used In this Plant)								
9	SRM Performance	1	2						
10	IRM Calibration	1	2						
11	LPRM Calibration			3	4	7	10	14	

Table 14.2-3 (Continued)

STARTUP TEST PROGRAM SUMMARY

		II	III	IV					V
Test No.	Startup Test Title	Open Vessel	Heatup	Percent Power					Warranty 100%
				10%	25%	50%	75%	100%	
12	APRM Calibration			3	4	7	10	14	14
13	Process Computer	1	2	3				14	
14	RCIC System		2						
15	HPCI System		2						
16	Reactor Vessel Temperature		2						
17	System Expansion		2						
18	Axial Power Distribution				4	7	10	13, 14	
19	Core Performance Evaluation		2	3	4	7	8, 10, 11	13, 14, 15	14
20	Elec. Output and Heat Rate								14
21	Flux Response to Rods				4	7	10	14	
22	Pressure Regulator				4		8, 10	14	

Table 14.2-3 (Continued)

STARTUP TEST PROGRAM SUMMARY

		II	III	IV					V
Test No.	Startup Test Title	Open Vessel	Heatup	Percent Power					Warranty 100%
				10%	25%	50%	75%	100%	
23	FW Syst: FW Pump Trip						10		
	Water Level STpt. chg.				4		10, 11	14, 15	
24	Bypass Valves				4		10, 11	14, 15	
25	Main Steam Isolation: Each Valve				4		10	14	
	All Valves						10		
26	Relief Valves				4				
27	Turbine Trip					7		14	
28	Generator Trip					6		14	
29	Flow Control					7	10	13, 14	

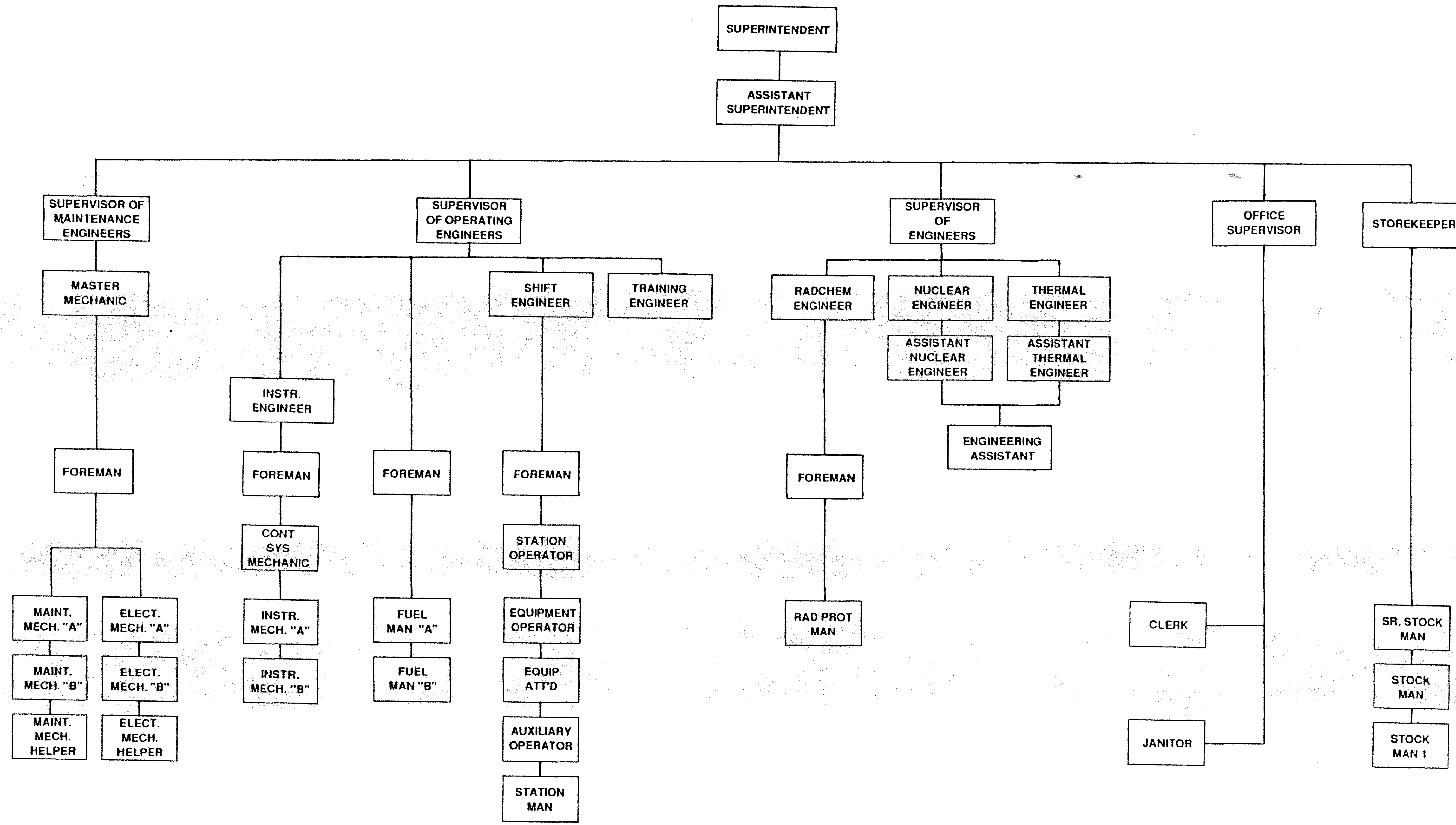
Table 14.2-3 (Continued)

