CHAPTER 14

14.0 INITIAL TEST PROGRAM

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On April 29, 2013, the name Carolina Power & Light Company (CP&L) was changed to Duke Energy Progress, Inc. (DEP). On September 13, 2016, the name Duke Energy Progress, Inc. was changed to Duke Energy Progress, LLC.

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This Section is not applicable to the H.B. Robinson Unit 2 Updated FSAR.

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14.2.1 SUMMARY OF TEST PROGRAM AND OBJECTIVES

The initial test program was divided into the following distinct phases:

Phase A Preoperational Tests

Phase B Core Loading

Phase C Initial Criticality and Power Escalation

The following subsections describe each phase of the initial test program.

14.2.1.1 Tests Prior To Reactor Fueling

Specific startup tests and operations were required to place specific plant systems and equipment in service prior to reactor fueling. The systems and equipment tested and the sequence in which the test was performed are listed below:

a) Switchgear System

b) Voice Communications Systems

c) Service Water System

d) Fire Protection System

e) Instrument and Service Air Systems

f) Nitrogen Storage System

g) Reactor Coolant System Cleaning (inspection)

h) Reactor Containment Air Circulation System

i) Feedwater System

j) Condensate Circulation System

k) Auxiliary Coolant System

l) Chemical Feed System

m) Chemical & Volume Control System

n) Containment Spray

o) Safety Injection System

p) Fuel Handling and Refueling Equipment Systems

q) Reactor Containment High Pressure Test

r) Cold Hydrostatic Tests

s) Radiation Monitoring System

t) Nuclear Instrumentation System

u) Radioactive Waste Disposal System

v) Sampling System

w) Hot Functional Tests

  1) Reactor Coolant System

  2) Chemical & Volume Control System

  3) Sampling System

  4) Safety Injection System

  5) Waste Disposal System

x) Primary and Secondary System Safety Valves Tests

y) Turbine Steam Seal & Blowdown Systems

z) Emergency Diesel-Electric System

aa) Reactor Control and Protection System

bb) Isolation Valve Seal Water System (IVSWS) and Isolation System

cc) Penetration Pressurization System.

The tests conducted on the engineered safety systems included the Containment System, Safety Injection System, the Containment Spray System, and the Containment Air Recirculation Cooling and Filtration System.

Abnormal plant conditions were simulated during testing when such conditions did not endanger personnel or equipment, or contaminate clean systems. Where predicted emergency or abnormal conditions were involved in the testing program, the detailed operation was provided in the test procedure. The test objectives incorporated testing of redundant equipment where it was involved.

14.2.1.2 Core Loading

The as-loaded core configuration was specified as part of the core design studies conducted well in advance of plant startup.

The core was assembled in the reactor vessel in water containing enough dissolved boric acid (usually at least 2000 ppm) to maintain the core multiplication constant at 0.90 or lower and was not subsequently changed until the end of the core cycle. Core moderator chemistry conditions

(particularly, boron concentration) were prescribed in the core loading procedure document and were verified by chemical analysis of moderator samples every eight hours during the core loading operations.

Core loading instrumentation consisted of two permanently installed plant source range (pulse-type) nuclear channels and two temporary incore source range channels plus a third temporary channel to be used as a spare. The permanent channels are monitored in the control room by licensed plant operators; the temporary channels were installed in the vapor container and were monitored by technical specialists of the Westinghouse Electric Corporation and by licensed Senior Reactor Operators of the Duke Energy Progress, LLC. At least one plant channel and one temporary channel were equipped with audible count range indicators. Both plant channels and both regular temporary channels displayed neutron count rate on count rate meters and strip chart recorders. Minimum count rates of two counts per second, attributable to core neutrons, were required on at least two of the four available nuclear channels at all times during core loading operations. Two artificial neutron sources, each rated at approximately 200 curies of Po^{210} alpha activity, were introduced into the core at appropriate specified points in the core loading program to ensure a neutron population large enough for adequate monitoring of the core.

Fuel assemblies together with inserted control components [rod cluster control (RCC) units or burnable poison inserts] were added to the core one at a time according to a previously established and approved sequence which had been developed to provide reliable core monitoring with minimum possibility of core mechanical damage. The core loading procedure documents included a detailed tabular check list which prescribed and verified the successive movements of each fuel assembly and its specified inserts from its initial position in the storage racks to its final positions in the core. Multiple checks were made of component serial numbers and types at successive transfer points to guard against possible inadvertent exchanges or substitutions of components.

An initial nucleus of eight fuel assemblies, the first of which bore an activated neutron source, was determined to be the minimum source-fuel nucleus which permitted subsequent meaningful inverse count rate monitoring. This initial nucleus was known by calculation and previous experience to be markedly subcritical (K_{eff} <0.90) under the required conditions of loading.

Subsequent fuel additions were made, one assembly at a time, with detailed inverse count rate ratio monitoring after each addition. The results of each loading step were evaluated by both Westinghouse technical specialists and DEP licensed operations personnel. Concurrent approval to proceed was required before the next prescribed step could be started.

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

a) The neutron count rates on all responding nuclear channels double during any single loading step.

b) The neutron count rate on any individual nuclear channel increases by a factor of five during any single loading step.

An evacuation alarm was coupled to the plant source range channels with a set point at five times the current count rate to provide automatic indication of high count rate during fuel addition.

In the event that an unacceptable increase in count rate had been observed on any or all responding nuclear channels, special procedures involving fuel withdrawal from the core, detector relocation, and charging of additional boric acid into the moderator would have been invoked by Westinghouse technical specialists with the approval of DEP licensed operational personnel.

Core loading procedures specified alignment of fluid systems to prevent inadvertent dilution of the reactor coolant, restricted the movement of fuel to minimize the possibility of mechanical damage, prescribed the conditions under which loading may proceed, identified chains of responsibility and authority and provided for continuous and complete fuel and core component accountability.

14.2.1.3 Initial Criticality and Power Escalation

14.2.1.3.1 Postloading Tests

Upon completion of core loading and installation of the reactor upper internals and the pressure vessel head, certain mechanical and electrical tests were performed prior to initial criticality. The electrical wiring for the rod drive circuits, the rod position indicators, the reactor trip circuits, and the in-core thermocouples was tested at the time of installation. Final operational tests were repeated on these electrical items.

Mechanical and electrical tests were performed on the RCC unit drive mechanisms. Tests included a complete operational checkout of the mechanisms. Checks were made to ensure that the rod position indicator coil stacks were connected to their proper position indicators. Similar checks were made on the RCC unit drive coils.

Tests were performed on the reactor trip circuits to test manual trip operation. Actual RCC unit drop times were measured for each rod control cluster. By use of dummy signals, the reactor protection system was made to produce trip signal for the various plant abnormalities that require tripping.

After filling and venting was completed, the final cold hydro tests were conducted.

A complete electrical and mechanical check was made on the in-core nuclear flux mapping system at the operating temperature and pressure.

14.2.1.3.2 Initial Criticality

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

Successive stages of RCC group withdrawal and of boron concentration reduction were monitored by observing the change in neutron count rate as indicated by the regular plant source range nuclear instrumentation as functions of RCC group position and, subsequently, of primary water addition to the reactor coolant system during dilution.

Primary safety reliance was based on inverse count rate ratio monitoring as an indication of the nearness and rate of approach of criticality of the core during RCC group withdrawal and during reactor coolant boron dilution. The rate of approach toward criticality was reduced as the reactor approached extrapolated criticality to ensure that effective control was maintained at all times.

Relevant procedures specified alignment of fluid systems to allow controlled start and stop, and adjustment of the rate at which the approach to criticality may proceed. Procedures also indicated values of core conditions under which criticality was expected and identified chains of responsibility and authority during reactor operations.

