SECTION 13

INITIAL TESTS AND OPERATION

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PREFACE

Section 13, Initial Tests and Operation, is comprised of information no longer applicable to an operating plant. It is submitted as part of the Updated FSAR for completeness and historical purposes. The applicable AEC questions/responses and AEC Regulatory Staff Positions have been incorporated in one document. No additional changes have been made other than to retype and reformat the text for consistency of the updated FSAR.

SECTION 13

INITIAL TESTS AND OPERATION

13.0 INTRODUCTION

This section describes the scope of tests and operations to be performed when construction is complete enough to operate and test individual components and systems through the 100 continuous hours acceptance run of full power for commercial operation. This test period is divided into two categories:

1. Preoperational testing generally refers to those tests performed prior to the initial core loading

2. Initial startup testing generally refers to those tests and operations from the initial core loading through the acceptance tests.

In the preparation of this section, the following AEC Guides were used as a guide for determining the tests to be performed:

1. "Guide for the Planning of Preoperational Testing Programs", USAEC, December 7, 1970

2. "Guide for the Planning of Initial Startup Programs", USAEC, December 7, 1970 (revised).

It should be noted that some of the tests described in the guides are considered preoperational tests, but because of their requirements, are performed during startup testing. An example is scram performance of control rods. This can only be done after the core is loaded and the vessel head is on, although this test appears in the Preoperational Guide. In such cases, the tests are addressed in the order of appearance in the guides to facilitate review. A notation specifies any deviation from the performance of a test outside of the time period in which it is categorized.

Administrative Procedures for Conducting the Test Program

The entire test program and operations will be under the direct control of Duquesne Light Company via the Joint Test Group (Refer to Section 13.2), including the preparation of test documents and performance of the tests. During the procedure preparation and test performance, technical assistance will be provided by Duquesne Light Company's contractors as deemed necessary. Detailed procedures will be prepared by Duquesne Light Company from design information, test specifications and procedures provided by Duquesne Light Company's contractors and equipment manufacturers. Prior to issuance of test procedures for performance, a review will be conducted with the Duquesne Light Company Organization and by the Joint Test Group.

Testing is conducted by Duquesne Light Company's personnel technically assisted as required by the contractor personnel. Test results will be evaluated and approved by Duquesne Light Company and the Joint Test Group.

Changes to approved test procedures will be documented and will become part of the final test procedures. The procedure for making these changes, including the reviews and approvals, is covered in detail in Section 13.2.

Personnel performing the tests will be part of the startup and operation organization and will be qualified by experience and training to perform these activities as stated in Section 13.2. These personnel will be under the supervision of the BVPS-1 Superintendent, Licensed Senior Operators and the Technical Supervisor.

Results of tests will be fully documented and reviewed as stated in Section 13.2. As appropriate, results will be incorporated in unit operating procedures. Any modification required to equipment during the performance of testing or as required based on test data will be documented and become part of the official unit records. Temporary changes to systems will be documented in the procedures and following completion of test will be restored to normal conditions and verified.

At the conclusion of each test, the completed test procedures along with all data and conclusions will be documented and filed as part of the permanent unit records.

13.1 TEST PROGRAM

13.1.1 Preoperational Test Program

The comprehensive testing program ensures that equipment and systems perform in accordance with design criteria prior to fuel loading. As the installation of individual components and systems is completed, they are tested and evaluated according to pre-determined and approved written testing techniques, procedures or check-off lists. Analyses of test results are made to verify that systems and components are performing satisfactorily and if not, to provide a basis for recommended corrective action.

The program includes tests, adjustments, calibrations and system operations necessary to ensure that initial fuel loading, initial criticality and subsequent power operation can be safely undertaken.

Whenever possible these tests are performed under the same conditions as experienced under subsequent unit operations. During system tests for which unit parameters are not available and cannot be simulated due to existing unit conditions the systems are operationally tested as far as possible without these parameters. The remainder of the tests are performed under unit conditions when the parameters are available. Abnormal unit conditions are simulated during testing when required and when such conditions do not endanger personnel or equipment or contaminate systems whose cleanliness has been established.

In general, preoperational testing is completed prior to core loading. As individual systems are completed, preoperational tests are performed to verify as near as possible, the performance of the system under actual operating conditions. Where required, simulated signals or inputs are used to verify the full operating range of the system and to calibrate and align the systems and instruments at these conditions. Later systems that are used during normal operation are verified and calibrated under actual operating conditions. Systems that are not used during normal unit operation, but must be in a state of readiness to perform safety functions, are checked under all modes and test conditions prior to unit startup. Examples of these systems are reactor trip system and engineered safety features system logic, operation checks and setpoint verifications.

Testing performed during the preoperational test program is outlined in Table 13.1-1 and shown in sequence of performance in Figure 13.1-1. In general, it is expected that all preoperational testing will be completed before fuel loading. In some cases, it will be necessary to defer certain preoperational tests until after core loading. These include such tests as the complete rod control system, rod position indication and complete in-core moveable detector system. These tests have been identified in Table 13.1-1. Prior to the performance of hot testing, following core loading, prerequisite cold testing will have been performed. Examples of these tests are the cold rod drop time measurement tests.

An instrumented piping preoperational vibration test program to measure the frequency and amplitude of piping systems utilizing recording accelerometers (time dependent) will be conducted, under simulated transients that are credible within the normal and upset operating modes of the most susceptible Class I piping systems. The simulated transients that will be performed during these instrumented tests will include:

1. Start and stop reactor coolant pumps with associated operation of valves (closures/openings) in reactor coolant piping systems

2. Start and stop residual heat removal (RHR) pumps with normal operation (closures/openings) of the associated valves in RHR piping systems

3. Operation of the safety injection piping system, including direct injection into the primary coolant loop

4. Operation of pressurizer relief valves and its associated discharge piping system

5. Start and stop auxiliary feedwater pump with normal operation (closures/openings) of the associated valves in the auxiliary feedwater piping system.

On all other Seismic Class I piping systems, non-instrumented vibratory test programs will be implemented during the preoperational test program. If excessive vibration is observed under the transient loadings specified in Section 13 and Appendix B, either restraints will be installed or an instrumented test program will be performed.

For instrumented test programs, the amplitude of the measured dynamic responses at predetermined points of piping systems will be converted to a dynamic stress intensity equivalence, to be combined with other primary stresses. The acceptable criteria will be based on the allowable primary stress limit of 1.25Sh as specified in ANSI-B31.1. Power Piping Code.

13.1.2 Initial Startup Test Program

Fuel loading begins when all prerequisite system tests and operations are satisfactorily completed. Upon completion of fuel loading, the reactor upper internals and pressure vessel head are installed and additional mechanical and electrical tests are performed as discussed in preoperational testing. The purpose of this phase of activities is to prepare the system for nuclear operation and to establish that all design requirements necessary for operation are achieved. The core loading and post loading tests are described below.

13.1.2.1 Fuel Loading

The reactor containment structure shall be completed and the containment integrity established and maintained during fuel loading.

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

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

The overall responsibility and direction for initial core loading is exercised by the station management. The overall process of initial core loading is, in general, directed from the charging floor of the containment structure. Procedures for the control of personnel and the maintenance of containment integrity are established prior to the fuel loading.

The as-loaded core configuration is specified as part of the core design studies conducted well in advance of station startup and as such is not subject to change at startup. In the event that mechanical damage is sustained during core loading operations to a fuel assembly of a type for which no spare is available onsite, an alternate core loading scheme whose characteristics closely approximate those of the initially prescribed pattern will be determined.

The core is assembled in the reactor vessel, submerged in reactor grade water containing enough dissolved boric acid to maintain a calculated core effective multiplication factor of 0.90 or lower. The refueling cavity is dry during initial core loading. Core moderator chemistry conditions (particularly, boron concentration) are prescribed in the core loading procedure document and are verified periodically by chemical analysis or moderator samples taken prior to and during core loading operations.

Core loading instrumentation consists of two permanently installed source range (pulse type) nuclear channels and two temporary incore source range channels plus a third temporary channel which can be used as a spare. The permanent channels when responding are monitored in the main control room by licensed station operators; the temporary channels are installed in the containment structure and are monitored by reactor engineering personnel and licensed station operators. At least one permanent channel is equipped with an audible count rate indicator. Both unit channels have the capability of displaying the neutron flux level on a strip chart recorder. The temporary channels indicate on rate meters with a minimum of 1 channel recorded on a strip chart recorder. Minimum count rates of two counts per second, attributable to core neutrons, are required on at least two of the four (i.e., 2 temporary and 2 permanent source range detectors) available nuclear source channels at all times following installation of the initial nucleus of eight fuel assemblies.

At least two artificial neutron sources are introduced into the core at appropriate specified points in the core loading program to ensure a neutron population of a minimum of 2 counts per second for adequate monitoring of the core.

Fuel assemblies together with inserted components (control rod assemblies, burnable poison inserts, source spider or thimble plugging devices) are placed in the reactor vessel one at a time according to a previously established and approved sequence which was developed to provide reliable core monitoring with minimum possibility of core mechanical damage. The core loading procedure documents include detailed tabular check sheets which prescribe and verify the successive movements of each fuel assembly and its specified inserts from its initial position in the storage racks to its final position in the core. Multiple checks are made of component serial numbers, types and orientation at successive transfer points to guard against possible inadvertent exchanges or substitutions of components and fuel assembly status boards are maintained throughout the core loading operation.

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

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

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

1. An unanticipated increase in the neutron count rates by a factor of 2 occurs on all responding nuclear channels during any single loading step after the initial nucleus of 8 fuel assemblies are loaded (excluding anticipated change due to detector and/or source movement).

2. The neutron count rate of any individual nuclear channel increases by a factor of five during any single loading step after the initial nucleus of 8 fuel assemblies are loaded (excluding anticipated changes due to detector and/or source movements).

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

Core loading procedures specify the condition of fluid systems to prevent inadvertent dilution of the reactor coolant, specify the movement of fuel to preclude the possibility of mechanical damage, prescribe the conditions under which loading can proceed, identify responsibility and authority and provide for continuous and complete fuel and core component accountability.

13.1.2.2 Postloading Tests

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

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

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

At all times that the control rod drive mechanisms are being tested, the boron concentration in the coolant-moderator is maintained such that criticality cannot be achieved with all control rod assemblies out.

A complete functional electrical and mechanical check is made of the incore nuclear flux mapping system at the operating temperature and pressure.

After final precritical tests, nuclear operation of the reactor begins. This final phase of startup and testing includes initial criticality, low power testing and power level escalation. The purpose of these tests is to establish the operational characteristics of the unit and core, to acquire data for the proper calibration of setpoints, and to ensure that operation is within license requirements. A brief description of the testing is presented in the following sections. Table 13.1-2 summarizes the tests which are performed from initial core loading to rated power and Figure 13.1-2 shows the sequence in which these tests are performed.

Initial criticality is established by sequentially withdrawing the shutdown and control groups of control rod assemblies from the core, leaving the last withdrawn full length control group inserted far enough in the core to provide effective control when criticality is achieved, and then continuously diluting the heavily borated reactor coolant until the criticality is achieved.

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

Inverse count rate ratio monitoring is used as an indication of the proximity and rate of approach to criticality of the core during control rod assembly group withdrawal and during reactor coolant boron dilution. The rate of approach is reduced as the reactor approaches the time extrapolated for criticality to ensure that effective control is maintained at all times. Written procedures specify the unit conditions, precautions and specific instructions for the approach to criticality.