STARTUP TEST PROGRAM SUMMARY

		II	III	IV					V
Test No.	Startup Test Title	Open Vessel	Heatup	Percent Power					Warranty 100%
				10%	25%	50%	75%	100%	
30	Recirc. System: Trip One Pump					7		14	
	Trip Both Pumps						10	14	
	Flow Calib.				4	7	10	14	
31	Loss of T-G and Offsite Power			3				14	
32	Recirculation Loop Control		2			7			
94	Temperature Coefficient		2						
95	Half Control Density Critical	1							
96	Gadolinia Worth							16[Note 2]	

Note 1 Test conditions for each test and power combination refer to Figure 14.2-6 Power Flow Map and Test Conditions.

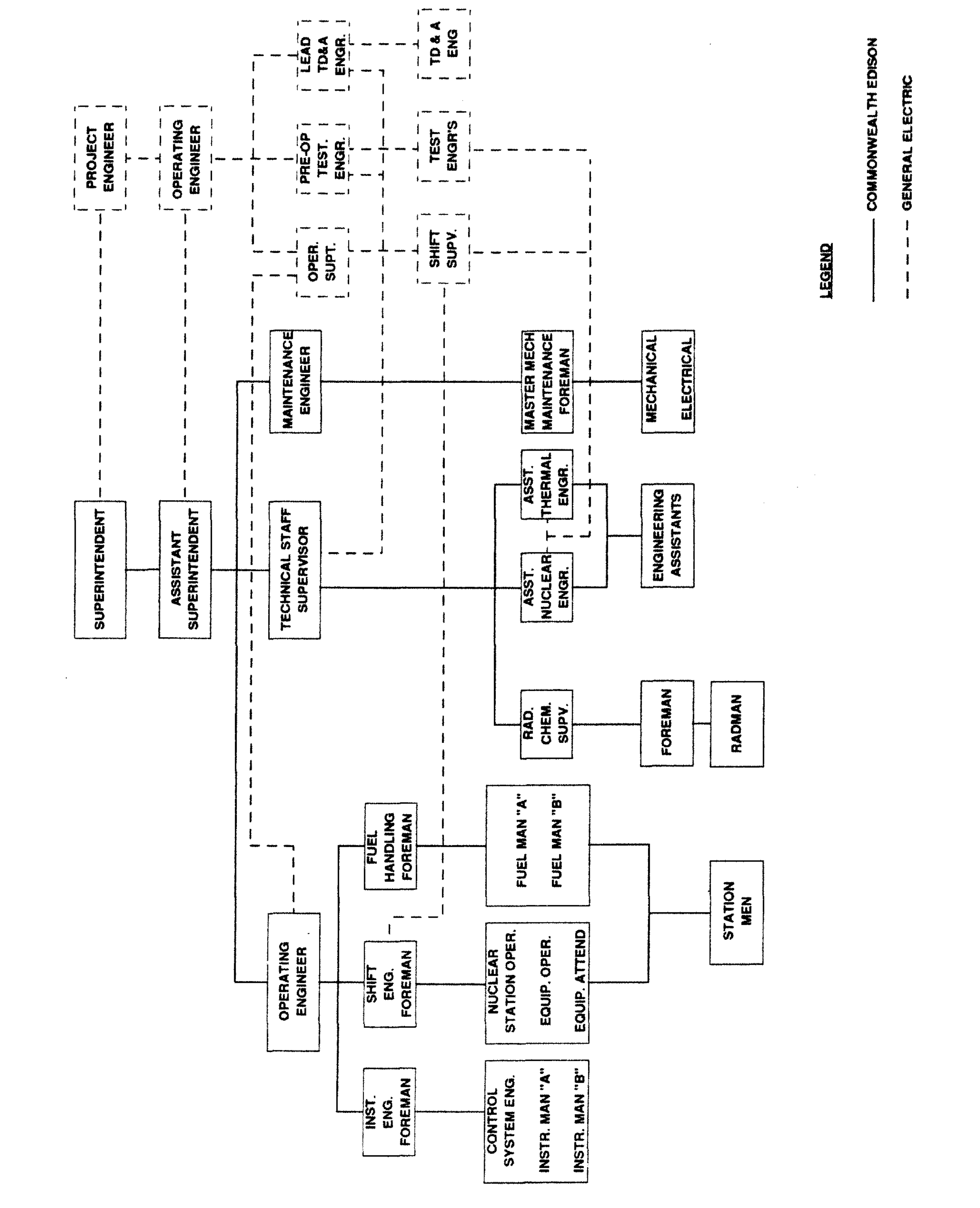
Note 2 Test #96 is performed at 95% power (Refer to Figure 14.2-6).