14.2.1.3.3 Zero Power Testing

Upon establishment of criticality a prescribed program of reactor physics measurements was undertaken to verify that the basic statics and kinetics characteristics of the core were as expected and that the values of kinetics coefficients assumed in the safety analysis were indeed conservative.

Measurements made at zero power and primarily at or near operating temperature and pressure included verification of calculated values of RCC group and unit worths, of isothermal temperature coefficients under various core conditions, of differential boron concentration worths and of critical boron concentrations as a function of RCC group configuration. Preliminary checks on relative power distributions were made in normal and abnormal RCC unit configurations.

Concurrent tests were conducted on the plant instrumentation including the source and intermediate range nuclear channels. RCC unit operation and the behavior of the associated control and indicating circuits were demonstrated and the adequacy of the control and protection systems was verified under zero power operating conditions.

Detailed procedures specified the sequence of tests and measurements to be conducted and the conditions under which each was to be performed to ensure the relevancy and consistency of the results obtained.

14.2.1.3.4 Power Level Escalation

When the operating characteristics of the reactor at zero power had been verified, a program of power level escalation in successive stages was undertaken. Both reactor and plant operational characteristics were closely examined at each stage and the relevance of the safety analysis was verified before escalation to the next programmed level was effected.

Reactor physics measurements were made to determine the magnitudes of the power coefficient of reactivity, of RCC group differential worth, and of relative power distribution in the core as functions of power level and RCC control group position.

Concurrent determinations of primary and secondary heat balances were made to ensure that the several indications of plant power level were consistent and to provide bases for calibration of the power range nuclear channels. The ability of the reactor control and protection system to respond effectively to signals from plant primary and secondary instrumentation under a variety of conditions encountered in normal operations was verified.

At prescribed power levels the response characteristics of the reactor coolant and steam system to dynamic stimuli were evaluated. The responses of system components were measured for loss of load and recovery, turbine trip, loss of flow, and trip of a single RCC unit.

Adequacy of radiation shielding was verified by gamma and neutron radiation surveys in the vicinity of the containment and throughout the plant 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 several tests and measurements.

14.2.2 ORGANIZATION AND STAFFING

The organization of the total startup group consisted of a team composed of Westinghouse, Ebasco, and CP&L people. The organizational chart shown in Figure 14.2.2-1 describes the startup organization.

The personnel assigned by Westinghouse varied. For initial criticality and subsequent tests, the Westinghouse Support Group was augmented by specialists from Pittsburgh. The CP&L organization, however, remained essentially the same for all phases of the startup program.

14.2.2.1 CP&L Organization

The CP&L startup organization was structured to meet the following criteria:

a) To ensure that personnel competent in management, organization, and operations were available to carry on the startup program on a 24-hour-a-day basis

b) To ensure that the transition from construction, to testing and startup, and to final operation was smooth and orderly

c) To ensure that the test program was adequately documented and that test results were reviewed to ensure that the tests verified that the plant was constructed and operated as designed.

To fulfill these requirements, personnel with broad supervisory experience and specific nuclear training were selected to provide supervision. Personnel with experience in the startup of both fossil and nuclear facilities and in the actual construction of the H.B. Robinson Plant were selected for startup duties.

Details of the various CP&L groups that were instrumental in the test and startup program are given in the following section.

14.2.2.1.1 Operating Management Group

The Plant Superintendent was directly responsible for CP&L activities. Supporting the Plant Superintendent was an Operations Management Group drawn from permanent plant personnel and Senior Engineers from the General Office. This group remained intact until the plant was accepted for commercial operation. The Operating and Results Supervisor directed all tests for CP&L. He qualified for an AEC Cold Senior Operator's License. A member of the General Office staff was assigned as Senior Physicist for the startup. He was assigned as needed to the Robinson Plant for the period extending from core loading to commercial operation. At the time of startup, he was an experienced nuclear physicist with over 12 years experience and had participated in several startup programs for newly designed power reactors. The Senior Radiation Control Engineer of the Company was assigned duties at Robinson as needed from core loading to commercial operation. He supervised Radiation Control activities. He was an experienced Health Physicist having worked at enrichment facilities and other power reactors. The Radiation Control Engineer was a permanent member, and the Senior Physicist was a member of the Plant Safety Committee during the startup program.

There was assigned to the Robinson Plant staff, for a minimum of one year from initial core loading, an individual with a minimum of a Bachelor's Degree in Engineering or the Physical Sciences and two years experience in such areas as reactor physics, core measurements, core heat transfer, and core physics testing programs.

14.2.2.1.2 Shift Supervision

During the period when active integrated plant testing was in progress during the startup program, a CP&L Shift Supervisor was assigned to the shift in addition to the shift foreman. When the Operating and Results Supervisor was on site, he could serve as the Shift Supervisor; however, when he was absent, he was relieved by an AEC-licensed, graduate engineer. The Shift Supervisor was in charge of plant activities during the shift, and had authority to terminate a test. He reported to the Operating and Results Supervisor, or in his absence or unavailability the Shift Supervisor reported to the Plant Superintendent.

The CP&L Shift Foreman was responsible to the Shift Supervisor for operating the plant and conducting the scheduled tests. He worked closely with the Westinghouse Shift Supervisor, keeping him advised of the progress of specific tests and the problems that were encountered. Shift Foremen had the authority to terminate a test at any time if they believed continuation of the test could lead to an unsafe condition. During phases B and C (See Section 14.2.1), and when directed for a specific phase A test, a Control Operator was assigned to assist the Shift Foreman.

The Shift Foreman and Control Operator were qualified to exercise the authority vested in them because of their extensive conventional power plant experience, their specific nuclear training, and their licensing by the AEC.

14.2.2.1.3 Supporting Groups

In support of the Operations Management Group, the CP&L organization included the following:

a) Engineering Support Group

The CP&L Engineering Support Group was staffed by graduate engineers qualified in the disciplines associated with nuclear power plant testing. In addition to graduate engineers on the staff of the H.B. Robinson Plant, this group was augmented by members of the Technical Services Group as the need arose. Consultants, when requested by CP&L to advise in specific areas, were a part of this group.

b) Instrument & Control Group

The Instrument & Control Group was responsible to assure that all necessary instrumentation, including temporary test instrumentation, had been installed and calibrated prior to a scheduled test. The Group Foreman reported to the Maintenance Supervisor. At least one instrument technician was assigned to each shift during phase B and C tests and during integrated phase A tests.

Members of the Instrument and Control Group had extensive experience in the startup and maintenance of conventional plants. Several of the senior technicians participated for a six-week period in the startup, including criticality, of the Ginna Plant of Rochester Gas and Electric Company.

c) Plant Maintenance Group

The Plant Maintenance Group, under the direction of the Maintenance Supervisor, was responsible for maintenance during the test program. This group represented experienced electricians and mechanics who are experienced in conventional plant startups and maintenance. Most of the personnel in this group had been on site during the construction of the nuclear plant.

d) Radiation Control Group

The Radiation Control Group, under the supervision of a foreman, was responsible to the Senior Engineer, Radiation Control, for all radiation control activities of the startup group. During phase B and C tests, a qualified Health Physics Technician was on each shift. This group was responsible for enforcing established procedures for control of radiation areas and for the release of the contents of the waste disposal system. Two technicians in this group were previously employed as health physics technicians at other reactor plants. All members of this group had received specialized training including a six-week Westinghouse course and several Public Health Service courses.

e) Plant Safety Committee

The Plant Safety Committee reviewed all phase B and C tests for nuclear safety. The Committee could be called into session at any time by the Plant Superintendent to review a particular situation and to advise him relative to plant safety considerations.

f) Company Nuclear Safety Committee

The Company Nuclear Safety Committee was activated in advance of core loading. This committee conducted an independent audit of plans and procedures associated with phase B and C operations.