13.1.2.3 Low Power Testing

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

The measurements are made at low power and primarily at or near operating temperature and pressure. Measurements, to include verification of calculated values of control rod assembly group reactivity worths, of isothermal temperature coefficient under various core conditions, of differential boron concentration reactivity worth and of critical boron concentrations as functions of control rod assembly group configuration are made.

In addition, measurements of the relative power distributions are made. Concurrent tests are conducted on the instrumentation including the source and intermediate range nuclear channels.

Procedures are prepared to specify the sequence of tests and measurements to be conducted and the conditions under which each is to be performed to ensure both safety of operation and the relevancy and consistency of the results obtained. If significant deviations from design predictions exist, unacceptable behavior is revealed, or apparent anomalies develop, the testing is suspended and the situation reviewed to determine whether a question of safety is involved, prior to resumption of testing.

13.1.2.4 Power Level Escalation

When the operating characteristics of the reactor and unit are verified by the low power testing, a program of power level escalation in successive stages brings the unit to its full rated power level. Both reactor and unit operational characteristics are closely examined at each stage and the conformance with the safety analysis verified before escalation to the next programmed level is effected.

Measurements are made to determine the relative power distribution in the core as functions of power level and control assembly group position.

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

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

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

Testing performed following core loading and during unit startup is outlined in Table 13.1-2. All precritical tests shall be completed prior to initial criticality and the results evaluated. Prerequisites for performing a test are specified in the individual test procedure. The sequence of testing is outlined in a startup test sequence, such that required prerequisite testing is completed prior to performing subsequent testing. Any special test instruments required are specified to be installed, calibrated and checked in the test procedure that specifies the test equipment. Where these test instruments are not left installed for future use, they are removed from the systems and removal is verified. The sequence of testing following core loading is shown by Figure 13.1-2. The sequence of testing may be modified in accordance with the BVPS-1 Test Program Administrative Procedures.

13.1.2.5 Augmented Startup Program

The BVPS-1 augmented startup program will be performed as indicated in Reference 1. There are two phases of the program; one consisting of additional startup testing and the second consisting of additional periodic at-power cycle testing. The purpose of the program is to obtain additional confirmation of the nuclear design bases for peaking factor calculations by conducting incore flux measurements under nonsteady-state conditions. These conditions include additional load following maneuvers and also special maneuvers whereby the axial flux difference is forced to the extreme of Technical Specification limits under constant axial offset power distribution control so as to approximate, as far as practicable, the most limiting power distributions which establish the peaking factor design envelope. Full core and special quarter core flux maps are taken throughout the resulting transient. Xenon conditions are compared with the corresponding calculated power distribution behavior. Testing will be performed at approximately 50, 75, 90 and 100 percent power levels with the exception of the fast ramp load follow test, which will not be performed.

Reference in Section 13.1

1. K. A. Jones et al, "Augmented Startup and Cycle 1 Physics Program," WCAP 8575, Westinghouse Proprietary Class 2, WCAP 8576, Non-Proprietary (August 1975).

13.2 TEST PROGRAM RESPONSIBILITIES AND IMPLEMENTATION

The Duquesne Light Company has the overall responsibility for development, supervision, performance and documentation of all of the preoperational and startup testing of the Beaver Valley Power Station Unit No. 1 (BVPS-1). Test procedure preparation and all test performance at BVPS-1 are under the control of Duquesne Light Company to ensure proper and effective emphasis is maintained on personnel and plant safety by all individuals participating in the testing program.

The BVPS-1 preoperational and startup test program objective is to prove conclusively the plant readiness and capability to operate safely within its designed limits. Included in the program shall be tests to verify the plants adequacy to cope with transient and accident conditions without endangering the health and safety of the general public.

Successful completion of the test programs will constitute a reasonable assurance that the plant can operate safely by demonstrating the knowledge and operating competence of the organization responsible for plant operation. Operation under abnormal or emergency conditions will have been tested by establishing suitable environmental conditions as closely as can reasonably be established or simulated to ensure the adequacy of the abnormal and emergency operating procedures. Concurrently, the adequacy of normal operating and test procedures as well as administrative controls will be confirmed. The operating experience gained during the test program provides additional training for station operations personnel complementing previous experience and training detailed in Section 12.

In order to accomplish these preoperational and startup testing objectives of BVPS-1 with a maximum assurance of safety and acceptability, a Joint Test Group has been created. This group consists of a qualified representative from Duquesne Light Company (applicant), Stone & Webster Company (constructor-engineer) and Westinghouse Electric Corporation (nuclear steam supply system vendor). The Duquesne Light Company representative is the Technical Assistant-Nuclear to the Manager, Power Production, who will act as chairman of the Joint Test Group. Alternates for each individual will be named to permit continuous performance of the group. This group will function in the capacities described below until Duquesne Light Company has formally accepted BVPS-1 for commercial operation. At that time, the responsibilities of the Joint Test Group will be assumed entirely by Duquesne Light Company.

The Joint Test Group is assigned the specific responsibility for coordination and performance of the organizations involved in accomplishing the successful completion of BVPS-1 preoperational and startup test program. They are responsible for review and approval of test schedules, test procedures, test evaluations and test modifications. The details of accomplishment of these efforts are explained later in this section.

The establishment of this group assures that each test schedule, procedure, and any modifications thereto, have been thoroughly reviewed for acceptability by all responsible parties prior to approval for performance. This provides the necessary control for preparation, coordination, performance and modification of the various tests and ensures they have been accurately and thoroughly evaluated to preclude incomplete or erroneous conclusions.

The scope of the preoperational and startup test programs and the responsibilities of the Joint Test Group will extend beyond safety-related systems though not necessarily incorporated in this document. The preoperational and startup test programs, when completed, will provide assurance that the plant will perform in accordance with the Technical Specifications approved for BVPS-1 and that all tests dictated in Sections 3 through 11 have been successfully performed and documented.

All plant systems operations required by the preoperational and startup test program are performed by authorized BVPS-1 operations personnel in cooperation with and under the cognizance of the BVPS-1 Test Section. The BVPS-1 Test Section consist of engineers who function under the direct supervision of the Technical Supervisor.

This group is charged principally with:

1. Preparation of draft test procedures

2. Final draft and issuance of approved test procedures

3. Incorporation of comments and issuance of approved modified test procedures

4. Providing technical assistance and resolution in the performance of tests (in cooperation with operations Shift Supervisor)

5. Compilation of test data

6. Issuance of test results reports

7. Maintaining and controlling active test schedules

8. Maintaining files of all test schedules, test procedures, test data and test results reports

9. Administrative control of the test program in-plant

10. All other responsibilities normally associated with the above listed efforts (i.e., determine and obtain reference documents and technical assistance for test procedure preparation and evaluation, assurance of adequacy of test devices and equipment to be used in any tests, provide number of qualified technical personnel to perform test, operate special test equipment, verify temporary test arrangements are properly installed and removed when necessary, etc.).

All operating personnel will be qualified, trained and appropriately licensed as prescribed by law. Supervision will be by licensed senior reactor operators and reactor operations will be performed by licensed reactor operators. Senior management and technical support personnel have been assigned on the basis of prior reactor plant operating and test experience and training. In most cases, these persons are licensed or have been previously certified in reactor operations (for more detail of qualifications and assignation refer to Section 12 and the BVPS-1 Technical Specifications).

Fuel loading will be performed principally by station operations personnel supervised by licensed senior reactor operators. Fueling procedures will follow a similar evolution (from draft through results documentation) as test procedures. Supervision and technical assistance will be supplemented by qualified Westinghouse (nuclear steam system supplier) technical personnel. Test Section engineers will be assigned during fuel load performance to assist in fulfilling the necessary inspection, identification, verification, core status monitoring, recording, documentation and such tasks which can most effectively be accomplished with technically oriented personnel.

All proof testing performed prior to preoperational testing will be verified by a check of documentation as required by each test procedure. The format, method of preparation and approval of detailed test procedures is described below. For the purpose of illustration, a listing of representative tests is given in Table 13.1-1; however, additional nonsafety related and specific plant tests will be included but are not necessarily herein documented. Integrated hot functional tests including simultaneous operation of auxiliary systems will be carried out formally as will overall plant performance in so far as practicable to accomplish that test objective as required. Where test or test aspects are not practical, simulation will be exercised to its practical limit.

Test procedure preparation shall commence sufficiently in advance of the scheduled tests so as not to interfere with the orderly accomplishment of the test program. The magnitude of the effort involved with test procedure preparation will vary based on estimates of the number of tests and when they are needed which is determined by the preoperational and startup test program schedule.

The following discussion describes the preparation, review and approval process, and the execution of BVPS-1 test procedures as well as the evaluation, documentation and approval of test results. The organizational responsibilities and qualifications are also included. The administrative procedures for initial issuance or modification to test procedures (refer to Figure 13.2-1) are also discussed.

The preoperational and startup test procedures are initially drafted by the Test Section engineers utilizing general test schedules and specifications generated by the Stone & Webster Engineering Corporation (S&W) or by the Westinghouse Electric Corporation (W). These draft test procedures are reviewed by the BVPS-1 Operations Group (and Onsite Safety Committee where appropriate) and any comments are resolved and/or incorporated into the procedure by the Test Section (See Figure 13.2-1). Comments of the BVPS-1 Health Physics and Chemistry Group and/or the Maintenance Group are also solicited where appropriate. When the BVPS-1 Operations personnel and Test Section completes a test procedure for Joint Test Group approval, copies of that procedure are submitted to the Joint Test Group. The Joint Test Group then distributes the procedure to their cognizant designers and/or constructors for further review and comment. At subsequent meetings of the Joint Test Group, the issued test procedure is reviewed and any engineering constructor or nuclear steam supplier comments, changes, additions or deletions are resolved. The Joint Test Group returns that test procedure to the Test Section where it is revised as recommended by the Joint Test Group. The test procedure is then issued in final form for approval by the Joint Test Group. Each of the individuals of the Joint Test Group will signify approval of the procedure by signature and date in the space provided on the cover sheet of the test procedure. The nuclear steam supply system representative of the Joint Test Group will not normally approve test procedures which deal with components or systems beyond the nuclear steam supply system engineers scope of interest. The nuclear steam supply system representative signature on these procedures are in a separate space and does not indicate approval but does indicate the nuclear steam supply representative has had the opportunity to comment and acknowledges that performance of the procedure does not detrimentally effect equipment or systems under his area of responsibility. The original signed procedure is retained in the files of the Test Section. Copies of this procedure will be made and sent to the BVPS-1 Operations Group, the engineer constructors, and the nuclear steam supply representative (as necessary).

Additionally, where loading of fuel in the reactor vessel commences, it will be necessary for the Onsite Safety Committee (refer to Section 12.5) to review in detail all tests involving reactivity control systems or engineered safeguards systems. This review deals with the scheduling of the tests, the test procedures as approved and the test evaluations as issued.

The BVPS-1 Superintendent signifies by his signature concurrence of the Onsite Safety Committee. The Onsite Safety Committee will determine on an individual case basis, whether review by the Offsite Review Committee is specifically required.

The BVPS-1 test procedures will consist principally of the following:

1. COVER PAGE: A descriptive title, issue date, identifying symbol, Test Section revision number and an approval signature section.

