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13.0 [HISTORICAL] INITIAL TESTS AND OPERATIONS

13.1 [HISTORICAL] TESTS PRIOR TO INITIAL REACTOR FUELING

The comprehensive testing program ensured that the equipment and system performed in accordance with design criteria prior to fuel loading. As the installation of individual components and systems was completed, they were tested and evaluated according to predetermined and approved written testing techniques, procedures, or check-off list. Field and engineering analyses of test results were made to verify that systems and components were performing satisfactorily and correction action was taken, when necessary.

The program included tests, adjustments, calibrations, and systems operations ensuring that initial fuel loading, initial criticality and subsequent power operation was completed in a safe manner. In general, testing was classified as hydrostatic, functional, electrical and operational. Functional tests verified that the system or equipment was capable of performing the function for which it is designed. Operational tests involved actual operation of the system and equipment under design or simulated design conditions.

Whenever possible, these tests were performed under the same conditions as experienced under station operations. During system tests for which unit parameters were not available and could not be simulated, the systems were operationally tested as far as possible without these parameters. The remainder of the tests were performed when the parameters became available. Abnormal unit conditions did not endanger personnel or equipment, or contaminate clean systems.

The tests described in Table 13.1-1 were performed prior to initial reactor fueling.

[Historical] Preoperational Piping Vibrational and Dynamic Effects Test Program

Paragraph 101.5.4 of the USAS B31.1-1967 Code for Pressure Piping states: "Piping shall be arranged and supported with consideration of vibration".

All piping systems listed below have been designed and supported in accordance with the B31.1 Code requirement for "consideration of vibration". This is accomplished by means of variable spring hangers, rigid supports, constant support hanger, pipe anchors, guides and snubbers.

Although a vibrational and dynamics effects test program is not required by B31.1, we did, during the course of the normal preoperational test program, visually check all piping systems for excessive vibration. Each given system was monitored during its check-out phase under the transient conditions imposed by routine starting and stopping of pumps and opening and closing of valves.

In addition, specific attention was directed at evaluating possible vibration problems during the performance of the following preoperational transient test:

Preoperational Test	Specific Transient
1. Reactor Coolant System Heatup	A. Operational test of Centrifugal

Preoperational Test		**Specific Transient**
		Charging Pump (Step Changes) B. Reactor Coolant Pump Start C. Operation of Pressurizer Power Operated Relief Valves D. Operation of Pressurizer Spray Valves E. Operation of Letdown Isolation Valves
2.	Reactor Coolant System at Temperature	A. Operation of Pressurizer Power Operated Relief Valves B. Reactor Coolant Pumps(Stopping and Starting)
3.	Reactor Coolant System Cooldown	A. Initiation of Residual Heat Removal
4.	Emergency Core Cooling Flow Test	Initiation and Termination of the following: A. Safety Injection (SI Pumps) B. Boron Injection (Centrifugal Charging Pumps with Primary Water) C. Safety Injection (RHR Pumps)
5.	Chemical and Volume Control System	A. Operational tests of Positive Displacement Charging Pump (Stop and Start)

Except for the piping associated with the above systems subjected to the listed transients, no special transients, deliberate system abnormalities, pump trips or valve closures were implemented during the normal preoperational tests for the remainder of the plant systems. Nor will a separate piping vibrational and dynamics effects test program be performed on the remainder of the plant systems.

The acceptance of an observed vibration was based on operator and cognizant engineer experience with consideration of the factors listed below to determine if practically no movement or movement of up to several inches would be allowed. Acceptability of a piping system vibrational or dynamic effect considered such items as:

1. pipe size and schedule,
2. length of run between supports,
3. type of support,
4. overall system configuration,
5. observed vibration frequency,

6. location of vibration or dynamic effect relative to stress concentration points such as nozzles or branch connections,
7. occurrence period (i.e., startup only or continuous during normal operation), and
8. for those systems subject to the transient listed above the amplitude of vibration that will theoretically cause the pipe to reach its elastic limit. Charts or nomographs were available during preoperational testing, to define these amplitudes as a function of pipe span and schedule, as an aid for the operator and cognizant engineer.

In addition, critical plant systems and components were physically examined (visually) for the following types of deficiencies which are indicative of possible vibration problems or associated dynamic effects:

1. Cracks in the grouting of equipment foundations.
2. Leaking gaskets in piping systems and pump seals.
3. Leaks from flanged connections in piping systems.
4. Metal to metal contact indications on piping system restraints.
5. Water hammer "noises" during transient operations.