14.2.2.2 Westinghouse Organization

The Westinghouse organization for testing and startup of the H.B. Robinson Plant was composed of personnel with specialized training and experience. All supervisory personnel were selected considering their technical proficiency, experience in previous startups, and their ability to manage a complex startup organization. The assignment of Westinghouse support personnel to shift work during phases B and C provided an additional level of technical competence to the startup organization. The one-on-one arrangement of a Westinghouse Shift Supervisor and CP&L Shift Foreman provided for an additional check and balance during the initial operation of the plant. During phase A, technical and operating advice and assistance were readily available from Westinghouse personnel located at the site or in Pittsburgh, Pennsylvania.

14.2.2.2.1 Operations Manager

The Westinghouse Operations Manager reported to the Westinghouse Project Manager and was responsible for safe and expeditious preparation and execution of preoperational tests. He provided the necessary technical direction during fuel loading and during the power test program. A resume is shown in Table 14.2.2-1.

a) <u>Responsibilities</u>

1) He was responsible for the overall coordination of the testing, startup, and necessary procedures and instructions for a nuclear power plant.

2) Under his direction, the testing and checkout for the turnover of equipment and systems from Construction to Operations and including final plant acceptance were completed.

3) He reviewed and approved test procedures and startup program schedules.

4) He obtained the necessary fuel loading engineer and nuclear test engineer support from Westinghouse Nuclear Engineering Systems, Pittsburgh, Pa. He obtained plant engineering support from Ebasco Services, Inc., New York, New York.

B <u>Criteria</u>

1) At least four (4) years in-depth involvement by education and experience in the testing and operation of nuclear power plants. At least two (2) years of this experience must have been in a responsible supervisory position.

2) He must have held a AEC Cold-SRO license or its equivalent for a pressurized water power reactor.

14.2.2.2.2 Senior Test and Operations Engineer

The Westinghouse Senior Test and Operations Engineer was responsible to the Westinghouse Operations Manager for the technical content, planning, and conducting of the plant test program. A resume is shown in Table 14.2.2-2.

a) <u>Responsibilities</u>

1) He was responsible for both the technical adequacy and the preparation of all preoperational test procedures.

2) He coordinated the work of the various test engineers and specialists where required in the overall test program.

3) He provided technical support and direction to the Westinghouse Shift Supervisor during core loading and during the critical phases of the test program.

4) He was responsible for the day-to-day operation of the plant and the performance of the tests being conducted by CP&L operating personnel, including critical phases of the test program.

5) He was responsible for the issuance of instructions to the Westinghouse Shift Supervisor and the implementing of test procedures.

6) He was delegated the responsibilities of the Operations Manager during periods when the Operations Manager was absent.

b) Criteria

1) At least four (4) years in-depth involvement by education and experience in the testing and operation of nuclear power plants.

2) He must have held an AEC Cold-SRO license or its equivalent for a pressurized water power reactor.

14.2.2.2.3 Senior Instrumentation and Control Test Engineer

He was responsible to the Operations Manager for the safe and orderly testing of all instrumentation and controls. A resume is given in Table 14.2.2-3.

a) Responsibilities

1) He was responsible for familiarization and training of all CP&L instrumentation and control technicians.

2) With the assistance of instrumentation and control technicians and/or other technical personnel as necessary, the Senior Instrumentation and Control Engineer coordinated the calibration, alignment, and verification of instrumentation.

3) He coordinated his work effort as scheduled by the Manager of Operations.

c) Criteria

The individual holding this position must have had technical training beyond the high school level and a minimum of three (3) years experience in the testing and operation of nuclear power plant instrumentation systems.

14.2.2.2.4 Shift Supervisor

A Westinghouse Shift Supervisor was assigned to each shift during the period from core loading through critical phases of the plant test program. He was responsible to the Westinghouse Senior Test and Operations Engineer. He worked with his counterpart, the CP&L Shift Foreman, who issued all instructions to the CP&L operating personnel for the operation of the plant. Resumes are shown in Tables 14.2.2-4 through 14.2.2-7.

a) Responsibility

1) When on shift he had to know the condition of the plant and the status of all systems and tests in progress.

2) He monitored all shift activities to assure that operations were conducted in accordance with approved procedures.

3) He kept his management informed of all significant problems, test status and plant status.

4) He provided on-shift technical direction as necessary.

b) Criteria

The individual holding this position must have had technical training beyond the high school level and a minimum of two (2) years experience in the testing and operation of nuclear power plants.

14.2.2.2.5 Core Loading Engineer

The Westinghouse Core Loading Engineer provided specialized technical guidance during the period core loading preparation through approach to criticality. He was responsible to the Westinghouse Operations Manager during this period. The resumes are shown in Table 14.2.2-2 and Table 14.2.2-11.

a) Responsibilities

1) He was responsible for technical guidance and assistance in fuel loading activities including changes to both reactivity and/or core geometry.

2) He was responsible for checkout and handling of special neutron counting equipment.

3) He provided technical guidance in the checkout of fuel handling equipment.

4) He reviewed the lineup of the plant and plant equipment for fuel handling.

5) He was responsible for the indoctrination and organization of fuel handling and control personnel.

6) He reviewed and assured the support of chemistry and radiation control personnel and equipment.

b) Criteria

He should have had at least three years experience in the testing and operation of nuclear power plants including participation in at least one initial core loading activity. He should have had received training either formal or through experience employing the plant's operation, functional testing of plant systems, and core loading operation.

14.2.2.2.6 Nuclear Test Engineer

The Westinghouse Test Engineer provided specialized technical assistance during the period from initial core loading through plant acceptance. He was responsible to the Westinghouse Operations Manager in the performance of specialized test guidance and evaluation.

a) Responsibilities

1) He provided technical guidance in test planning, sequencing and execution.

2) He evaluated special test results and recommended appropriate action to the Operations Manager.

3) He was responsible for technical evaluations of reactivity monitoring during fuel loading activities including changes to both reactivity and in-core geometry.

b) Criteria

1) He should have had a B.S. Degree in Engineering or Physical Sciences with two years of experience in nuclear plant testing and evaluation.

2) He should have been intimately familiar with the design and performance criteria of the reactor and core as set forth in the FSAR, Technical Specifications, and design documents.

3) He should have been responsible and intimately familiar with the test objectives, procedures, and criteria for reactor acceptance including coordination, acquisition, and evaluation of test data.

14.2.2.2.7 Westinghouse Support Groups

Preoperational and hot functional tests (phase A) were implemented in conformance with detailed written procedures. Engineering reviews of test data were conducted to assure proper component and/or system performance.

If a phase A test indicated unknown or unexpected results, specialists were to be consulted from the cognizant design group. The Westinghouse Operations Manager could request and coordinate the assignment of additional Westinghouse support personnel as follows:

a) The Westinghouse Core Loading Group was at the site during core loading (phase B). Their responsibilities were to ensure that nuclear fuel was handled in accordance with approved procedures, and to ensure the proper operation, positioning, and monitoring of the special incore loading instrumentation. Their concurrence was required prior to inserting each fuel assembly in the core.

b) During initial criticality and power operations (phase C), a special Westinghouse Support Group was at the site. Their purpose was:

1) To ensure proper data was obtained

2) To conduct an onsite evaluation of the data

3) To terminate any operation in the event the data indicated a question of reactor safety was involved.

Resumes of additional startup personnel are shown in Tables 14.2.2-8 through 14.2.2-24.

TABLE 14.2.2-1

RESUME OF WESTINGHOUSE OPERATIONS MANAGER

Education:

High School Graduate
Received a B.S. degree from Kings Point Merchant Marine Academy in Engineering. U.S. Navy Damage Control School, ABC Warfare. Nuclear Power School in Idaho Falls, Idaho, BWR Seminar, San Jose, California, BWR Simulator, Morris, Illinois.