2. PURPOSE OF TEST: A brief statement as to the objective or reason for performing the test. All applicable BVPS-1 Technical Specifications will be referenced and reference may also be made to other sections of this FSAR, equipment specifications, etc.

3. GENERAL TEST METHOD: A brief discussion of the manner in which the test will be performed. This discussion does not go into the step by step sequence, but should be sufficiently detailed that the reader will understand how the test is to be conducted.

4. SPECIAL TEST EQUIPMENT: This section should list in detail what equipment, other than installed operational equipment and instruments, is required to obtain the required data or to perform the test.

5. PREREQUISITES: A list of items, events or actions that must be completed prior to the start of a test. Included will be such items as a check that necessary quality assurance documentation has been completed and in certain cases, a field inspection to establish that the systems are ready for testing. All other tests or portions of tests that must have been satisfactorily completed and all test equipment that must be calibrated or otherwise made operable and any environmental conditions, if applicable, and not covered under Initial Station Conditions will be included in the prerequisites.

6. INITIAL STATION (SYSTEM) CONDITIONS: A list of conditions that the station or system must be in at the start of the test performance. This section may make reference to appropriate station operating procedures but should be specific as to conditions of the station and/or systems affected.

7. PRECAUTIONS AND LIMITATIONS: This should be a precise list of all applicable precautions that are to be taken prior to, during and following performance of the test. These should cover the safety of personnel and operating equipment, identifying protective devices, apparel, personnel conduct and any items related to safety. All limitations that will be or possibly could be approached are to be clearly stated.

8. PROCEDURE: The procedure is written in a step by step manner as required to direct the persons performing the test. It should also indicate when data is recorded, which specific instruments are read and the frequency of recording data. For procedures which are anticipated to be performed only once, the data sheets may be found in this section. Any contingencies are provided for in this section. All temporary changes made in plant are required to be restored to normal in this section following test performance unless required as a prerequisite for a subsequent test. If so, it is so stated and requires that such subsequent action follows directly and that its procedure requires restoration of temporary plant changes.

9. ACCEPTANCE CRITERIA: States as clearly as possible the criteria that must be met to consider the test results satisfactory, and ultimately, the test completed. The source of the acceptance criteria will normally be identified as well as referenced. If no acceptance criteria is available or clearly defined, it shall be so pointed out as well as designated an authority for resolution of the problem. A copy of both the test procedure and data must be placed on file with the DLC Test Section.

10. REFERENCE: A list of all sources of information considered necessary for the successful completion of the test procedures.

11. DATA SHEETS: For test procedures that will be of a periodic nature or where the required data is too extensive to be included in Item 8 above, recording data sheets will be provided at the end of the procedure.

All operations supervision is instructed that tests are only performed in accordance with approved test procedures. If it is not possible to perform the test as specified by the approved test procedure, the test may not be performed until the procedure is altered or modified as necessary and authorized. Any change(s) to an approved test procedure are dealt with by the Joint Test Group in a manner similar to the method specified for incorporating comments into a draft test procedure. Where it is not possible to perform the test safely and with acceptable results in accordance with the approved test procedure, and it is not prudent to delay performance of the test to allow necessary procedure changes to be incorporated in accordance with the above specified manner, an alternate approved method may be used.

Within the DLC BVPS-1 organization, the on-duty Shift Supervisor and responsible Test Engineer on-shift are authorized by the Joint Test Group on a predefined limited basis to make required minor changes or modifications to the approved test procedure. The on-duty Shift Supervisor is responsible for ensuring that the changes to the approved procedure do not compromise station or personnel safety while the responsible Test Section engineer ensures that the results of the test are not compromised. Where the change to the procedure results in a change in the scope of the test or alters the acceptance criteria, the Duquesne Light Company on-shift personnel will contact by phone their respective supervisors prior to approving the change. The Station Superintendent (Chief Engineer in his absence) may authorize the change for both the Operations Group and Test Section. When the test procedure concerns the nuclear or safety-related portion of the station, the On-Site Safety Committee Chairman or Vice Chairman will be contacted to determine the degree of participation by the On-Site Safety Committee prior to approving modifications to an already approved procedure.

The on-duty Shift Supervisor will authorize the Test Section engineer to make the necessary "pen and ink" changes to the approved test procedure and to the Operations Group, the constructor-engineer and the nuclear steam supplier copies of the approved procedure. The changes incorporated in the procedure will be specifically listed on the cover sheet of the procedure. The on-duty Shift Supervisor, responsible BVPS-1 Test Section engineer, the constructor-engineer and the nuclear steam supplier (if necessary) shift personnel will initial the cover sheet of the procedures indicating their approval of the change. It is the responsibility of those representatives initialing the change to secure authorization necessary from their own organization prior to initialing the change. If any representative withholds approval of the change, the test is to be delayed or suspended and the Joint Test Group will resolve any problems.

All operations supervisors and Test Section engineers are instructed that this alternate method of changing approved test procedures shall not be used to make changes to Joint Test Group approved procedures for reasons of station or personnel convenience. All tests must be performed in accordance with the approved procedure. Changes to the approved procedure that if incorporated, would significantly improve the utilization of the station or personnel will be noted by the on-shift Test Section engineer. These changes can be forwarded to the Joint Test Group with a recommendation of consideration for formal incorporation.

For many of the tests performed during the overall BVPS-1 preoperational and startup effort, specific acceptance criteria are included within the test procedure as stated above. This allows on-shift evaluation of the results and the test and some determination whether or not the test may be suspended, extended or repeated. For some tests, where it is not possible or practical to state specific acceptance criteria, general acceptance criteria are included to assist on-shift determination, with a detailed evaluation of the results of the test conducted subsequent to the completion of the test.

All of the data obtained during the test are retained by the Test Section and will be filed for future reference.

Should any question exist on the adequacy of test results, the Joint Test Group will assign responsibility for preparing a written evaluation of the results of a test in the form of a test results report to an individual organization of the Joint Test Group. The Test Section prepares and issues written evaluations of the results of tests performed by the Duquesne Light Company. The Test Section may contact the constructor-engineer or nuclear steam supplier to utilize their expertise if considered needed to properly evaluate the results of tests. For some of the less complex acceptance tests, the test result report may conceivably consist of a brief statement of the acceptance criteria and acknowledgement that it was satisfactorily met. For the complex tests, a more extensive test result report is submitted.

All test reports and evaluations are sent to the Joint Test Group for approval of evaluation. Should any one member of the Joint Test Group question the adequacy or conclusion(s) of the report as issued, the Joint Test Group resolves the question(s) and authorizes the originating organization to issue a revised test result report for approval. The Joint Test Group also determines if a test must be repeated to obtain acceptable results. The members of the Joint Test Group (the nuclear steam supplier as necessary) indicates approval of the report by affixing their signatures in the applicable spaces provided on the test result report. The signed report is sent to the Test Section where copies are made and distributed to those persons or organizations which approved the respective test procedure which yielded the results. The original signed test result report is retained on file by the Test Section for record and future reference.

Should any deficiencies be discovered, discrepancies develop and/or modification to systems be required, these are noted in the test report. The party or organization responsible for performing corrective action is determined and notified by the Joint Test Group. Following completion of the required corrective action, the Joint Test Group determines if a test must be performed in its entirety or only a certain portion(s) of the test need be repeated. In most cases, the subsequent test and evaluation are handled as if it were a separate test to assure satisfactory documentation of the corrective action.

Following successful completion of the BVPS-1 preoperational and startup test program, the Joint Test Group is dissolved and all approval and disapproval functions, relating to station testing, which were the responsibility of this group, will become the responsibility of the BVPS-1 Station Superintendent.

During the preoperational and startup test program, the Test Section will be augmented as necessary with sufficient qualified technical personnel to assist in the research and preparation of test procedures, test performances, test evaluations and documentation of test results. These supplemental personnel will be provided primarily by the Technical Services Section of the Power Stations Department and the Engineering and Construction Division at Duquesne Light Company. Additional assistance may be obtained through contracting with qualified consulting agencies.

As previously stated, the overall control for safe and complete accomplishment of the BVPS-1 preoperational and startup test program is the delegated responsibility of the Joint Test Group.

The qualifications of the Joint Test Group are as follows:

The Chairman and Duquesne Light Company representative was the Technical Assistant-Nuclear to the Manager, Power Production. This position was held by Mr. John Carey. Mr. Carey had sixteen years of power plant experience, the last four of which had been nuclear. He is a graduate electrical engineer and had successfully completed several nuclear training courses including the complete Shippingport Training Course and Westinghouse Nuclear Power Plant Simulator Course. He had spent three years as the BVPS-1 Station Superintendent and three years as the Station Superintendent of a fossil fired power station.

The nuclear steam supply systems contractor representative on the Joint Test Group was designated as the Westinghouse BVPS-1 Site Service Manager. This was Mr. Donald Wieland. Mr. Wieland had thirteen years of experience with Westinghouse specifically dealing with Nuclear Power Plants in the area of construction and start up. His efforts were backed by technical assistance provided by Westinghouse personnel qualified in the various systems when necessary.

Replacement of individual members was expected to occur during the course of the project, but replacements will be required to possess comparable qualifications.

The Architect Engineer representative was the Lead Advisory Engineer. This position was held by Mr. Ray D. Lombard. He is a graduate Electrical Engineer. He has broad experience in all phases of nuclear plant technology, covering a period of 20 years. He has been involved in the start up of four previous PWR nuclear power plants commencing with the initial start up testing of the Shippingport Nuclear Power Plant.

Technical assistance was provided by DLC Substations and Shop Department, the constructor-engineer (Stone & Webster), the nuclear steam supply system vendor (Westinghouse), plant equipment vendor service representatives and special service contractors (WISCO, NUS and WNES Pre-Service Inspection Group). These groups performed specific tasks such as inspection, calibration, startup checks, monitoring, etc. Such tasks are prerequisite to or in direct assistance or coordination with preoperational testing and plant startup testing. In some cases, they are the individuals responsible for the correction of deficiencies in-plant as determined prior to, during or subsequent to the various tests.