When the above types of indications were evident, further investigation was performed to establish and correct adverse conditions.

13.2 [HISTORICAL] FINAL STATION PREPARATION

Fuel loading began after all prerequisite system tests and operations were satisfactorily completed and the facility operating license was obtained. Upon the completion of fuel loading, the reactor upper internals and pressure vessel head were installed and additional mechanical and electrical tests were performed. The purpose of this phase of activities was to prepare the system for nuclear operation and to establish that all design requirements necessary for operation were achieved. The core loading and post loading tests are described below.

During initial fuel loading and related physics testing additional technical support was provided. The major considerations in this planning came from the recommendations of the reactor vendor and the accumulated experience of the Applicant's technical personnel. Part of this experience was the Westinghouse nuclear engineering training program which was undertaken by two of the Applicant's engineers. This consisted of a three month formal lecture series in Pittsburgh followed by active participation in a major Westinghouse PWR start-up similar to the Cook units. This program progressed through the fuel loading and the actual start-up. Using the results of this training program during the preparation and review of the detailed test procedures for Cook Plant, each start-up test and operation was evaluated for its manpower requirements in all aspects; reactor operation, instrumentation, data taking, data reduction and analysis.

Augmentation of the standard plant operating crews was made on a case by case basis. The sources of additional manpower was gathered from the Plant staff, the American Electric Power Service Corporation engineering staff, Nuclear Start-Up Services personnel and Westinghouse personnel. As indicated in Section 12.1 of the FSAR, Westinghouse provided certain technical assistance during core loading, initial start-up and pre-commercial operation.

Westinghouse provided technical assistance to AEP during installation, start-up, testing and operation of Westinghouse-Nuclear Steam Supply System (W-NSSS) equipment. Through this technical assistance, Westinghouse assured itself that the W-NSSS was installed, started, tested and operated in conformance with design intent. The Westinghouse personnel that provided this technical assistance interpreted Westinghouse requirements and acted as the technical liaison with Westinghouse headquarters to resolve problems with W-NSSS equipment.

The Westinghouse manning requirements during the initial tests and start-up program was established by the Westinghouse Site Manager. Requests were made by him for technical assistance from Westinghouse specialists.

Westinghouse provided on-site technical assistance required through the completion of the acceptance tests.

American Electric Power Service Corporation (AEPSC) was responsible through its cognizant engineers for the successful completion of the initial start-up and power escalation program by providing technical assistance and support to the Plant operating staff. The cognizant engineer drew upon the AEPSC, specifically calling on the members of the Nuclear Division for technical

assistance and support in following tests as they were performed, for recording and analyzing data, and preparing detailed test reports.
Other cognizant engineers in the various disciplines similarly exercised coordination and interface responsibilities during the test program. They either spent time at the site or closely communicated with site personnel.

13.2.1 [Historical] Initial Core Loading

The overall responsibility and direction for initial core loading was exercised by the Plant Manager. The overall process of initial core loading was, in general, directed from the operating deck of the containment structure. Standard procedures for the control of personnel and the maintenance of containment security were established prior to fuel loading. Westinghouse provided technical advisors to assist during the initial core loading operation.
The as-loaded core configuration was specified as part of the core design studies conducted well in advance of station start-up and as such, was not subject to change at start-up. In the event that mechanical damage was sustained during core loading operations by a fuel assembly of a type for which no spare was available on site, an alternate core loading scheme whose characteristics closely approximate those of the initially prescribed pattern would have been determined.
The core with control rods was assembled in the reactor vessel, submerged in water containing enough dissolved boric acid to maintain a calculated core effective multiplication constant of 0.90 or lower. The refueling cavity was dry during initial core loading. Core moderator chemistry conditions (particularly boron concentration) were prescribed in the core loading procedure document and was verified periodically by chemical analysis of moderator samples taken prior to and during core loading operations.
Core loading instrumentation consisted of two permanently installed source range (pulse type) nuclear channels and three temporary incore source range channels. The permanent channels were monitored in the Control Room; the temporary channels were installed in the containment structure and were monitored locally. At least one permanent and one temporary channel was equipped with an audible count rate indicator. Both permanent channels had the capability of displaying the neutron flux level on a strip chart recorder. The temporary channels were indicated on rate meters with one channel recorded on a strip chart recorder. Minimum count rates attributable to core neutrons were required on at least two of the five (i.e., three temporary and two permanent source range detectors) available nuclear source channels at all times following installation of the initial eight fuel assemblies.
At least two artificial neutron sources were introduced into the core at appropriately specified points in the core loading program to ensure an adequate neutron population.
Fuel assemblies together with inserted components (control rod assemblies, burnable poison inserts, source spider, or thimble plugging devices) were placed in the reactor vessel one at a time according to a previously established and approved sequence that was developed to provide reliable core monitoring with minimum possibility of core mechanical damage. The core loading