Experience:

4/69 to Startup	Assigned to the Carolina Power & Light Site as Operations Manager. Responsible for the startup of H.B. Robinson Steam Electric Plant, Unit No. 2. Duties included preparation of all test procedures, operating procedures, and system descriptions. Testing to commence with the preoperational test phase and continue through the 100-hour power run for plant acceptance. Responsible for scheduling plant activities and personnel requirements from construction plant turnover through customer acceptance.
4/67 to 4/69	Preoperational Test Engineer (Acting Operations Manager) assigned to the General Electric (BWR) Dresden site. Responsible for the preparation, execution, and data evaluation of all testing up to and including fuel loading.
2/66 to 4/67	Supervisor of Planning and Scheduling with Westinghouse Electric Corporation in the Bettis Atomic Power Laboratory.
4/64 to 2/66	Supervisor of Plant Modification at National Reactor Testing Station, Idaho Falls, Idaho. Responsible for scheduling and coordinating all the plant support groups in the performance of a major plant modification.
3/62 to 4/64	Plant Operations Crew Supervisor at National Reactor Testing Station, Idaho Falls, Idaho. Responsible for the safe and efficient operation of the reactor plant and auxiliary systems. This on-crew supervisor is also responsible for organization and direction of crew training of Naval officers, enlisted men, and civilian personnel. The crew supervisor also serves on a qualification examining board that passes on the acceptance and qualifications of all senior reactor operators.
8/61 to 3/62	Requalified on single and dual plant operations at Naval Reactors Facility as a Nuclear Plant Operations Engineer (supervisory reactor operator).
7/60 to 8/61	Test Engineer in the Bettis resident field office to the USS Long Beach Nuclear Cruiser, Bethlehem Steel Shipyard, Quincy, Mass. Responsible for installation and acceptance testing through and including sea trials.

TABLE 14.2.2-1 (continued)

1/57 to 7/60	Assigned to the construction follow group responsible to the Atomic Energy Commission, Westinghouse being the prime contractor, for construction integrity and testing of a dual reactor plant - prototype for the USS ENTERPRISE. Following construction, qualified as a Chief Operator (supervisory reactor operator) for both single and dual plant operation.
6/56 to 1/57	Entered the Naval Reactors Training Course qualifying as a Chief Operator on single reactor operation - prototype for the USS NAUTILUS.

TABLE 14.2.2-2

RESUME OF WESTINGHOUSE SENIOR TEST AND OPERATIONS ENGINEER/
CORE LOADING ENGINEER

Education:

High School Graduate
Attended Brigham Young University and the University of Hawaii.
Service Education: Instructor School, Leadership School, Nuclear Power School, Recruiting School, Electrician Mate School Class "B".

Experience:

7/69 to	Startup Senior Test and Operations Engineer at H.B. Robinson Steam Electric Plant, Unit No. 2, with Westinghouse Electric Corporation. Responsible for getting all startup procedures completed and an orderly safe startup of the CP&L Nuclear Power Plant. Direct supervision of the Shift Supervisors in hydro-testing, flushing, and putting all systems into operation. Supervised and directed fuel loading operations at the 1780 MWT Nuclear Plant, Rochester Gas & Electric Company, Rochester, New York. Successfully handled and transferred into the reactor vessel 121 fuel assemblies. Supervised latching of the control rod drive shafts, cleaning, and reinstalling the reactor vessel head. Assisted with indexing the fuel handling equipment and training the RGE operators in its use.
10/66 to 7/69	Senior Instructor for engineering department at Fleet Submarine Training Facility, Pearl Harbor. Forty-two instructors under my supervision.
8/66 to 9/66	Student-Instructor School, San Diego, California.
7/64 to 8/66	Chief Master at Arms of the USS HUNLEY, a ship with a crew of 1200 men.
7/63 to 7/64	Senior Instructor, 1st semester training at A1W, a dual reactor Navy Power Plant. Responsible to the Navy and Westinghouse for training students on the systems and theory of operation of a nuclear reactor. Twenty-five instructors and one hundred eighty students under my supervision.
7/62 to 7/63	Engineering Officer of the watch at A1W, a dual reactor power plant at Areo, Idaho. About eighty men under my supervision. Trained other Engineering Officers and enlisted trainees in operation of a nuclear steam plant. Qualified on all electrical, steam, fuel, lube oil, and radiological control systems used in support of a Nuclear Power Plant.
12/61 to 7/62	Student at Nuclear Power School, Vallejo, California and Idaho Falls, Idaho. Graduated 16th out of a class of 143.

TABLE 14.2.2-2 (continued)

11/59 to 12/61	Recruiter in charge, Billings, Montana. Seven counties in my recruiting district.
9/59 to 12/59	Student-Navy Recruiting School, San Diego, California.

TABLE 14.2.2-3

RESUME OF WESTINGHOUSE SENIOR INSTRUMENTATION
AND CONTROL TEST ENGINEER

Education:

High School Graduate
Attended the University of Wyoming. Received a B.S. Degree in Electrical Engineering.
Also attended Naval War College-OCS-Newport, Rhode Island.
Attended Civil Engineer Contruction Officer School, Port Heuneme, California.

Experience:

1/70 to Startup	Senior Engineer (I&C) at H.B. Robinson Steam Electric Plant, Unit No. 2, Westinghouse Electric Corporation. Responsible to the Manager of Operations for calibration and operation of all Primary Plant Protective and Control Instrumentation System and Secondary Plant Instrumentation Systems. Instruct customer personnel in the mode of accurate calibration methods and operational aspects of instrumentation.
4/68 to 1/70	Senior Engineer (I&C) at Robert Ginna Nuclear Power Plant for Rochester Gas and Electric at Rochester, N.Y. Responsible to the Manager of Operations for calibration and operation of all Primary Plant Protective and Control Instrumentation Systems and Secondary Plant Instrumentation Systems. Instructed customer personnel in the mode of accurate calibration methods and operational aspects of instrumentation.
4/62 to 4/68	Senior Engineer (Electrical) at Westinghouse A1W Project, National Reactor Testing Station, Idaho Falls, Idaho. Responsible for A1W Test Instrumentation System encompassing systems capable of receiving, conditioning, displaying, or processing all plant parameter testing data for physics or specialized testing and routine record information. Also responsible for installing incore thermocouple and hydraulic pressure sensors to achieve the above information. Directly responsible for field design, modification, and trouble shooting problems of plant nuclear and non-nuclear Instrumentation Control Systems and Electrical Power Distribution Systems. Periodically taught a course in electronics and instrumentation systems to Naval officers and Westinghouse Engineering personnel.
10/60 to 4/62	A1W Plant Reactor Engineer at Westinghouse A1W Project, National Reactor Testing Station, Idaho Falls, Idaho. Directly responsible to Manager of A1W Operations for all functions performed by individual crew reactor engineers. Afforded consulting services and directed troubleshooting and maintenance on A1W Plant Instrumentation and Control Systems.

TABLE 14.2.2-3 (continued)

9/57 to 10/60	Crew Reactor Engineer at Westinghouse A1W Project, National Reactor Testing Station, Idaho Falls, Idaho. Involved with Vendor fabrication, installation, and initial checkout of all nuclear, non-nuclear, and Rod Control Systems for the highly enriched reactor and seed and blanket reactor at A1W. Responsible on a crew basis for the operation and maintenance of all Instrumentation and Control Systems. Directly responsible to the Shift Supervisor for Critical operation of both the reactors and the training of Navy personnel in the field of Nuclear Theory and all aspects of reactor operation.
3/57 to 9/57	Crew Reactor Engineer at Westinghouse A1W Project, National Reactor Testing Station, Idaho Falls, Idaho. Trained and qualified for position of Reactor Engineer on Nuclear Submarine Prototype. Directly responsible to Shift Supervisor for the operation and maintenance of all nuclear and non-nuclear instrumentation systems. The efforts involved in this position are identical to the A1W position listed directly above.
9/53 to 3/57	U.S. Naval Civil Engineer - Lt. JG USNR. Managed major construction and assigned to construction follow services in Wisconsin, Michigan, and Illinois for the 9th Naval District. Last two years of assignment served as Resident Officer in Charge of Construction at Naval Air Station, Denver, Colorado. Directly responsible for construction of a major scramble hangar for the Air Force and various site major construction contracts.