BVPS UFSAR UNIT 1

TABLES FOR CHAPTER 13

Table 13.1-1

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		I. UNIT INSTRUMENTATION
1. Nuclear Instrumentation (excore)	Prior to core loading and initial criticality	Prior to core loading, nuclear instruments will have been aligned and source range detector response to a neutron source checked. Just before initial criticality all channels will be checked to verify high level trips, alarm setpoints, audible count rates where applicable, operation of strip chart recorders and the proper operation of any auxiliary equipment.
2. Process Instrumentation (temperature, pressure, level and flow instruments)	Ambient and at temperature. (Equipment shall have been aligned per manufacturer's instructions and applicable test procedures).	During fill and pressurization, heatup and hot functional testing, the alignment and operation of these instruments will be verified by comparison with one another and with special instrumentation. The temperature and auxiliary flow instruments are calibrated at the various steady state temperature levels and setpoints adjusted as required. Applicable alarm and control setpoints are checked for conformance with design values.
		II. REACTOR COOLANT SYSTEM
1. Vibration, Frequency, and Amplitude	Prior to core loading	Vibration sensors on the reactor coolant pumps monitor the amplitude of vibration of these pumps during startup and operation.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		II. REACTOR COOLANT SYSTEM (CONT'D)
2. Expansion and Restraint	Prior to core loading during heatup and cooldown.	During the heatup to operating temperature, selected points on components and piping of the reactor coolant system (RCS) are checked at various temperatures to verify that they can expand unrestricted. At cold unit conditions prior to heatup, gages are installed and base line data established for making measurements during heatup. Any points of interference detected during the heatup are corrected prior to increasing the temperature. Following cooldown to ambient temperature, the piping and components are checked to confirm that they return to their approximate cold unit base points.
3. Integrated Hot Functional Tests	Heatup, at temperature and during cooldown. (Hydrostatic testing shall be satisfactorily completed and RCS instruments aligned and operational).	Using pump heat, the RCS is tested to check heatup and cooldown procedures and to demonstrate satisfactory performance of components and systems that are exposed to RCS temperature. To verify proper operation of instrumentation, controllers and alarms, provide design operating conditions for checkout of auxiliary systems. Among the demonstrations performed are: a. That water can be charged by the chemical and volume control system at rated flow against normal reactor coolant pressures. b. To check letdown flow rate for each operating mode. c. To check response of system to change in pressurizer level. d. To check procedures and components used in boric acid batching and transfer operations.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		II. REACTOR COOLANT SYSTEM (CONT'D)
		e. To check operation of the excess letdown and seal water flow paths.
		f. To check steam generator level instrumentation response to level changes.
		g. To check thermal expansion of system components and piping.
		h. Perform isothermal calibration of resistance temperature detectors and incore thermocouples.
		i. Operationally checkout the residual heat removal system.
		j. Visual and surface examination of the upper and lower core structures at control areas.
4. Component Tests		
a. Pressurizer	At operating temperature. (The hydrostatic test shall have been satisfactorily completed and the pressurizer heaters and spray function checked in advance.)	During the hot function testing, the pressure controlling capability of the pressurizer shall be demonstrated. After core loading, with reactor coolant pumps operating and with full spray, the pressure reducing capability of the pressurizer is verified. With the spray secured and all heaters energized, the pressure increasing capability of the pressurizer is verified.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		II. REACTOR COOLANT SYSTEM (CONT'D)
b. Pumps and Motors	At ambient conditions and during heatup and at temperature	As the various pumps and motors are placed in operation they are checked for: 1. Direction of rotation 2. Vibration 3. Power requirements 4. Lubrication 5. Cooling 6. Recirculation flow 7. Flow and pressure characteristics 8. Megger and hi pot tests (as applicable) 9. Òverload protection 10. Correct power supply voltage Flow and pressure data are taken to verify that these parameters are within values used in systems analysis or used in the functional requirements. Other results are compared to manufacturer's specifications or published standards.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		II. REACTOR COOLANT SYSTEM (CONT'D)
c. Steam Generators	At ambient condition and during heatup at temperature. (The secondary system shall have been satisfactorily hydrostatically tested.)	During heatup and at temperature the instrumentation and control systems of the steam generators are checked under hot and cold shutdown conditions. The ability to cool down the unit using the steam generators is demonstrated. The functioning of the blowdown system is also checked.
d. Relief and Safety Valves	Pressure Conditions	The setpoints of the relief and safety valves are verified from vendor certification data or by bench or in unit tests. When verified by in unit tests, setpoints are checked by using a pressure assist device which adds to the force due to pressure. Once the valve leaves its seat, this assist device is vented allowing the valve to reseat immediately. Following lifting and blowdown of any valve, the reseating of the valve is verified.
e. Main Steam Stop Valve	At operating temperature and no flow.	At hot conditions and with pressure equalized across the valve, the operation of the main steam stop valves are verified. The operating times are verified to be within expected values.
f. Miscellaneous Valves	At ambient temperature and pressure conditions.	At ambient condition, the operation and timing of miscellaneous system valves are checked and the operating times and valve leakage measured where applicable.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		II. REACTOR COOLANT SYSTEM (CONT'D)
5. Pressure Boundary Integrity Tests		
a. Hydrostatic Test	Below 200 F (after cleanliness, verification and fill of system).	Cold hydrostatic testing of the reactor coolant system and associated auxiliary systems are performed at test pressures as specified by ASME standards for the system. Prior to pressurization and where applicable, the system is heated above the minimum temperature for pressurization. The pressure is increased in increments and at each increment inspections are made for leakage. Leaky valves or mechanical joints are not a basis for rejecting the test. Test pumps used for pressurization are equipped with relief valves to relieve the capacity of the pumps to prevent inadvertently overpressurizing the system.
b. Base Line Data for Inservice Inspection	During preoperational testing	Systems and components that require inspection in accordance with the Technical Specifications are examined completely once for base line data either following the cold hydrostatic test or following hot functional testing depending on the system and component and its availability and accessibility. Data from tests inspections provide base line data for inservice inspection per the Technical Specifications.
c. Nondestructive Testing of stainless steel safe ends and critical components	Prior to hydrostatic test	All reactor coolant system weld joints are nondestructively tested using liquid penetrant and/or radiographic tests as required by Section III of the ASME Boiler and Pressure Vessel Code.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		III. REACTIVITY CONTROL SYSTEMS
1. Chemical and Volume Control System Tests	At ambient conditions, during heatup, at temperature and during cooldown of the RCS. System components shall have been operationally checked out.	Operations are conducted with the chemical and volume control system to checkout the different modes of dilution and boration and verify flows in the different modes. Where required, the adequacy of the system used to maintain the highest boric acid concentration in solution is also verified. The ability to adequately sample, and the sampling techniques are demonstrated.
2. Emergency Boron Shutdown System	At ambient conditions prior to core loading.	The pressure/flow characteristics of the emergency boration system is verified by pumping into the reactor coolant system.
3. Automatic Reactor Power Control Systems Tests	Preoperational conditions (Installation checks shall have been made.)	The system alignment is verified at preoperational conditions to demonstrate the response of the system to simulated inputs. These tests are performed to verify that the system will operate satisfactorily at power. At power the alignment of the system is verified by programmed step changes and under actual test transient conditions.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		III. REACTIVITY CONTROL SYSTEMS (CONT'D)
4. Incore Thermocouples and Ion Chambers		
a. Incore Thermocouples	During heatup and at temperature.	During heatup and at temperature, the incore thermocouples are calibrated to the average of the RCS resistance temperature detectors. All readout and temperature compensating equipment is checked during the calibration and isothermal corrections for thermocouples determined.
b. Moveable Detector System	At ambient conditions prior to core loading and following core loading.	Prior to core loading, the functioning of the moveable detector system is verified under the various modes of operation. The indexing is checked using a dummy cable to the thimble positions. The response of each channel is verified using simulated detector inputs. Following core loading and insertion of the thimbles in the core, the system is checked out to ensure free passage to all positions and set the limit switches. During flux mapping at power, the detector responses to neutron flux are verified.
5. Control Rod Systems Tests		
a. Rod Control System	Hot unit conditions prior to core loading	During the installation check of this system, it is energized and operationally checked out with mechanisms connected to each power supply. The ability of the system to step the mechanism is verified, the alarm functions checked out and the correct values of system parameters adjusted.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		III. REACTIVITY CONTROL SYSTEMS (CONT'D)
b. Rod Drop Performance	Cold and hot unit conditions following core loading	At cold and hot unit conditions following core loading, the drop times of the full length rods shall be measured. The drop time is measured from the release of the rod until the rod enters the top of the dashpot. This time is verified to be less than the maximum value specified in the Technical Specifications.
c. Rod Position Indication	At ambient conditions and at temperature following core loading	During rod control system tests the rod position indication system is aligned to provide rod movement indication. Rod bottom setpoints are also adjusted during these tests. After unit heatup individual rod position indication is calibrated to the rod power supply step counter.
6. Auxiliary Startup Instrumentation Test	Prior to core loading	Three separate temporary source range instruments will be installed in the core during core loading operations. One of these channels will serve as a spare to the other two channels. During the core loading operations these detectors are relocated at specific loading steps to provide the most meaningful neutron count rate. The response of each channel to a neutron source is verified prior to core loading.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		IV. PROTECTION SYSTEM
1. Reactor Protection System	Prior to core loading. (Installation checks shall have been performed.)	Prior to core loading the operation of the reactor trip system is verified under all conditions of logic utilizing outputs, or simulated outputs from each of the nuclear and process and other protection sensors. The individual protection channels are tested to check the redundancy of the systems. The protection channels are verified through to tripping of the reactor trip breakers. The trip time of each reactor protection signal is also measured from the output of the sensor to tripping of the reactor trip breaker. These times are verified to be less than the values identified in the safety analysis report.
2. Engineered Safety Features System	Prior to core loading. (Installation checks shall have been performed.)	Prior to core loading the operation of the engineered safety features logic systems shall be verified for all conditions of trip logic. Testing will be performed with each of the sensor inputs of simulated inputs. The engineered safety features channels are verified through to the relay or controller that actuates the engineered safety features device.
		V. POWER CONVERSION SYSTEM
1. System Tests		
a. Vibration Frequency and Amplitude	Hot Functional Testing	During initial operation and startup the turbine and major secondary system pumps are checked for vibration frequency and amplitude and data recorded.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		V. POWER CONVERSION SYSTEM (CONT'D)
b. Expansion and Restraint	During heatup, at temperature, and cooldown prior to core loading	Verify that reactor coolant piping and associated major secondary piping expand as designed during heatup and cooldown. Recording devices will be installed at selected points and movements will be observed and recorded during predetermined stages of preoperational testing.
2. Components and Individual Subsystems		
a. Steam Generator Pressure Relief and Safety Valves	Pressure Conditions	The setpoints of safety valves are verified from plant tests at pressure and temperature conditions. Setpoints are checked by using a pressure assist device which adds to the force due to pressure. Once the valve leaves the seated position the assist device is vented, allowing the valve to reseat immediately. Steam relief valve setpoints are made during instrument alignment and verified by unit transient tests.
b. Steam Generator Auxiliary Feedwater Pumps	Prior to Initial Criticality	During hot functional testing prior to initial criticality, the steam generator auxiliary feedwater system is checked out to verify its ability to feed the steam generators. Automatic starting is checked during checkout of the engineered safety features logic systems tests.
c. Turbine Control and Bypass Valves	Hot Functional Testing	During hot functional testing prior to initial criticality, the turbine control and bypass valves are checked for operability.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		V. POWER CONVERSION SYSTEM (CONT'D)
d. Feedwater and Feedwater Control System	Prior to hot functional testing and at power	The feedwater and condensate pumps are operationally checked out prior to hot functional testing. During power escalation, the power is slowly increased and the ability of the feedwater pumps to maintain level in the steam generators is verified. The steam generator level control system is aligned prior to filling the system and during fill, the system is used to monitor level in the steam generator. Prior to startup, the ability of the feedwater regulating valve control system to control the valves using simulated signals is demonstrated. During startup, when at power the ability of the system to control level under transient conditions is also verified.
e. Condenser Circulating Water	Prior to hot functional testing and at power	Prior to hot functional tests, the main circulating water pumps are operationally checked out. During hot functional system testing, while dumping steam to the condensers, the ability of the circulating water system to maintain condenser temperatures and back pressure at that condition is verified. During power escalation, the ability of the system to maintain back pressure is verified to 100 percent load conditions.
		VI. AUXILIARY SYSTEMS
1. Reactor Coolant Makeup System Test	During hot functional testing	Prior to hot functional testing, components of this system are operationally checked and setpoints made. During hot functional testing and power operation the makeup ability to the reactor coolant system is demonstrated.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		VI. AUXILIARY SYSTEMS (CONT'D)
2. Seal and Pump Cooling Water Test	Prior to heatup and at temperature	Prior to pump operation and with the system pressurized, flow to the pump seals and cooling water flow is adjusted to specified values using installed instruments. During hot functional testing when at operating temperature and pressure, seal and cooling flows and temperatures at checked and verified to specified values.
3. Vent and Drain System Test	During initial primary fill and pressurization and during hot functional testing	Venting of the reactor coolant system is done during initial filling by venting the reactor vessel head and pressurizer and venting at the reactor coolant pump seals during initial operation. During hot functional testing following core loading the secondary system is vented while bringing steam back to the secondary system. Secondary drains are tested for unrestricted flow.
4. Component Cooling System Test	During hot unit conditions	Component cooling to the various components in the system is adjusted. During hot functional testing and during cooldown, data is taken to verify that adequate cooling is provided to each component and temperature limits are being maintained.
5. Residual Heat Removal System Test	During initial core loading and cooldown following hot functional testing	This system is operationally checked prior to initial core loading by verifying pressure and flows for the various flow paths. The system is used to recirculate ambient temperature water during initial core loading. During cooldown, following hot functional testing, the heat removal capability of the system is demonstrated.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

	Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
			VI. AUXILIARY SYSTEMS (CONT'D)
6.	Purification System Test	Operating temperature	During hot plant conditions operation of the purification system is demonstrated by verification of flow, pressure drops and temperatures, without ion exchanger resins added.
7.	Fire Protection System Test	Prior to unit start-up	Components and equipment of the fire protection system are checked for completeness and functionally tested to verify system pressure at full flow conditions. Operations are also conducted from emergency power source to demonstrate the capability of these systems.
8.	River Water System Test	Prior to and during hot unit testing before core loading	The system is operationally checked out to verify pressure flow. River water flow is verified to components in the system. Operation is demonstrated from the emergency power source.
9.	Auxiliary Building Ventilation	Prior to unit start-up	The system is operated to demonstrate and balance flows to the areas supplied from the system and to verify motor currents, speeds, make setpoints and check alarms.
10.	Instrument Air System Tests	Hot functional testing	Operation of air operated equipment shall be verified within the range of design operating pressure values. Other air operated components will be tested to ensure that they fail in the safe mode upon loss of operating pressure.
11.	Mechanism and Rod Position Indication Coil Cooling System Test	Prior to hot functional testing	The system is operationally checked out to verify air flow, motor current, speed and to make setpoints and check alarms.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		VI. AUXILIARY SYSTEMS (CONT'D)
12. Neutron Shield Tank Cooling System	During hot functional testing	The system is operationally checked out to verify adequate cooling of the shield tank water and to check temperature alarm functions.
13. Leak Detection System Tests (Sensitivity and accuracy to detect leaks).	Prior to and during preoperational tests.	Temperature detectors in the drain lines from safety valves and the reactor vessel head seal are checked to verify their sensitivity to detect leaks and their alarm functions checked. Pressurizer relief tank and primary drain transfer tank No. 1 levels and temperature sensors are calibrated and associated alarms checked.
14. Primary Sampling System	Prior to and during hot functional testing	Operations will be performed to: a. Establish purge times. b. Demonstrate that liquid and gas samples can be obtained from sample points. c. Demonstrate that valves, instruments and controls function properly. d. Verify proper functioning of the sample cooler. e. Demonstrate that sample vessels can be removed and replaced without problems.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

	Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
			VII. ELECTRICAL SYSTEMS TESTS
1.	Normal Distribution Test (transformers, motors, relay switches, power supplies, etc., phasing and meggering where applicable).	Prior to unit startup and systems operation.	The integrity and operation of these components is verified prior to being energized by meggering, hi pot testing, continuity tests and operational testing and controlling devices as applicable. After being energized, phasing and voltage regulation tests are performed where applicable.
2.	Vital Bus Test (full load test using all power sources).	Prior to unit operation.	Tests are performed to verify that the vital bus load can be supplied from all power sources under normal and power failure conditions. In particular, tests are performed to verify that transfers take place under loss of power and redundant features function per design.
3.	Direct Current Systems Test.	Prior to unit operation.	The redundant features of the battery, battery charger and inverters are checked out. The capacity of the battery and voltage regulation is verified. The ability of each inverter to maintain design output under varying direct current input is also verified.
4.	Communications Systems Test (telephone, public address, intercoms, and evacuation signals).	Prior to fuel loading	To verify proper communications between all onsite stations and interconnection to commercial telephone service. To balance and adjust amplifiers and speakers and verify that evacuation alarms can be heard at all stations throughout the unit. Also, to verify that all temporary communications at the fuel loading stations and control stations are functioning properly.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

	Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
			VII. ELECTRICAL SYSTEMS TESTS (CONT'D)
5.	Emergency Power Systems (manual start and synchronization, full automatic loading tests, under loss of all alternating current voltage).	Prior to hot functional tests	Manual starting and loading of generators is demonstrated to verify nameplate rating. The automatic starting and loading of the diesel generators is demonstrated under loss of normal alternating current power. The operation of the logic and sequencing of circuit breakers is demonstrated. Load duration tests are demonstrated over several hours of operation along with voltage regulation tests.
			VIII. CONTAINMENT SYSTEMS
1.	Reactor Containment Tests	Prior to core loading	Reactor containment verification tests will be performed in accordance with the requirements set forth in Safety Guide No. 18 as described in Section 5.6. Reactor containment leakage rate tests will be performed in accordance with the requirements set forth in 10CFR50 Appendix J, as described in Section 5.6.
2.	Ventilation System Test	Prior to hot functional testing	The system is operated to balance air flows, verify pressure drops, motor currents, speeds, make setpoints and check alarms. The air flows are also verified to be equal to or greater than design. Further discussion can be found in Section 5.4.
3.	Containment Sprays	Prior to unit operation	Tests are performed to verify response control signals, sequencing of the pumps, valves and controllers as specified in the system description and manufacturer's technical manuals, and to check the time required to actuate the system after a containment high-high pressure signal is received. System full flow tests are performed to verify adequacy of system to perform design functions.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		VIII. CONTAINMENT SYSTEMS (CONT'D)
4. Containment Isolation Tests	Prior to unit operation	The operation of systems and components used for containment isolation will be verified in accordance with the requirements of 10CFR50 Appendix J, Class B tests.
5. Hydrogen Removal System Test	Prior to unit operation	A system test is performed educting containment air and adding hydrogen to the system to 3 percent concentration, passing the gas through the heater and recombiner and analyzing the effluent to ascertain removal of the hydrogen.
		IX. FILTRATION SYSTEMS
1. Filtration Systems (testing performed on particulate and charcoal filter system in containment and auxiliary structures for post accident and routine release of gaseous and particulate effluent).	Prior to unit operation	Testing will be performed to verify flows, pressure drops and effectiveness of these systems in performing their function. Further discussion can be found in Section 6.6.
		X. EMERGENCY CORE COOLING SYSTEM
1. System Tests (expansion and restraints)	Prior to unit operation	The piping systems and components are tested under simulated operating conditions of thermal gradients and pressure/flow, to verify the thermal displacements of piping systems as previously computed.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		X. EMERGENCY CORE COOLING SYSTEM (CONT'D)
2. High Pressure Safety Injection Tests	Prior to unit operation	This system is operationally checked to verify pressure/flow values used in the FSAR. Tests are also conducted to check pump motor currents, speeds and system setpoints and to verify operation from normal and emergency power sources. More specifically that: a. Manual and remotely operated valves are operable manually and/or remotely. b. Valves installed for redundant flow paths operate as designed. c. Pumps perform their pressure/flow design functions satisfactorily. d. The proper sequencing of valves and pumps occurs on initiation of a safety injection signal. e. The fail position on loss of power for each remotely operated valve is as specified. f. Valves receiving signals on high containment pressure (CIA) operate when supplied with these signals. g. Level and pressure instruments are set at the specified points and provide alarm and reset at the required setpoint valves.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		X. EMERGENCY CORE COOLING SYSTEM (CONT'D)
a. High Head Safety Injection (HPSI) Flow Test	Hot operating conditions	Hot operating conditions: The guide allows this to be verified by analysis; however, the operability of the check valves must be demonstrated through testing. This can be done by delivering water to the RCS with the charging/SI pumps during hot functional testing by lowering the RCS pressure and observing an increase in pressurizer level and reduction of SI piping temperature. As soon as these conditions are noted and the operation of the check valve verified, the test would be terminated to minimize thermal shock on the system.
3. Low Pressure Safety Injection	Prior to unit operation	The low head safety injection system is checked to verify design flow, flow paths, motor current, speeds and setpoints. Tests are conducted to verify operation from normal and emergency power sources. More specifically that: a. Manual and remotely operated valves are operable manually and/or remotely. b. Valves installed for redundant flow paths operate as designed. c. Pumps perform their pressure/flow design functions satisfactorily. d. The proper sequencing of valves and pumps occurs on initiation of a safety injection signal.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		X. EMERGENCY CORE COOLING SYSTEM (CONT'D)
		e. The fail position on loss of power for each remotely operated valve is as specified.
		f. Valves receiving signals on high containment pressure (CIA) operate when supplied with these signals.
		g. Level and pressure instruments are set at the specified points and provide alarm and reset at the required setpoint valves.
a. Low Pressure Safety Injection (LPSI) Recirculation Test	Ambient conditions	a. The LHSI pump performance will be verified while aligned for recirculation with the exception that suction will be from the RWST. A portion of the flow will be directed to the charging pump suction. Discharge will be to the open RCS.
		b. To avoid delivering sump water to the clean reactor coolant and safety injection systems, the LHSI sump suction path cannot be utilized. However, the simplicity of the sump and suction piping arrangement and the short length of the piping justifies not performing the test. The conservatively calculated total suction line loss, including half blocked screening, is only 8.4 ft. The margin in the available NPSH (calculated minus required) for the worst case of one LHSI pump as single failure is approximately 4.7 ft at the initiation of recirculation flow to the core (see Section 6.3.3.9). Comparing the line loss with the margin gives further confidence in the ability of each pump to perform without verification testing.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		X. EMERGENCY CORE COOLING SYSTEM (CONT'D)
		c. The LHSI and the outside recirculation spray (ORS) pumps (which might be used as a test substitute) and their suction lines are almost entirely buried. It is, therefore, no longer possible to install instrumentation that would adequately demonstrate the validity of the line loss portion of the NPSH calculations over the full line length. The use of sump level, pump discharge pressure and flow rate to establish the line loss would also prove inadequate because the measurement errors will result in an error in "measured" line loss on the same order of magnitude as the calculated value. Considering that the line loss calculation is quite straightforward, it appears justifiable not to run such a test with either type of pump.
		d. However, the ORS pumps will be tested while taking suction from the sump during other preoperational testing. Therefore, these pumps will also be used, within the limits of their as-built configuration, to verify the validity of the line loss calculations. A temporary pressure tap will be installed in each ORS pump suction line. This tap will be located between the 12 inch motor-operated gate valve and the penetration of the valve pit wall nearest the pump suction. The test data can be compared with calculations for the partial suction line. The loss will be that from the circular cap screen, a portion of the suction line and the one valve. This verification will give further assurance that the LHSI pumps will deliver flow as required during recirculation because of the similarity of the suction paths.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		X. EMERGENCY CORE COOLING SYSTEM (CONT'D) e. The NPSH calculations assume that there is no problem of vortexing and that the suction lines are unblocked. To assure that these assumptions are valid, and therefore that the sump suction path can be relied upon without a flow test, the following will be done: (1) Vortex control will be demonstrated by taking suction from the sump using an outside recirculation spray (ORS) pump drawing water through a single suction point (the cross-connected point will be blocked during the test). The flow will be increased to a value above that required by a single LHSI pump, and the sump water level will be lowered below the level it will reach at initiation of recirculation. To maintain a sufficient water level in the sump without flooding the entire containment floor, a temporary dam will be utilized. This dam conforms approximately to the outline of the sump framing inside of the trash bar grating (see Figure 6.4-2 for sump configuration). Thus the tested pump will take suction through only the circular cap screen. The water will be returned to the dammed sump via temporary piping installed for use in flushing of the recirculation spray system. The suction points of the ORS pumps are similar to those of the LHSI pumps. The temporary dam size and configuration will not support testing beyond the single pump. To do more at this stage of construction would be prohibitive.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing

X. EMERGENCY CORE COOLING SYSTEM (CONT'D)

(2) Assurance that the LHSI suction lines (from the sump through and including the 12"-C42 check valves) are unblocked will be provided by the following:

(a) The lines will be cleaned so that they are free of excessive foreign material, grease, oil and flux.