QUAD CITIES STATION
UNITS 1 & 2

STATION OPERATING ORGANIZATION

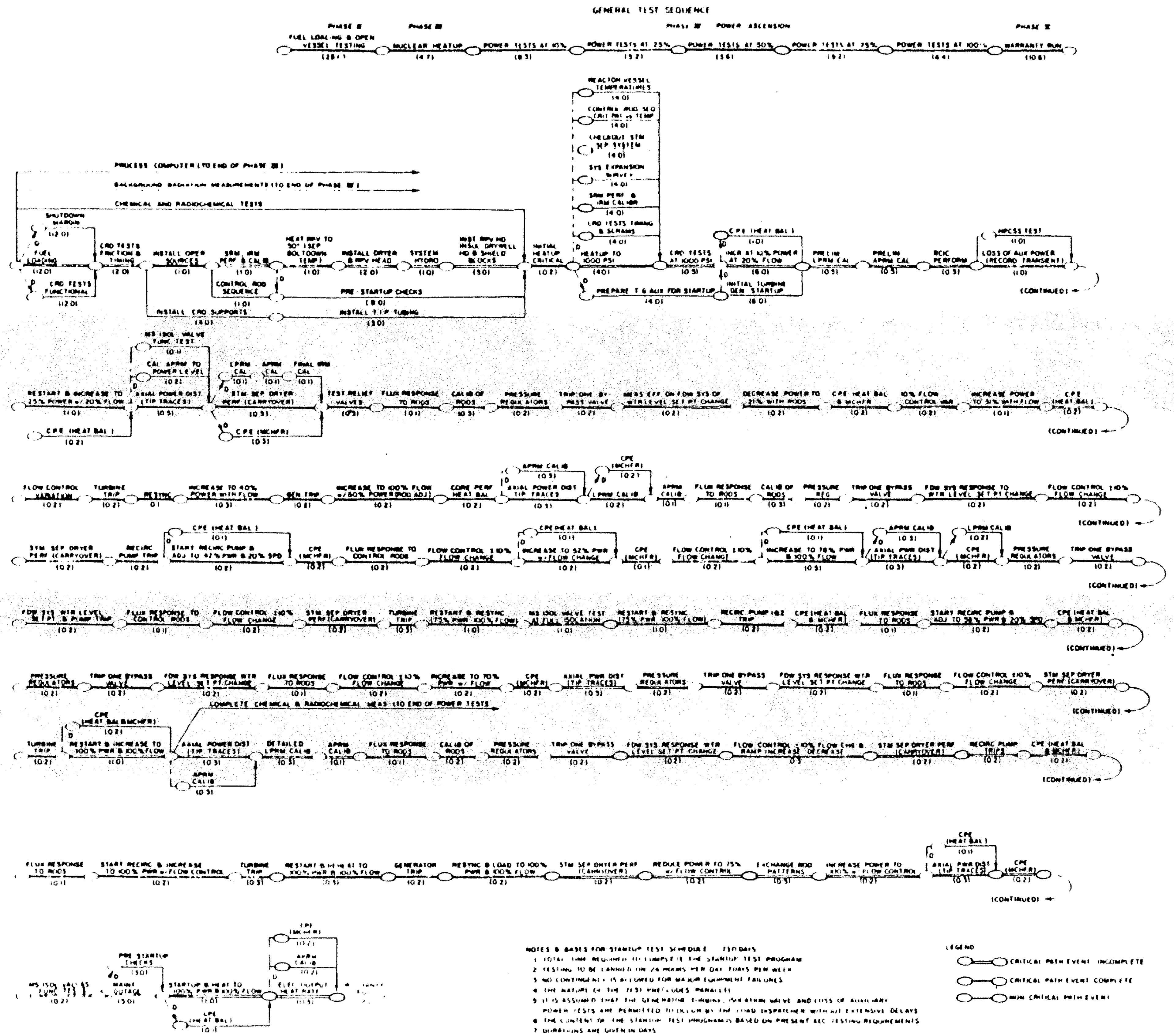
FIGURE 14.2-1



QUAD CITIES STATION
UNITS 1 & 2

GENERAL ELECTRIC STARTUP INTERFACE WITH STATION OPERATING ORGANIZATION

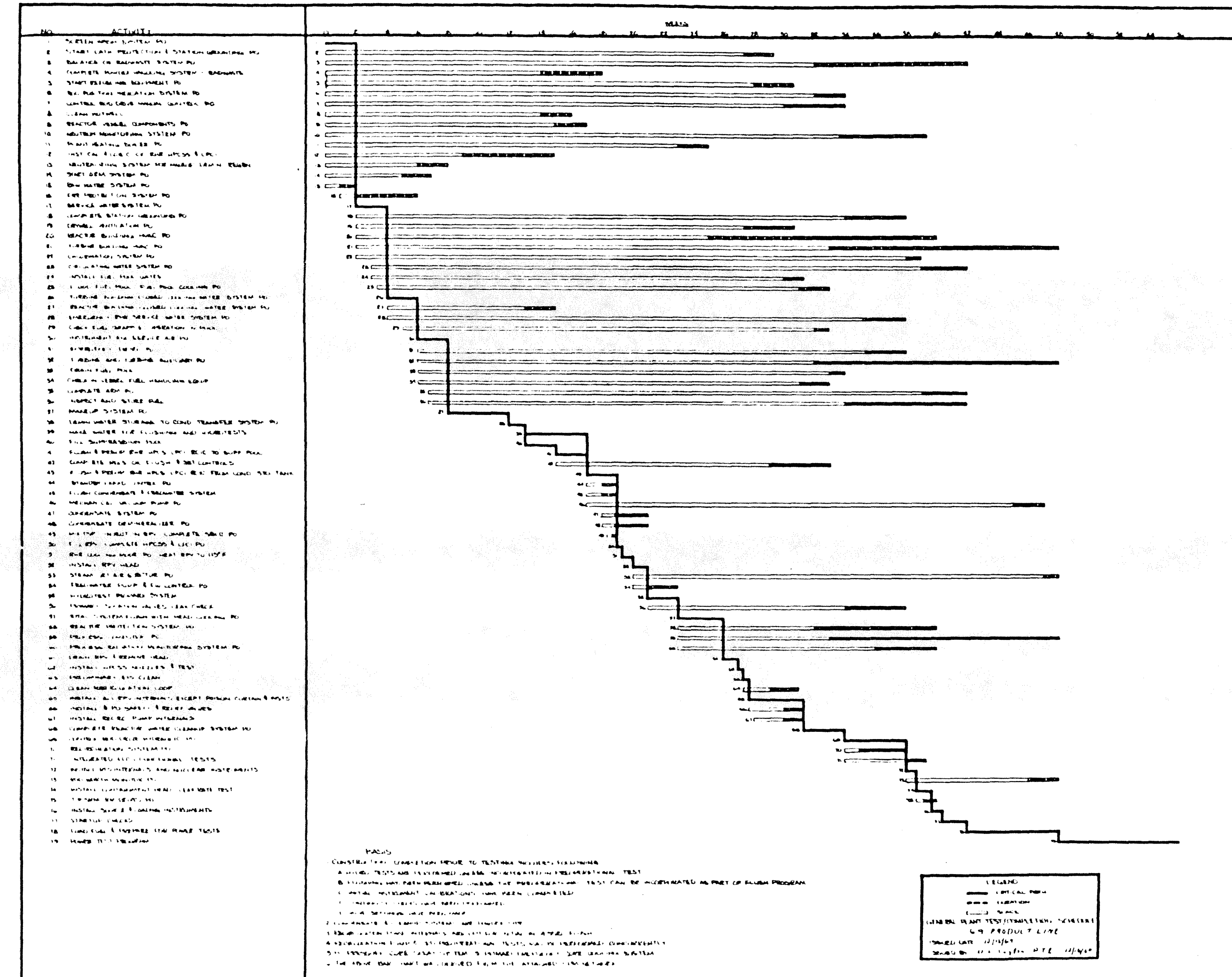
FIGURE 14.2-2



QUAD CITIES STATION
UNITS 1 & 2