TABLE 14.2.2-4

RESUME OF WESTINGHOUSE SHIFT SUPERVISOR

Education:

High School Graduate
Attended several Navy electrical and nuclear power training schools.

Experience:

3/1/70 to Startup	Senior Test and Operations Engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through the startup program. Responsibilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests at the H.B. Robinson Steam Electric Plant Unit No. 2, Hartsville, South Carolina.
5/69 to 3/1/70	Supervisory Service Engineer A with Westinghouse Electric Corporation, RG&E Project, Rochester, N.Y. Worked as Shift Engineer. Responsible for coordinating and directing, as necessary, the startup testing on rotating shifts during fuel loading, low power physics, and power operation.
11/68 to 5/69	Supervisory Service Engineer A with Westinghouse Electric Corporation, RG&E Project, Rochester, N.Y. Worked as I&C Startup Engineer during the circuit checkouts, calibration, and checkout of instrumentation and control valves.
8/60 to 11/68	Employed by Piqua Nuclear Power Facility as Shift Supervisor. Held Senior License for about 6 years. Responsible for technical supervision of shift personnel and for health physics activities in the absence of the health physicist. Also acted as Shift Supervisor during hot functional testing, initial core loading, critical testing, and power operation.
6/58 to 8/60	Employed by Atomics International. Responsible for operation and maintenance of organic moderated reactor and reactor experiments and associated systems. Also responsible for electric maintenance.
6/51 to 6/58	U.S Navy - Advancing to EM1 and Engineering Watch Supervisor USS NAUTILUS. Performed duties of an electrician and was responsible for operation of steam electric and nuclear systems. Also responsible for electric maintenance on main power equipment. Participated in the startup and testing of the NAUTILUS.

TABLE 14.2.2-5

RESUME OF WESTINGHOUSE SHIFT SUPERVISOR

Education:

High School Graduate
Received a B.S. in mechanical engineering from the University of Delaware.
Received a B.S. Degree from Kings Point Merchant Marine Academy in engineering.
Licensed as a Reactor Operator on SL1 Army Prototype Reactor, Idaho Falls, Idaho. Attended Babcock and Wilcox Nuclear School at Lynchburg College, Lynchburg, Va.

Experience:

6/69 to Startup	Senior Test and Operations Engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through the startup program. Responsibilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests. Duties include plant hydrotest, mechanical and system startup; preoperational tests, hot functional tests, and acceptance tests; fuel receipt, handling and loading.
6/67 to 6/69	Westinghouse Electric Corporation - Water Province Department. Employed as Plant Superintendent at the 1,000,000 GPD vapor compression plant located at the Rosewell, New Mexico Brackish Water Test Facility. Duties included the supervision of all personnel, maintenance, and operation of the plant and associated equipment.
7/66 to 6/67	Assumed position of Plant Manager. Duties required maintaining the necessary lines of communication between Westinghouse and the Office of Saline Water in the field and in Washington, D.C.
12/65 to 7/66	Employed by Burns and Roe as part of startup crew for the nuclear power plant at Oyster Creek, New Jersey. Participated in arrangement for scheduling startup of plant, as well as setting up a preliminary chemical cleaning of entire plant.
7/64 to 12/65	Independent Marine Surveyor. Service same as indicated for period 5/63 to 12/63.
12/63 to 7/64	American Export Isbrandsten Lines General Agents N.S. SAVANNAH. Services retained by company to supervise annual inspection of nuclear and conventional plants. Had responsibility to coordinate with the operating personnel the isolation of the various component systems for hydro testing or internal inspection as required by USCG in such a fashion that safe operation of plant was not

TABLE 14.2.2-5 (continued)

	jeopardized. I was named alternate chief engineer for the vessel when it became necessary for the Savannah's permanent chief to leave the area on business. In this capacity, I was, on several occasions, responsible during the startup of the nuclear and conventional power plants for training and testing of the vessel's new group of reactor operators.
5/63 to 12/63	Independent Marine Surveyor. Services were retained by former steamship operator clients of Marinus, Inc. to attend ships on per diem basis to arrange and supervise shipyard and voyage repairs. Settlement of any crew problems or changes, as well as expediting cargo and vessel movements, were also part of routine responsibilities.
4/59 to 5/63	States Marine Lines - General Agents for N.S. SAVANNAH. Employed by company and government on selective basis to train for reactor operator on the Savannah power plant. After training and qualifying as reactor operator, I was made senior watch officer which gave added responsibility of the operation of the nuclear and conventional plants.
12/54 to 4/59	Marinus, Inc. Employed as a port engineer. Work consisted of the arranging for all types of ship repairs, from simple pipe renewals to complete plant overhauls or hull plate replacements.
9/51 to 12/54	Various Steamship Companies - During these periods I was employed as a licensed marine engineer in a seagoing capacity on various types of ships. Duties performed were as required by the position held from Third Engineer to Chief Engineer inclusive.

TABLE 14.2.2-6

RESUME OF WESTINGHOUSE SHIFT SUPERVISOR

Education:

High School Graduate
Attended Nuclear Power School in the U.S. Navy
Attended Machinist Mate A School
Also Attended welding school.

Experience:

3/1/70 to Startup	Senior Test and Operations Engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through the startup program. Responsibilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests at the H.B. Robinson Steam Electric Plant Unit No. 2, Hartsville, South Carolina.
10/69 to 3/70	Shift Supervisor with Westinghouse Electric Corporation, RG&E Project, Rochester, New York. Responsible for the coordinating, directing, and operation of the plant from core loading through the power test program and plant acceptance.
5/68 to 10/69	Mechanical Startup Supervisor with Westinghouse Electric Corporation, RG&E Project, Rochester, New York. Also worked as construction engineer on installation of reactor components and carried out cold hydro and assisted in fuel loading.
4/68 to 5/68	Qualified NDT Level Two with Westinghouse Electric Corporation, RG&E Project, in dye penetrant and magnetic particle inspection.
5/61 to 3/68	In the U.S. Navy. Machinist Mate, 1st Class. Also lead welder on a Nuclear Submarine. Qualified 250/1500/1. Had a two year tour of new construction submarine. Took part in four nuclear refuelings. Also qualified as an Engine Room Supervisor.

TABLE 14.2.2-7

RESUME OF WESTINGHOUSE SHIFT SUPERVISOR

Education:

High School Graduate
Various Navy Schools in the area of steam propulsion and support equipment, diesel engines, air conditioning and refrigeration. Basic nuclear power school, a college level curriculum dealing in the theory and operation of pressurized water reactors. Including six months of practical experience on an operational prototype reactor plant.