(b) The 12"-C42 check valves will be checked to verify they are installed in the correct direction and that they open properly.

(c) The motor operated sump suction valves (MOV-SI860A&B) will be demonstrated operable. Verification that they open fully will be provided by direct observation.

(d) The remainder of the suction path upstream of the check valves, including the cross connecting U-bend, will be viewed using optical devices. This will verify that the piping is clear of obstruction.

Access for (2)(b) and (2)(c) will be available when the 12"-G42 gate valves are removed from the suction path for reinstallation as MOV-SI862A and B. The lines will be maintained clean in accordance with (2)(a) from this time on.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		X. EMERGENCY CORE COOLING SYSTEM (CONT'D)
4. Accumulator Tests	Prior to unit operation	The accumulators will be used to flush the injection lines at low pressure and demonstrate that the motor operated valves stroke properly and the check valves are free to open.
5. Core Flooding Flow Test	Ambient conditions	Ambient conditions: Because of the inability to reduce the RCS pressure rapidly enough to develop meaningful results for pipe flow resistance determination, this test will be performed with accumulator blowdown into the RCS with the reactor vessel open.
		XI. FUEL STORAGE AND HANDLING SYSTEM
1. Spent Fuel Pool Cooling System Test	Prior to unit startup	Tests are performed to verify flow through the spent fuel pool demineralizer and filters, the heat exchanger loops, operation of the skimmer loop, verify pump performance and alarm setpoints and determine that valves, instruments and controls function correctly.
2. Refueling Equipment (hand tools and power equipment)	Prior to storage of new fuel and initial core loading	Tests are performed prior to core loading to demonstrate the functioning of the fuel transfer system and the fuel handling tools using a dummy assembly. The sections that involve the spent fuel facility are checked prior to storage of new fuel.
		XII. REACTOR COMPONENTS HANDLING SYSTEM
Reactor Component Handling System	Prior to installation of components	Testing is conducted on cranes and fuel handling equipment. Indexing is performed, motor currents and speeds verified and limit switch setpoints set.

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		XIII. RADIATION PROTECTION SYSTEM
Process, Criticality and Area Monitor Tests	Prior to core loading and unit operation.	Prior to core loading the radiation alarms associated with core loading are checked out and alarm setpoints are verified. Process and area monitor sensors and channels are calibrated per manufacturer's instructions and alarm setpoints made.
		XIV. RADIOACTIVE WASTE SYSTEM
Radioactive Waste System	Prior to unit operation	To verify satisfactory flow characteristics through the equipment, to demonstrate satisfactory performance of pumps and instruments; to check for leaktightness of piping and equipment, to check the operation of packaging and waste reduction equipment and to verify proper operation of alarms and controls. More specifically that: a. All piping and components are properly installed as per design specification b. Manual and automatic valves are operable c. Instrument controllers operate properly d. Alarms are operable at required locations e. Pumps perform their system function satisfactorily f. Pump indicators and controls are operable at required locations

Table 13.1-1 (CONT'D)

LIST OF PREOPERATIONAL TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		XIV. RADIOACTIVE WASTE SYSTEM (CONT'D)
		g. The waste gas compressors operate as specified
		h. The gas analyzers operate as specified
		i. The waste evaporators are operational
		j. The hydrogen and nitrogen supply packages are sufficient for all modes of operation.

Table 13.1-2

LIST OF STARTUP TESTS

	Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
			I. PRECRITICAL TESTS AFTER FUEL LOADING
1.	Mechanical and Instrument Test on Control Rod Drive and Rod Position Indicators	Prior to initial criticality	Operational testing of the rod control systems is conducted to check the controlling features, adjust setpoint and verify rod speeds and sequencing of power to the rod drives. Following core loading and installation of the rod mechanisms, operations are conducted to verify operation of the rod mechanisms over their full travel, the latching and releasing features are demonstrated and calibration of the position indicators are performed over the rod full range travel.
2.	Reactor Trip Circuit and Manual Trip Tests	Prior to initial criticality	Operational testing is conducted to verify the reactor protection circuits in the various modes of tripping, including manual reactor trip up to the tripping of the reactor trip breakers.
3.	Rod Drop Measurement and Hot at Rated Flow and No Flow	Prior to initial criticality	At cold and hot plant conditions following core loading the drop times of the full length rods are measured. The drop time is measured from the release of the rod until the rod enters the top of the dashpot. This time is verified to be less than the maximum value specified in the Technical Specifications.
4.	Pressure Test of Reactor Coolant System	Prior to initial criticality	Following core loading and installation of the reactor vessel head and torquing of the reactor vessel heads studs, pressure testing is performed at 100 psi above operating pressure to verify that there is no leakage past the head and vessel seal. The pressure integrity of the reactor coolant system will have been verified prior to core loading.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		I. PRECRITICAL TESTS AFTER FUEL LOADING (CONT'D)
5. Chemical Tests (to establish water quality)	Prior to heatup	Water for reactor coolant system fill and makeup is analyzed for chloride content, conductivity, total dissolved solids, pH, clarity and fluorides. During preoperational testing hydrazine is added to scavenge oxygen. Following core loading and prior to exceeding 250 F, hydrogen is added to scavenge oxygen during critical operation. Prior to, at criticality, and during power escalation, chemical analysis is performed to verify requirements.
6. Calibration and Neutron Response - (Check of Source Range Monitor)	Prior to core loading	Prior to core loading, the source range channels are aligned and operationally checked out. The detector anode voltage is set based on data derived from using a neutron source. After a power history has been established on the core, the detector anode and discriminator voltages are reset based on data obtained at that time.
7. Mechanical and Electrical Test of Traversing Incore Monitor	Prior to initial criticality	Prior to core loading the moveable detector systems are operationally checked out in all modes of operation to verify the indexing and to ensure free passage of detectors into all positions. Following core loading and insertion of the detector thimbles, the system is again operationally checked out by ensuring the free passage of detectors into all inserted thimbles. Electrical tests are performed using simulated signals to checkout the recorders. During physics measurements, the system is operationally checked when doing flux mapping.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		I. PRECRITICAL TESTS AFTER FUEL LOADING (CONT'D)
8. Reactor Coolant Flow Test	Prior to unit initial criticality	Following core loading, measurements are made of elbow tap differential pressures to make relative comparison. At hot shutdown conditions following core loading, measurements of loop elbow differential pressure drops are made. Using this data with the reactor coolant pump performance curve, the calculated flow is verified to the design flow. Flow coastdown and transients following reactor coolant pump stoppages are also determined.
9. Pressurizer Effectiveness Test	At hot shutdown following core loading	At hot no load temperature and pressure the effectiveness of the pressurizer heaters in maintaining and increasing system pressure is demonstrated. The heaters are energized, and the pressure is compared with an expected pressure rise given in the procedure. The ability of the spray system to reduce pressure is also demonstrated. The spray valves are opened and the pressure decrease is compared with the expected pressure decrease given in the procedure.
10. Vibration Measurements on Reactor Internals	During and following hot functional testing	Comprehensive vibration measurements have been made during hot functional testing prior to core loading for Rochester Gas and Electric, R. E. Ginna Unit 1, Carolina Power and Light, H. B. Robinson Unit 2 and Consolidated Edison, Indian Point Unit 2. The results of these tests have been documented and submitted to the AEC Director of Reactor Licensing. These data will be the basis for acceptance of follow plants of similar design without repeating these tests. During hot functional testing, the unit is operated with full flow for a

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		I. PRECRITICAL TESTS AFTER FUEL LOADING (CONT'D)
		minimum of 240 hr in order to achieve approximately 20 million cycles on the internal components. Following hot functional testing for all units, the internals will be removed and inspected for vibration effects prior to core loading.
		II. INITIAL CRITICALITY AND LOW POWER TESTS
1. Initial Criticality	Unit at hot shutdown	The objective is to bring the reactor critical for the first time from the unit conditions specified. Prior to start of rod withdrawal, the nuclear instrumentation shall have been aligned, checked and conservative reactor trip setpoints made. All rods are withdrawn except the last controlling group, which is left partially inserted for control once criticality is achieved by boron dilution. At preselected points in rod withdrawal and boron dilution, data is taken and inverse count rate plots made to enable extrapolating to the expected critical point. The all-rods-out boron concentration is thus determined.
2. Radiation Surveys	At steady state conditions during power escalation	Radiation surveys are made during the power escalation to determined dose levels at preselected points throughout the plant due to radiation. Instruments used are calibrated to known sources, and the calibration is rechecked following the survey.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

	Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
			II. INITIAL CRITICALITY AND LOW POWER TESTS (CONT'D)
3.	Calibration of Nuclear Instruments with Power and Determination of Overlap	After start-up and during escalation	After initial criticality and during escalation into the intermediate and power ranges, data is taken to verify overlap between the source, intermediate and power range channels. This data is collected until the overlaps are firmly established. During low power escalation, the power range detector currents are monitored and compared with the intermediate range currents to verify response of the power range detectors. The power range nuclear channels are calibrated to reactor thermal output based on measurement of secondary unit feedwater, feedwater temperature and steam pressure.
4.	Effluent Radiation Monitors (calibration against known effluent concentration)	Prior to unit start-up	These instruments are calibrated to a known radiation source or to analog signals which have been calibrated to known radiation sources.
5.	Moderator Temperature Reactivity Coefficient	Zero power tests	At normal no load temperature and no nuclear heating, reactor coolant system cooldown and heatup are accomplished using the steam dump and reactor coolant pumps operation as required. An approximate 5 F change in temperature is initiated and during these changes Tavg and reactivity are recorded on an X-Y recorder. From these data, the temperature coefficient is determined.
6.	Pressure Reactivity Coefficient Measurements		Direct measurements of pressure coefficient of reactivity are not made since the effects of pressure on reactivity are of second order when compared with other effects.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

	Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
			II. INITIAL CRITICALITY AND LOW POWER TESTS (CONT'D)
7.	Control Rod Reactivity Worths - Determination of individual and group differential and integral worth and verification of worth for shutdown capability	Zero power tests	Under zero power conditions at near operating temperature and pressure, the nuclear design predictions for rod cluster control assembly (RCCA) groups differential worths are validated. These validations are made from boron concentration sampling data, RCCA group positions and recorder traces of reactivity. From these data, the integral RCCA group worths are determined. The minimum boron concentration for maintaining the reactor shutdown with the most reactive RCCA stuck in the full out position is determined. The determination is made from analysis of boron concentration and RCCA worths.
8.	Boron Reactivity Worth Measurement	Zero power tests	Differential boron worth measurements are made by monotonically increasing or decreasing reactor coolant boron concentration. Compensation for the reactivity effect of the boron concentration change will be made by withdrawing or inserting, respective control rods to maintain moderator average temperature and power level constant and observing the resultant accumulated change in core reactivity corresponding to these successive rod movements.
9.	Determination of Boron Concentration of Initial Criticality and Reactivity Allocation	Zero power tests	These determinations are described under II-1 (initial criticality) above.
10.	Flux Distribution Measurement with Normal Rod Patterns	Zero power	Flux distribution measurements with normal rod patterns are taken during the zero power physics tests.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		II. INITIAL CRITICALITY AND LOW POWER TESTS (CONT'D)
11. Chemical Tests to Demonstrate Ability to Control Water Quality	Prior to criticality and during power escalation	Prior to criticality, the procedures and equipment for performing chemical analysis of primary and secondary systems are demonstrated. During power escalation, sampling is performed and analysis is done to verify that plant chemistry is within specifications.
12. Pseudo Rod Ejection Test, to Verify Safety Analysis (Hot)	Hot zero power	Incore measurements are made under pseudo ejected rod conditions simulating the zero power accident to determine the hot channel factors and verify that they are within assumptions made in the accident analysis.
		III. POWER ASCENSION TESTS
1. Power Reactivity Coefficient Evaluation and Power Defects Measurement (30%, 50%, 75%, and 100%)	During power escalation	During each power escalation, recorder traces are made of reactor power and reactivity changes. From these traces, the power coefficient of reactivity and power defects are determined.
2. Manual and Automatic Unit Response to Load Changes (30%, 50%, 75% and 100%)	During power	Unit response to the following load changes is demonstrated: a. +10% step load change from 30%, 75% and 100% power b. 50% load reduction from 75% and 100% power c. Plant trips from power levels up to 100% During the performance of these tests, recordings are analyzed for control systems behavior and requirements for realignment. Acceptance criteria such as the unit not tripping (where applicable), relief and safety valves not lifting, and steam dump operating correctly are identified in the individual procedures.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		III. POWER ASCENSION TESTS (CONT'D)
		At approximately 15 to 30 percent power, the automatic control systems are checked by simulating controlling parameters with a test signal and observing controller response, programmed step changes in the control parameter and switching to automatic and observing the ability of the parameter to achieve the net setting without appreciable overshoot or oscillation. During the transient tests, these systems are operationally checked under actual design load changing conditions.
4. Chemical Analysis - (30%, 50%, 75% and 100%)	During power escalation	During low power physics tests and at 30%, 50%, 75% and 100% power, samples of reactor coolant are taken and analysis performed to verify that coolant chemistry requirements can be maintained.
5. Effluents and Effluents Monitoring Systems (30%, 50%, 75%, and 100%)	During power escalation	Effluent monitors are installed at selected locations in the plant to monitor for radioactive constituents in the effluents. Instruments detect any changes in activity, and alert the operator as to when radiochemical analysis should be performed.
6. Evaluation of Core Performance (30%, 50%, 75% and 100%)	During power escalation	As steady state power points, incore data is obtained and analysis performed to verify that the core performance margins are within design predictions, for expected normal and abnormal rod configurations.
7. Loss of Flow	Prior to criticality	Reactor coolant system response to loss of flow for various combinations of pump stops is determined from hot shutdown conditions. These tests are discussed in test I-8.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

	Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
			III. POWER ASCENSION TESTS (CONT'D)
8.	Turbine Trip (100%)	At power	Turbine trip will be performed from 100 percent power to verify that safety valves do not lift and that the plant can be maintained in a hot shutdown condition.
9.	Generator Trip (100%)	At power	Not normally required due to the use of intercept valves.
10.	Shutdown from Outside the Control Room	Hot shutdown conditions	The test of the shutdown panel (SDP) will demonstrate that the turbine can be tripped and the reactor can be tripped, placed and maintained in a hot shutdown condition. The test of the shutdown panel will be conducted in the range of 5 to 10 percent reactor power level, with the turbine generator synchronized to the Duquesne Light Company system and the station service bused in the normal arrangement for 5 to 10 percent reactor power. The test of the SDP will demonstrate the operation of the controls and indicators described in Sections 7.4.1.1 and 7.4.1.2 Redundant instrumentation of the remote emergency shutdown panel is verified to the reading within allowable limits of the main control room instrumentation.
11.	Loss of Offsite Power	During preoperational testing	Tests are performed in which loss of voltage and an SIS signal are simulated and starting of the diesels and connecting of the emergency loads on the emergency bus are demonstrated. Automatic starting of diesel generator and automatic sequential starting of motors on the 4 kv bus will be verified.
12.	Radiation Survey and Shielding Effectiveness (50% and 100%)	At power tests	The surveys to verify the effectiveness of the shielding have been discussed under Radiation Survey. These surveys will be conducted up to and including 100 percent power.

Table 13.1-2 (CONT'D)

LIST OF STARTUP TESTS

Title of Test or Measurement	Unit Condition/ Prerequisite	Test Objective and Summary of Testing
		III. POWER ASCENSION TESTS (CONT'D)
13. Part-length Rod Insertion (75%)	Approximately 75% power	At approximately 75 percent of full power, tests are performed to verify the effectiveness of the part-length control rods.
14. Pseudo Rod Ejection Test to Verify Safety Analysis	50% power	Incore measurements are made with individual rods withdrawn out of bank position to determine the resulting hot channel factors and verify that they are within expected limits. These determinations are made from moveable detector and thermocouple data.

PRESSURE AND TEMPERATURE PROFILE

① RCS COMPLETION AND EQUIPMENT INSTALLATION

1 REACTOR COMPONENT HANDLING EQUIPMENT CHECKOUT (XII)

② RCS CLEANING AND INITIAL RCS FILL

1 PROCESS INSTRUMENTATION (TEMPERATURE AND PRESSURIZATION INSTRUMENTATION. FOR HEATUP AND PRESSURIZATION) (I-2)
2 PUMPS AND MOTORS TESTS REQUIRED FOR COLD FUNCTIONAL TESTING OF SYSTEMS (II-4-b)
3 CHECKOUT OF VALVES REQUIRED FOR COLD FUNCTIONAL TESTS (II-4-f) (II-4-d)
4 VENT AND DRAINS SYSTEM TESTS (VI-3)
5 FIRE PROTECTION SYSTEMS (VI-7)
6 AUXILIARY BUILDING VENTILAION SYSTEMS TESTS (VI-9)
7 COMMUNICATION SYSTEMS TEST FOR COLD FUNCTIONAL (VII-4)

③ COLD FUNCTIONAL TESTING

1 RCS AND ASSOC. SYSTEM HYDROSTATIC TESTING (II-5-a)
2 CHECKOUT OF VALVES REQUIRED FOR CONTAINMENT TESTS (II-4-f)
3 REACTOR COOLANT PUMP SEAL AND COOLING WATER SYSTEM TESTS (VI-2)
4 CONTAINMENT ISOLATION TESTS (VIII-4)
5 VIBRATION, FREQUENCY, AND AMPLITUDE OF RCS COMPONENTS (II-1)
6 BASE LINE DATA FOR INSERVICE TESTING (II-5-b)
7 SPENT FUEL PIT COOLING SYSTEM TEST (XI-1)

④ PREPARATION FOR HOT FUNCTIONAL TESTING

1 PROCESS INSTRUMENTATION (TEMPERATURE PRESSURE. LEVEL AND FLOW INSTS: FOR HEATUP AND PRESSURIZATION) (I-2)
2 PUMPS AND MOTORS TESTS REQUIRED FOR HOT FUNCTIONAL TESTS (II-4-b) (VI-2)
3 CHECKOUT OF VALVES REQUIRED FOR HOT FUNCTIONAL TESTS (II-4-f) (II-4-d)
4 FEEDWATER AND FEEDWATER CONTROL SYS. CHECKOUT (VII-2-d)
5 CONDENSER CIRCULATING WATER SYSTEM CHECKOUT (V-2-e)
6 COMPONENTS COOLING SYSTEMS TESTS (VI-4)
7 RIVER AND RAW WATER SYSTEM TEST (VI-8)
8 NORMAL POWER DISTRIBUTION TESTS (VII-1)
9 VITAL BUS TESTS (VII-2)
10 DC SYSTEM TESTS (VII-3)
11 COMMUNICATIONS TEST FOR HOT FUNCT. (VII-4)
12 EMERGENCY POWER SYSTEM TEST (VII-5)
13 CHEMICAL AND VOLUME AND CONTROL SYSTEM TESTS (III-1)
14 STEAM GENERATOR AUXILIARY FEEDWATER SYSTEM (V-2-b)
15 MECHANISIM AND ROD POSITION INDICATION COIL COOLING SYSTEM TEST (V-11)
16 CONDENSATE SYSTEM TEST

⑤ RCS HEATUP

1 EMERGENCY CORE COOLING SYSTEM EXPANSION AND RESTRAINTS (X-1)
2 LEAK DETECTION SYSTEM TESTS (VI-13)
3 REACTOR COOLANT MAKEUP SYSTEM CHECKOUT (VI-1)
4 STEAM GENERATOR-CHECKOUT (II-4-c)
5 PRESSURIZER-PRESSURE CONTROL (II-4-a)
6 EXPANSION AND RESTRAINT OF RCS AND POWER CONVERSION COMPONENTS (II-2) (V-1-b)
7 PRESSURE, TEMPERATURE, LEVEL AND FLOW INSTRUMENTATION OPERATIONAL CHECKOUT (I-2)
8 OPERATIONAL CHECKOUT OF SAMPLING SYSTEM (VI-14)
9 COMPONENT COOLING SYSTEM TESTS
10 RHR SYSTEMS TESTS (VI-5)
11 CONTAINMENT VENTILATION SYSTEM TEST (VIII-2)

⑥ INTEGRADED HOT FUNCTIONAL TESTING (2c)

1 REACTOR INTERNALS, VIBRATION (I-10) (TABLE 14.1-2)
2 INTEGRADED HOT FUNCTIONAL TEST (II-3) (VII-4) (VI-2)
3 RTD/TC CALIBRATION (III-4-a)
4 RELIEF AND SAFETY VALVES (II-4-d)
5 MAINSTEAM STOP VALVES (II-4-e)
6 TURBINE CONTROL AND BYPASS VALVES (V-2-c)
7 ROD CONTROL SYSTEM TEST WITH MECHANISMS TO POWER SUPPLY (NO DRIVE SHAFT CONNECTED) (III-5-a)
8 VENT AND DRAIN SYSTEM TESTS (VI-3)
9 NEUTRON SHIELD TANK COOLING SYSTEM TEST (VI-12)
10 INSTRUMENT AIR SYSTEM TEST (VI-10)
11 CHEMICAL & VOLUME CONTROL SYSTEMS TESTS (III-1)
12 STEAM GENERATOR AUXILIARY FEEDWATER SYSTEM (V-2-b)
13 PURIFICATION SYSTEMS TESTS (VI-6)
14 TURBINE ROLL AND SYN.