procedure documents included a detailed tabular check sheet that prescribed and verified the successive movements of each fuel assembly and its specified inserts from their initial position in the storage racks to their final position in the core. Checks were made of component serial numbers and types to guard against possible inadvertent exchanges or substitutions of components, and two fuel assembly status boards were maintained throughout the core loading operation.

An initial nucleus of eight fuel assemblies, the first of which contained an activated neutron source, was the minimum source-fuel nucleus permitting subsequent meaningful inverse count rate monitoring. This initial nucleus was determined by calculation and previous experience to be markedly subcritical under the required conditions of loading.

Each subsequent fuel assembly addition required detailed neutron count rate monitoring to determine that the just loaded fuel assembly did not excessively increase the count rate and that the extrapolated inverse count rate ratio did not decrease for unexplained reasons. The results of each loading step were evaluated by plant personnel and technical advisors before the next prescribed step was started.

Criteria for safe loading required that loading operations would stop immediately when:

a. An unanticipated increase in the neutron count rate by a factor of two occurred in all the operating channels during any single loading step after the initial nucleus of eight fuel assemblies was loaded (excluding anticipated change due to detector and/or source movement).

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

An audible alarm in the containment building and control room would sound when the source range channels reached a predetermined count rate. This alarm would automatically alert the loading operators of an indication of an increasing count rate.

Core loading procedures specified: (a) the alignment of fluid systems to prevent inadvertent dilution of the reactor coolant, (b) restrictions on the movement of fuel to preclude the possibility of mechanical damage, (c) prescribed conditions under which loading would proceed, and (d) continuous and complete fuel and core component accountability.

13.2.2 [Historical] Post Loading Tests

Upon completion of initial core loading, the reactor upper internals and the pressure vessel head were installed and additional mechanical and electrical tests were performed prior to initial criticality. The final pressure tests were conducted after filling and venting were completed. Mechanical and electrical tests were performed on the control rod drive mechanisms. These tests included a complete operational checkout of the control rod drive mechanisms. Checks were made to ensure that the control rod assembly position indicator coil stacks were connected to their position indicators. Similar checks were made on control rod drive mechanism coils.

Tests were performed on the reactor trip circuits to test manual trip operation and actual control rod assembly drop times were measured for each control rod assembly. The reactor control and protection system trip functions were tested to ensure the system functioned properly.
At all times while the control rod drive mechanisms were being tested, the boron concentration in the coolant (moderator) was high enough such that criticality could not be achieved, even with all control rod assemblies out.
A complete functional electrical and mechanical check was made of the incore nuclear flux mapping system at system operating temperature and pressure.
The tests described in Table 13.2-1 were performed prior to initial criticality.

13.3 [HISTORICAL] INITIAL TESTING OF THE OPERATING REACTOR

Following satisfactory completion of fuel loading and final precritical tests, nuclear operation of the reactor began. The final phase of startup and testing included Initial Criticality, Low Power Testing and Power Level Escalation. The purpose of these tests was to establish the operational characteristics of the unit and core, to acquire data for the proper calibration of set points, and to ensure that operation was within license requirements. A brief description of the testing is presented in the following sections. Table 13.3-1 summarizes the tests which were performed from initial core loading to rated power.

13.3.1 [Historical] Initial Criticality

Initial criticality was established by sequentially withdrawing the shutdown and control groups of control rod assembles from the core, leaving the last withdrawn control group inserted far enough in the core to provide effective control when criticality was achieved, and then continuously diluting the heavily borated reactor coolant until the chain reaction was self-sustaining.

Initial start-up procedures required continuous monitoring by both plant source range nuclear instrumentation channels; these procedures, which included RCC Assembly group withdrawal, were not commenced nor continued unless both channels were responding, i.e., that both channels had a minimum count rate attributable to core neutrons.

Successive stages of control banks of rod assembly group withdrawal and of boron concentration reduction were monitored by observing changes in neutron count rate as indicated by the source range nuclear instrumentation.