Experience:

11/69 to Startup	Senior Test and Operations Engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through the startup program. Responsilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests. Duties include system flush, plant hydrotest, mechanical and system startup, preoperational tests, hot functional tests, and acceptance tests; also, fuel receipt, handling, and loading.
11/68 to 11/69	Mechanical Startup Engineer at the Rochester Gas and Electric Company Nuclear Power Plant, Rochester, N.Y.
8/66 to 11/68	Nuclear Machinery Division Supervisor and Steam and Reactor Plant Operational Assistant Supervisor in the U.S. Navy. (Engineering Watch Supervisor) - USS PATRICK HENRY (SSBNW599) (BLUE CREW).
7/64 to 8/66	Nuclear Machinery Division Supervisor. (Engineering Watch Supervisor) - USS SHARK (SSN591).
10/62 to 7/64	Nuclear Machinery Division Supervisor. (Engineering Watch Supervisor) - USS THEODORE ROOSEVELT (SSBN600) (BLUE CREW). To obtain this qualification, it is necessary to qualify on on all Engineering Watch Stations, including actual performance of three Reactor Startups as the Reactor Operator, supervise one (1) complete Reactor Startup, from ambient to normal self sustaining conditions and one (1) complete shutdown and cooldown. The Engineering Watch Supervisor is qualified to relieve the Engineering Officer of the Watch at any time.
9/60 to 10/62	Instructor and counselor, Nuclear Power Training Unit, West Milton, New York. Also during this period of time, attended Westinghouse Training course for S5W Reactor Plants, conducted at Bettis Atomic Laboratory, Pittsburgh, Pa.

TABLE 14.2.2-7 (continued)

10/59 to 9/60	Nuclear Power School.
5/56 to 10/59	Diesel Engine operator and leading machinist on conventional submarine.
6/49 to 5/56	Machinist Mate on USS GEORGE CLYMER (APA-27). Leading to Machinist Mate in charge of Mechanical Division.
4/46 to 6/49	Theater Manager, Ritz Theater, Linden, Texas.
12/42 to 4/46	U.S. Navy. Served on cruisers during WW II, advanced to Petty Officer First Class prior to separation.

TABLE 14.2.2-8

RESUME OF WESTINGHOUSE I & C ENGINEER

Education:

High School Graduate.
Associate Arts Degree (Math) from S. Colorado State College.
Bachelors of Science (Electrical Engineering) University of Colorado.
Began graduate work at University of Idaho graduate extension in Idaho Falls, Idaho.
Attended 13-week classroom study of the Fundamental Operation of Nuclear Test Reactors at the National Reactor Testing Station.

Experience:

12/69 to Startup	Senior Test and Operations Engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through the startup program. Responsibilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests. Duties include supervising installation and calibration of reactor control instrumentation and process instrumentation.
9/68 to 12/69	I&C Startup Engineer at R.E. Ginna Nuclear Power Plant in Rochester, N.Y.
6/66 to 9/68	Qualified Reactor Engineer at the Materials Test Reactor and the Advanced Test Reactor at the National Reactor Testing Station. Advanced Test Reactor (250 MW Thermal) Startup Responsibilities: Performance of preoperational and startup tests prior to initial criticality. Reviewing reactor and experimental loop operating procedures. Operating the reactor during low power physics tests. Shutdown responsibilities: Performance of reactor refueling operations. Insertion and removal of in-core experiments. Supervise work being done by the Maintenance and/or Project Engineering Groups. Materials Test Reactor (40 MW Thermal) Startup and power operation responsibilities: Performance of rod drop and other preoperational tests. Reviewing reactor and experimental loop operating procedures. Operating the reactor and all associated experimental facilities. Shutdown Responsibilities: Performance of Reactor Refueling Operations. Insertion and removal of in-core experiments. Supervise work being done by the Maintenance and/or Project Engineering Groups.

TABLE 14.2.2-8 (continued)

9/65 to 6/66	Student at University of Colorado.
6/65 to 9/65	Engineering Trainee with International Minerals and Chemical Corporation in Carlsbad, N.M.
Prior to '65	Student

TABLE 14.2.2-9

RESUME OF WESTINGHOUSE I & C ENGINEER

Education:

High School Graduate
Two years college, Northwestern State Teachers College, Alva, Oklahoma.
Naval Service Schools: Electronics Technician and Guided Missiles. Six correspondence courses in Radio and Electronics Engineering from Capitol Radio Engineering Institute, Washington, D.C.

Experience:

3/69 to Startup	Senior Test and Operations Engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through the startup program. Responsibilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests. Supervise instrument calibration, insure construction complies with specifications and design. Prepare procedures for the testing and startup of the power plant and procedures for operation of the power plant.
1/69 to 3/69	Supervisory Service Engineer, Nuclear Energy Systems, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. Provided liaison and technical coordination between Westinghouse Electrical Design Group and Ebasco Electrical Design Group.
2/65 to 12/68	Outhull Training Assistant, Westinghouse Electric Corporation Naval Reactors Facility, Idaho Falls, Idaho. Administered and supervised the classroom phase of the training program for naval nuclear plant operators. Instructed naval officers in system operation of reactor control systems and instrumentation. Maintained qualification and assumed periodic duties as shift crew reactor engineer.
4/59 to 2/65	Shift crew, Reactor Operations Engineer, Westinghouse Electric Corporation, Naval Reactor Facility, Idaho Falls, Idaho. Under the general direction of the plant operations crew Supervisor, directed and advised all Navy and Westinghouse Reactor Plant Operators in the operation of a nuclear power plant. Followed up on all abnormal reactor plant conditions for the purpose of detecting physical and operational malfunctions. Instructed operators and operator trainees in the method of correcting abnormal conditions.

TABLE 14.2.2-9 (continued)

1/58 to 4/59	Reactor Service Technician, Westinghouse Electric Corporation Naval Reactors Facility, Idaho Falls, Idaho. Identified faulty units and components, repaired, calibrated and operationally tested Reactor Control and Instrumentation Systems.
10/36 to 10/57	U.S. Navy. Various duties in increasing responsibility in electronics and guided missile repair and maintenance. Completed naval service as a Chief Warrant Officer.

TABLE 14.2.2-10

RESUME OF WESTINGHOUSE I & C TECHNICIAN

Education:

High School Graduate
First Year College "General Education Development Test"
College Level Algebra and Introduction to Calculus Courses
Nuclear Power Plant Operators Course with Instrumentation Specialty
Numerous courses completed in Electronics, Radar Repair, Radio Repair, Instructor Training, Nuclear Power Plant Crew Training, Oscilloscope Maintenance, Operation and Maintenance of a 512 Channel Spectrum Analyzer, and General Radio-Operation and Maintenance of Sound and Vibration Survey Equipment. Certified as a Nuclear Power Plant Operator, a Senior Engineering Technician, and as an Instructor of Nuclear Components.

Experience:

12/68 to Startup	Nuclear Power Supervisory Service Engineer with Westinghouse Electric Corporation, CP&L Project, Hartsville, South Carolina. Responsible for supervision of customer personnel in the checkout and calibration of H.B. Robinson No.2 Nuclear Power Plant Instrumentation.
11/67 to 12/68	Supervisory Service Engineer responsible for: 1. Electrical and Instrumentation Modifications made to the Saxton Test and Research Reactor. 2. Electrical and Instrumentation Instructor, Power Plant Operators course conducted by Westinghouse Electric Corporation at Saxton, Pa.
11/66 to 11/67	Nuclear Power Senior Instructor, Instructor and student, Instrument Training.
11/58 to 11/62	ection of Army Nuclear Power Plant Operators School.
11/63 to 11/66	Instrumentation Maintenance Supervisor (Maintenance support team to all Army Reactors).
9/63 to 11/66	Instrument Maintenance Specialist
5/56 to 5/58	Student, Repairman and Maintenance Supervisor
3/50 to 3/67	Student, Signal Inspector, and Depot Repair Supervisor in the U.S. Army.

TABLE 14.2.2-11

RESUME OF WESTINGHOUSE ONSITE ENGINEER/CORE LOADING ENGINEER

Education:

High School Graduate
Received a BBA Degree from the University of Washington, Seattle, Washington.
received A.S. from Mitchell College, New London, Connecticut.