⑦ RCS COOLDOWN

1 RESIDUAL HEAT REMOVAL SYSTEMS TESTS (VI-5)
2 STEAM GENERATOR (II-4-L)

⑧ CONTAINMENT TESTS

1 REACTOR CONTAINMENT TESTS (VIII-1)
2 CHECKOUT OF VALVES REQUIRED FOR CONTAINMENT TESTS (II-4-f)
3 CONTAINMENT SPRAY (VIII-3)
4 HYDROGEN REMOVAL TESTS (AS APPLICABLE) (VIII-5)

⑨ PREPARATION FOR CORE LOADING

1 EMERGENCY BORON SHUTDOWN SYSTEM TESTS (III-2)
2 MOVEABLE DETECTOR SYSTEM WITH DUMMY CABLE (III-4-d)
3 AUXILIARY STARTUP INSTRUMENTATION TESTS (TEMPORARY SOURCE INSTS.) (III-6)
4 COMMUNICATIONS SYSTEMS TEST FOR CORE LOADING (VII-4)
5 REFUELING EQUIPMENT (HAND TOOLS AND EQUIPMENT) (XI-2)
6 REACTOR COMPONENT HANDLING (XII-1)
7 PROCESS, CRITICALITY AND AREA MONITORS (XIII-1)
8 NIS (SOURCE RANGE) RESPONSE TO NEUTRON SOURCE AND SYSTEM CHECKOUT (I-1)
9 OPERATIONAL CHECKOUT OF REACTOR PROTECTION SYS. (IX-1)
10 OPERATIONAL CHECKOUT OF ENGINEERED SAFETY FEATURES SYSTEM (IX-2)
11 HIGH PRESSURE SAFETY INJECTION TEST (X-2)
12 LOW PRESSURE SAFETY INJECTION TEST (X-3)
13 FILTER SYSTEM (IX)
14 RADIOACTIVE LIQUID & GASEOUS WASTE SYSTEM (XIV)
15 BASELINE DATA FOR INSERVICE TESTING (II-5-b)
16 ACCUMULATOR TEST (X-4)

CORE LOADING

NOTE :
THE DESIGNATIONS FOLLOWING THE TEXT TITLE REFERS TO ITEM NUMBER IN TABLE 13.1-1

13.1-1
PREOPERATIONAL TEST SEQUENCE
BEAVER VALLEY POWER STATION UNIT NO. 1
UPDATED FINAL SAFETY ANALYSIS REPORT

REV. 0 (1/82)

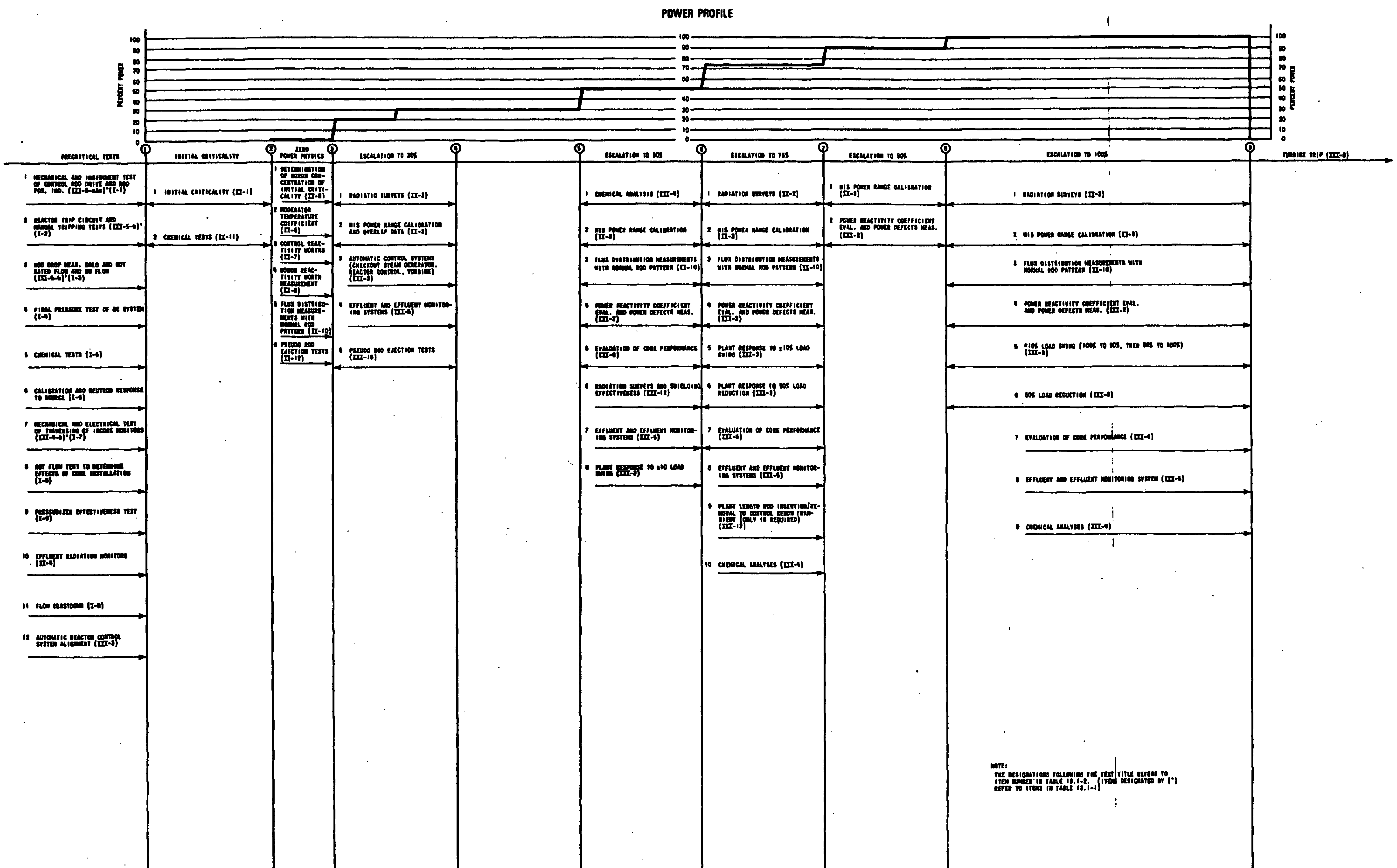
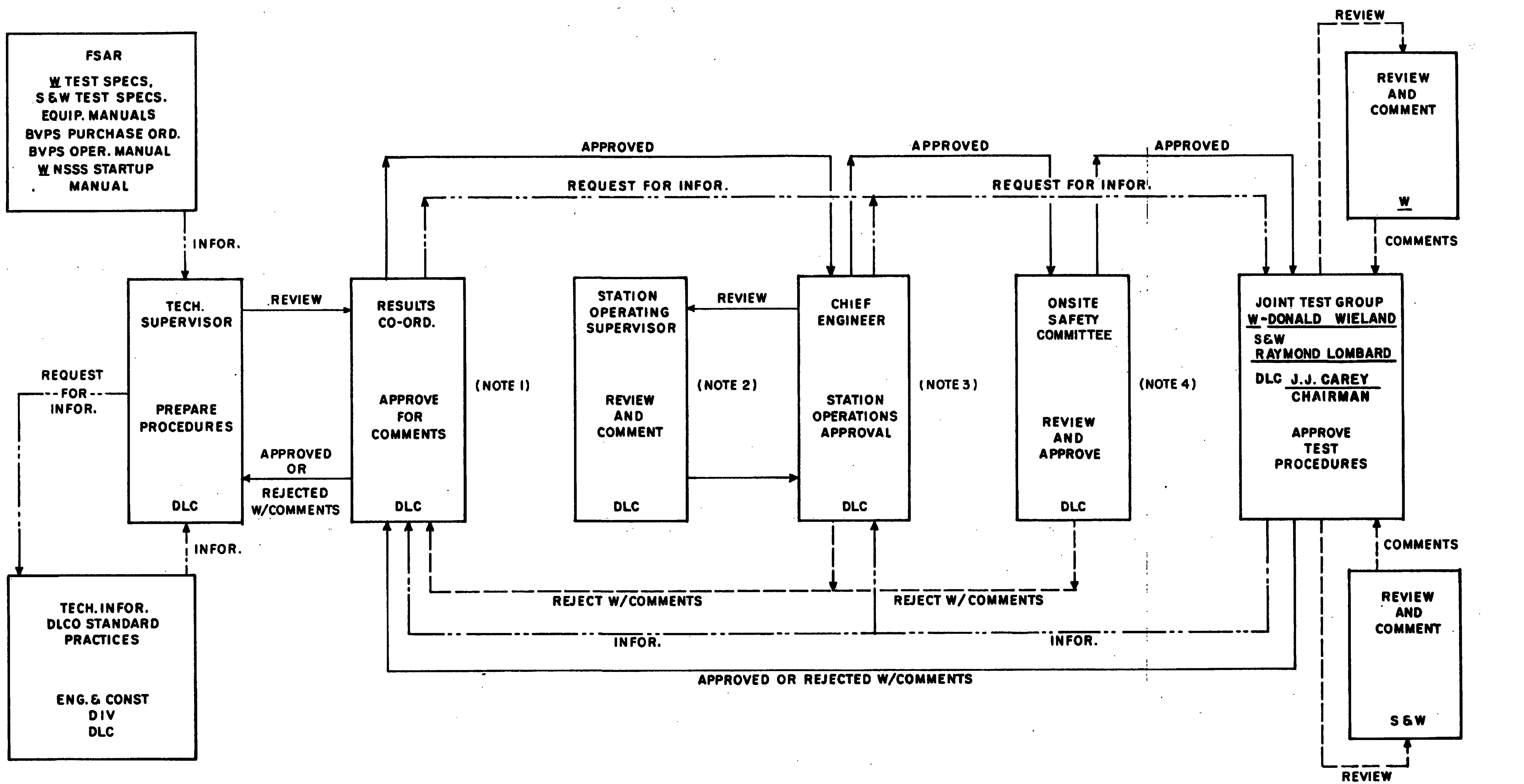


FIGURE 13.1-2
STARTUP TEST SEQUENCE
BEAVER VALLEY POWER STATION UNIT NO. 1
UPDATED FINAL SAFETY ANALYSIS REPORT

REV. 0 (1/82)



NORMAL FLOW PATH

INFORMATION FLOW PATH

IF REQUIRED FLOW PATH

NOTE 1: RESULTS CO-ORD. MAY HAVE RX. CONT. CHEM. REVIEW

NOTE 2: STATION OPER. SUPVR. MAY HAVE SHIFT SUPVR. REVIEW

NOTE 3: CHIEF ENG. MAY HAVE STATION MAINT. SUPVR. REVIEW

NOTE 4: ONSITE SAFETY COMM. MAY HAVE OFFSITE REVIEW COMM. REVIEW

FIGURE 13.2-1
PREOPERATIONAL TEST
PROCEDURE FLOW PATH
BEAVER VALLEY POWER STATION UNIT NO. 1
UPDATED FINAL SAFETY ANALYSIS REPORT