GENERAL PLANT STARTUP TEST PROGRAM

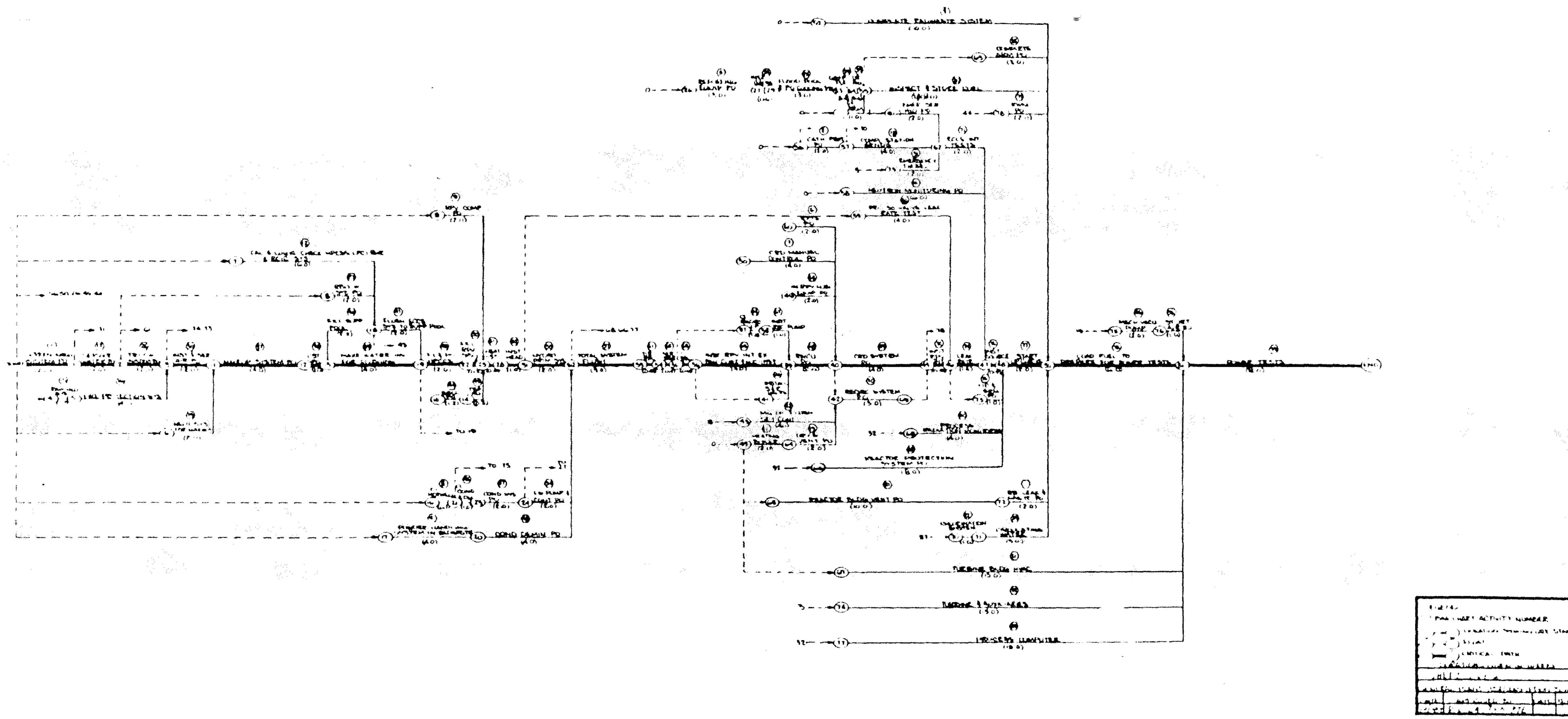
FIGURE 14.2-3



QUAD CITIES STATION
UNITS 1 & 2

GENERAL ELECTRIC TEST AND COMPLETION SCHEDULE

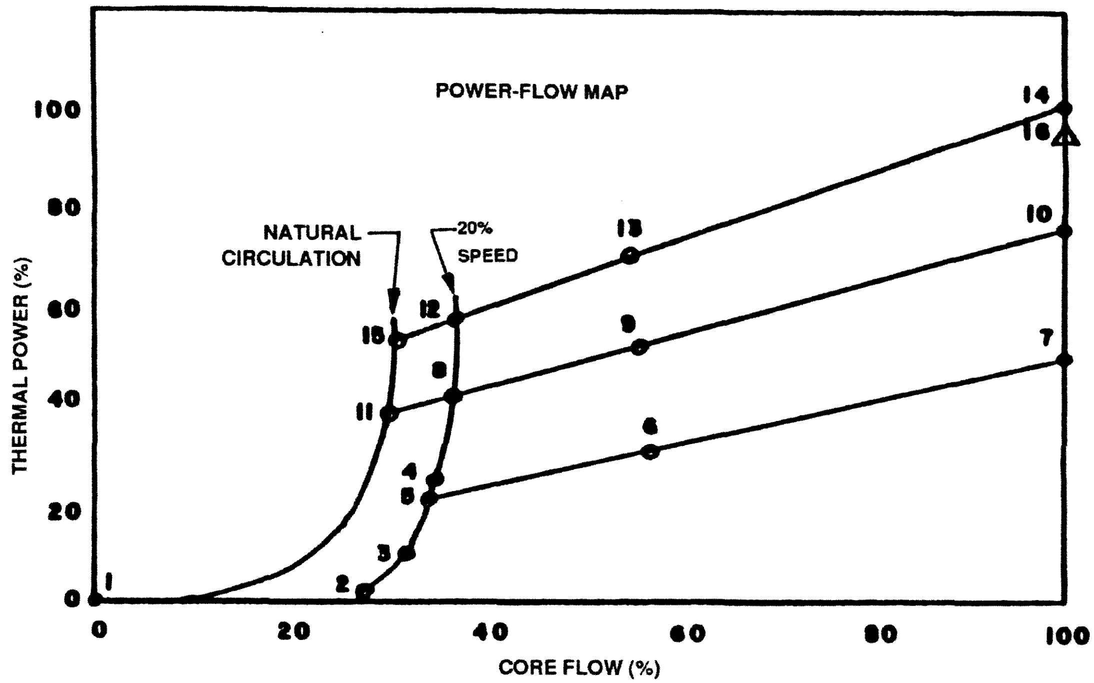
FIGURE 14.2-4



QUAD CITIES STATION
UNITS 1 & 2

GENERAL ELECTRIC TEST AND
COMPLETION SCHEDULE (CONTINUED)

FIGURE 14.2-5



Test Condition No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Rod Pattern	V	V	a	b	c*	c*	c	d*	d*	d	d*	e*	e*	e	e*	f*
% 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	100*
% Power	0*	5*	10*	25*	21	31	50*	42	52	75*	39	58	70*	100*	54	95

1 SEE TABLE 14.2-3 FOR STARTUP TEST TITLES.
2 POWER IN PERCENT OF RATED THERMAL POWER, 2511 MWt.
3 CORE FLOW IN PERCENT OF RATED CORE RECIRCULATION FLOW $98x10^6$ lb/hr.
* IN THIS TABLE THE ASTERISKED VALUES ARE SET AS INITIAL TEST CONDITIONS, NON-ASTERISKED VALUES ARE ESTIMATES.
NC= NATURAL CIRCULATION CONDITION.
V= VARIES

QUAD CITIES STATION
UNITS 1 & 2

POWER-FLOW MAP AND TEST CONDITIONS

FIGURE 14.2-6