Experience:

10/68 to Startup	Senior Test and Operations Engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through core loading. Responsibilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests. Duties entail technical supervision to construction contractor personnel in fluid systems and mechanical components of the H. B. Robinson Steam Electric Plant in Hartsville, South Carolina. Supervised and directed fuel loading operations at the 1780 MWt Nuclear Plant, Rochester Gas & Electric Company, Rochester, New York. Successfully handled and transferred into the reactor vessel 121 fuel assemblies. Supervised latching of the control rod drive shafts, cleaning, and reinstalling the reactor vessel head. Assisted with indexing the fuel handling equipment and training the RGE operators in its use.
1/63 to 10/68	Westinghouse Electric Corporation, Astronuclear Laboratory, Jackass Flats, Nevada. Employed as a mechanical engineer. Duties consisted of supervising nuclear rocket technicians during preparation and testing of NERVA nuclear rocket engines. Was Lead Engineer at Test Cell "A" complex. Console operator on Test Support Systems Console during test firings of Los Alamos Scientific Laboratory nuclear rocket engines. Received special schooling in Radiation Monitoring and Safety and Health Physics operations to qualify as Console Operator for nuclear rocket engine test firings.
5/61 to 1/63	Employed by the Fluor Corp. as Superintendent of Cryogenics Engineering Dept. Held various positions on Atlas ICBM bases at Fairchild AFB and Altus, Oklahoma, during construction, installation, and checkout of Atlas D and F series of ICBM's.

TABLE 14.2.2-11 (continued)

5/59 to 6/61	Employed by Vinnell Corp. as Instructor and On-the-job Training Supervisor at the "SAGE" installation, Tacoma, Washington. The "Semi-Automatic Ground Environmental" control system was part of the North American Air Defense Command System. Duties included instructing and supervising Air Force personnel in operation and maintenance of SAGE support systems and power plants.
6/57 to 5/59	Student at the University of Washington, Seattle, Washington.
9/37 to 6/57	Advanced in the U.S. Navy (Submarines) from Apprentice Seaman to Chief Petty Officer (Chief Engineman). Major portion of Naval service was spent in submarines from 1939 to 1957, including duty of USS NAUTILUS, first atomic powered submarine. Included four years as an Instructor in Engineering Department at U.S. Naval Submarine School.

TABLE 14.2.2-12

RESUME OF WESTINGHOUSE ON SITE ENGINEER

Education:

High School Graduate
Graduated with a B.S. in Mechanical Engineering from Tulane University, New Orleans, Louisiana.

Experience:

5/69 to Startup	Presently employed as engineer responsible for assuming the duties of a Westinghouse Operations Shift Supervisor during the testing of components and/or systems from the construction phase through the startup program. Responsibilities also include the preparation of test procedures and supervising the performance of both preoperational and startup tests. Duties include system flush, plant hydrotest, mechanical and system startup; preoperational tests, hot functional tests, and acceptance tests; fuel receipt, handling and loading.
4/68 to 5/69	Westinghouse Electric Corporation - RG&E Project, Rochester, New York. Employed as Supervisory Service Engineer, Grade B, Mechanical Systems: Flushing, plant hydrotest, mechanical construction.
5/67 to 4/68	Bailey Meter Company, Wickliff, Ohio. Participated in Instrument sales and service. Duties included design engineering and startup of combustion control instrumentation.

TABLE 14.2.2-13

RESUME OF WESTINGHOUSE TRAINING COORDINATOR

Education:

High School Graduate
Attended 48 week U.S. Naval Electronics School, Great Lakes, Illinois.
Attended U.S. Navy Nuclear Power School at New London, Connecticut.
Student at S1W Prototype, U.S. Navy Nuclear Power Training Unit, Idaho Falls, Idaho.

Experience:

1/69 to Startup	Employed by Westinghouse Training Division as the On-Site Training Coordinator for the H.B. Robinson Steam Electric Plant, Unit No. 2, Hartsville, South Carolina. Anticipate an SRO license on H.B. Robinson.
'67 to 12/68	Assigned to USS LAPON (SSN661) in charge of Reactor Control Division, United States Navy. Qualified as Engineering Watch Supervision and Engineering Officer of the Watch.
'65 to '67	Assigned to USS LEWIS AND CLARK in charge of Reactor Control Division. Responsible for training of Reactor Operators. Qualified as Engineering Watch Supervisor and Engineering Officer of the Watch.
'62 to '65	Assigned to USS JAMES MONROE (SSBN662). Served on board during construction and testing of the Reactor Plant. Duties included training of Reactor Control Division as Reactor Operators and in Maintenance and Operation of all Reactor Control Equipment. Qualified as Engineering Watch Supervisor and as Engineering Officer of the Watch.
'59 to '62	Assigned on board USS SCULPIN (SSN590) as Reactor Operator. During this period, duties involved training of Reactor Operator, Maintenance on all Reactor Control Equipment.
5/59 to 6/59	Attended Westinghouse Training Course for S5W Reactor at Bettis Atomic Laboratory, Pittsburgh, Pa.
4/57 to 5/59	Assigned to S1W Prototype as Reactor Operator Instructor. Qualified as Chief Reactor Operator during this time. Instructed Chief Reactor Operator Course for Nuclear Trained Officers.
1/57 to 4/57	Student S1W Prototype, U.S. Navy Nuclear Power Training Unit, Idaho Falls, Idaho.

TABLE 14.2.2-14

RESUME OF WESTINGHOUSE NUCLEAR OPERATIONS ENGINEER

Education:

B.S. Nuclear Engineering - University of Tennessee, 1964
M.S. Nuclear Engineering - University of Tennessee, 1967
Ph.D. Nuclear Engineering - University of Tennessee, 1969

Experience:

11/69 to Startup	Participated in the physics testing during the startup of RGE plant. Acted as a shift supervisor during all zero power testing and through power escalation tests at 50 percent. Continued checkout of startup physics programs in the plant computer on site.
6/69 to 1/70	Checkout of physics computer programs used on the RGE PRODAC-250 computer during startup operations.
3/69 to 7/69	Other activities include nuclear operations follow of Connecticut Yankee, Core I. This includes core reactivity follow, power distribution using in-core instrumentation and excore detector response evaluation.
2/69 to 3/69	Westinghouse PWR Division Senior Engineer. At Indian Point 1 side for startup and physics testing for Cycle 3. Also co-author of subsequent physics test reports (scope of work included measurement of control rod worth, moderator temperature coefficients, minimum shutdown margin and Boron worth).
'67 to 68	Oak Ridge National Laboratory as Nuclear Engineer. Reactor (part time)physics calculations, experimental heat transfer.
6/64 to 9/64	Westinghouse PWR Division Engineer. Nuclear follow of Saxton Core 1 operations. Nuclear design of Saxton Plutonium Core 2.
6/63 to 9/63	Westinghouse PWR Division Engineer. Core reactivity follow of Saxton operations.

TABLE 14.2.2-15

RESUME OF WESTINGHOUSE NUCLEAR OPERATIONS ENGINEER

Education:

BSME, Ohio State University, 1957
Graduate studies Nuclear Engineering, University of Cincinnati, 1961

Experience:

1961 to Startup	Westinghouse Electric Corporation Nuclear Energy Systems Division Nuclear Core design and fuel management. Analysis and evaluation of experimental data. Fellow Engineer. Participated in Saxton Physics Testing, Southern California Edison Project load follow testing and NOK Startup, power escalation, and part-length rod tests.
1957 to 1961	General Electric Corporation-Engineer Aircraft Nuclear Propulsion Department.

TABLE 14.2.2-16

RESUME OF WESTINGHOUSE NUCLEAR OPERATIONS ENGINEER

Education:

B.S. Physics - Drexel Institute of Technology, 1965
M.S. Physics - Pennsylvania State University, 1968.