Primary safety reliance was based on inverse count rate ratio monitoring as an indication of the nearness to criticality of the core during control rod withdrawal and during reactor coolant boron dilution. Written procedures specified: alignment of fluid systems to allow controlled start and stop of boron dilution to control the rate at which criticality was approached; indicated values of core conditions under which criticality was expected.

13.3.2 [Historical] Low Power Testing

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

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

of control rod assembly group configuration. In addition, measurements of the relative power distributions were made.
Detailed procedures were prepared to specify the sequence of tests and measurements to be conducted and the conditions under which each was to be performed to ensure both safety of operation and the relevancy and consistency of the results obtained.

13.3.3 [Historical] Power Level Escalation

When the operating characteristics of the reactor and unit were verified by the low power testing, a program of power level escalation in successive stages brought the unit to its full rated power level. Both reactor and unit operational characteristics were closely examined at each stage and the relevance of the safeguards analysis were verified before escalation to the next programmed level.
Measurements were made to determine the relative power distribution in the core as functions of power level.
Secondary system heat balances ensured that the various indications of power level were consistent and provided bases for calibration of the power range nuclear instrumentation channels. The Reactor Control System was verified to respond correctly to signals from primary and secondary instrumentation under a variety of conditions encountered in normal operations.
At prescribed power levels the dynamic response characteristics of the reactor coolant and steam systems was evaluated. The response of system components was measured for 10% reduction of load and recovery, 50% reduction of load and recovery and turbine trip.
Adequacy of radiation shielding was verified by gamma and neutron radiation surveys inside the containment and throughout the station site. The sequence of tests, measurements and intervening operations was prescribed in the power escalation procedures together with specific details relating to the conduct of the tests and measurements.

13.3.4 [Historical] Post Startup Surveillance and Testing Requirements

Post startup surveillance and testing requirements were designed to provide assurance that essential systems, which include equipment components and instrument channels, are always capable of functioning in accordance with their original design criteria. These requirements can be separated into two categories:
a. The system must be capable of performing its functions, i.e., pumps deliver at design flow and head, and instrument channels respond to initiating signals within design calibration and time responses.
b. Reliability is maintained at levels comparable to those established in the design criteria. The testing requirements described in the Technical Specifications establish this reliability and provide the means by which this reliability is continually reconfirmed. Verification of operation

of complete systems is checked at refueling intervals. Individual checks of components and instrumentation are made at more frequent intervals as outlined in the Technical Specifications. The techniques used for the testing of instrument channels include a preoperational calibration which confirmed values obtained during factory test programs. These reconfirmed calibration values became the reference for recalibration maintenance at refueling intervals during plant life. Periodic testing, as defined in the Technical Specifications, includes the insertion of a predetermined signal that trips the channel bistable. Indication of the operation is confirmed and recorded.

Testing of components such as pumps, is initiated through manual actuation. If response times are important, they are measured and recorded. The capability to delivery design output is checked by instrumentation and compared against design data. Allowable discrepancies are established in the Technical Specifications. The component is operated sufficiently long to allow equalization of operating temperatures in bearings, seals, and motors. Checks are made on these parameters as required. The component is surveyed for excessive vibration. Readings are recorded.

The Applicant believes that testing in accordance with the above described program provides a realistic basis for determining maintenance requirements and, as such, ensures continued system capabilities including reliability equal to that established in the original criteria.

13.4 [HISTORICAL] OPERATING RESTRICTIONS

13.4.1 [Historical] Safety Precautions

The measurements and test operations during low power and power escalation were similar to normal station operations at power, and normal safety precautions were observed. Those tests which require special operating conditions were accomplished using test procedures which prescribe necessary limitations and precautions.

13.4.2 [Historical] Initial Operation Responsibilities

The Plant Manager had the overall responsibility for supervising and directing all phases of testing. All system operations in the testing program were performed by station operators in accordance with approved written procedures. Those procedures included such items as delineation of administrative and test responsibilities, equipment clearance, test purpose, conditions, precautions, limitations, and sequence of operation. Procedural changes were made only in accordance with an approved standard procedure requiring review and approval of the change(s) by experienced supervisory personnel.

Test procedures stating the test purpose, conditions, precautions, and limitations were prepared for each test. All such procedures were reviewed and approved by D.C. Cook personnel in accordance with approved standard procedures prior to implementation. Also refer to Section 13.3 for additional information.