Experience:

4-1-68 to Startup	Westinghouse NES Engineer
	Participated in the recurrent physics testing and analysis at the SCE site.
	Participated in the startup testing of the Obrigheim (Germany) plant.
	Participated in the startup testing and analysis at the Zorita site.
	Participated in startup testing of the Indian Point I plant for Cycle III.
	Participated in the physics testing and analysis during the startup of the NOK plant from zero power. Aside from all the regular testing, a special series of tests with part-length rods were performed.

TABLE 14.2.2-17

RESUME OF WESTINGHOUSE NUCLEAR OPERATIONS ENGINEER

Education:

Technical Student at Westinghouse Electric Corporation in The Nuclear Design Group from 1960 to 1963.
B.S. Degree, University of Pittsburgh, Electrical Engineering, 1963.
M.S. Degree, University of Pittsburgh, Nuclear Engineering, 1967.

Experience:

9 years — Westinghouse Nuclear Energy Systems Divisions Nuclear Engineering Design and Physics Measurements.

Job responsibilities which directly relate to onsite data procurement, physics testing, and reactor startup during this period include onsite testing at the CVTR, SAXTON, SCE, CON-ED, CY AND ZORITA nuclear power stations. Specific details and job responsibilities include the following:

a. CVTR - Performed the fuel management nuclear design, specified physics programs, performed and followed the physics testing programs throughout conception, measurement procurement, analysis and reporting.

   Throughout this period accumulated onsite time was approximately 3 months.

b. SAXTON - Assisted during the early phase of the SAXTON startup and physics testing program. During this period the reactivity meter and testing methods were being developed. Actual site time was approximately one (1) month.

c. SCE - Assisted during fuel loading, physics testing, and startup at San Onofre. During this time actual time on site was approximately four (4) months.

d. CON-ED - Lead engineer responsibilities of physics testing program including measurement procurement and analysis of the third cycle startup at Indian Point Unit No. 1. Site time approximately on (1) month.

e. CY - Lead engineer responsibilities for core loading, physics testing and startup program at Connecticut-Yankee. Also had lead responsibility in the power escalation program in matters pertaining to physics testing, core performance, and evaluation. Site time was approximately three (3) months.

TABLE 14.2.2-17 (continued)

f. ZORITA - Lead engineer responsibilities of total physics testing and startup program at the "Jose Cabrera" plant in Spain. Worked on power escalation program. Time spent at the site was approximately three (3) months.

In addition to the participation in physics measurements at large PWR plants, participated in critical experiments at the Westinghouse Reactor Evaluation Center (WREC), in connection with various research and development programs at Westinghouse Electric Corporation. In particular, had lead responsibility in the planning, procurement and evaluation of critical experiments, which, (a) correlated a relationship between the power production between UO_2 and PuO_2 fuel rods, and; (b) mocked up the CVTR high power density test assemblies.

Other onsite experience not directly related to reactor startup was the development and performance of on-site gamma scanning measurements in the reactor spent fuel pit area. In this capacity he had lead responsibility in the planning, procurement, and evaluation of gamma scanning measurements performed at the Yankee Rowe, Selni, Con. Ed., and RGE nuclear power stations.

TABLE 14.2.2-18

RESUME OF WESTINGHOUSE NUCLEAR OPERATIONS PHYSICIST

Education:

B.S. Mathematics - University of South Carolina - 1949
M.S. Physics - University of South Carolina - 1954
Oak Ridge School of Reactor Technology - 1954-1955

Experience:

1962 to Startup	Westinghouse Nuclear Energy Systems Division, Manager, Nuclear Operations. PWR responsibilities at Saxton, Con Ed Unit 1, TRINO, SENA, Southern California Edison, Connecticut-Yankee, Zorita, and RGE involving Core Loading Physics, Zero Power Physics Testing, Physics Tests at Power including Power Distribution Evaluation from In-Core Instrumentation, Shutdown Capability, Control Rod Worth, Reactivity Coefficients, and Core Capability Evaluation. Member of SCE Nuclear Safety and Audit Review Committee. Saxton Safety Committee. Westinghouse Reactor Evaluation Center Safety Committee.
1959 to 1962	Westinghouse Electric Corporation - Fellow Engineer. Responsible for Carolina-Virginia Reactor Nuclear Design and Critical Experiment Program. Carolina-Virginia Reactor Nuclear Startup Program including Core Loading Physics, Zero Power Physics Testing, In Core Instrumentation Analysis, and Operating Physics under Post Construction Follow Program.
1955 to 1959	General Electric Corporation - Engineer and Principal Engineer - Aircraft Nuclear Propulsion Department.

TABLE 14.2.2-19

RESUME OF WESTINGHOUSE NUCLEAR OPERATIONS ENGINEER

Education:

BEE - Clemson University - 1949

Experience:

1968 to Startup	Westinghouse Nuclear Energy Systems Divisions - Senior Engineer in Licensing Engineering. Participated in startup of RG&E Project, Rochester, New York.
1961 to 1968	Senior Engineer in Field Office for startup - testing and refueling of submarine reactors. Had lead responsibilities in the cold and hot functional, initial criticality, and power-acceptance test program of 12 initial submarine reactor startups. Also had responsibility as a refueling engineer.
1956 to 1961	Westinghouse - Bettis Laboratory - Senior Design Engineer in Control Engineering for submarine reactors and plant design.
1949 to 1956	Con. Ed. Company of New York - Design Engineering in Electric and Gas Distribution Engineering.

TABLE 14.2.2-20

RESUME OF WESTINGHOUSE NUCLEAR OPERATIONS ENGINEER

Education:

B.S. - Physics - University of Notre Dame - 1968

Experience:

1968 to Present	Westinghouse Nuclear Energy Systems Divisions. Associate Engineer. Reduction, analysis and evaluation of test results, nuclear plant startup operations. Onsite experience at SCE power escalation and recurrent physics testing, and physics testing at Indian Point Unit 1, Saxton, and Rochester Gas and Electric.

TABLE 14.2.2-21

RESUME OF WESTINGHOUSE TRANSIENT ANALYST

Education:

M.S. - University of Brussels, Belgium; Physics - 1950
M.S. - University of Brussels, Belgium; Special Physics Option - 1950
MSEE - University of Pittsburgh, Pennsylvania; Control and Nuclear Option - 1960

Experience:

1958 to Startup	Westinghouse Nuclear Energy Systems Division - Penn Center. Manager, Control and Protection Analysis. Transient Analysis, Nuclear Instrumentation, Control and Protection System Design.
	At SENA (Centrale Nucleaire Des Ardennes) participated in plant power escalation startup testing - Developed on site, test and procedures for special tests as required, and participated in test result evaluation.
	At Connecticut Yankee participated in power escalation tests.
	Evaluation of NOK (Beznau Plant - Switzerland) plant transient data during power escalation test program.
	Plant startup of the Rochester Gas and Electric Plant (transient tests and control and protection system evaluation).
	Westinghouse Belgian Licensee (A.C.E.C.); Manager of the Accelerator Group, Design of Nuclear Particle Accelerator Machines.

TABLE 14.2.2.22

RESUME OF WESTINGHOUSE TRANSIENT ANALYST

Education:

BSEE - Virginia Polytechnic Institute - 1961
M. Nuclear Engineering - University of Virginia - 1963

Experience:

1964 to Startup	Westinghouse Nuclear Energy Systems Divisions - Penn Center. Lead Engineer for safety analysis and plant transient studies for several plants (including Rochester Gas and Electric and Zorita). Prepared functional requirements for control and protective instrumentation systems for the above plants. At SCE (Southern California Edison Project) participated in plant power escalation startup testing - Developed on site, test and procedures, for special tests as required and participated in test result evaluation. At Connecticut Yankee participated in tests to evaluate RTD noise. Plant startup at the Zorita nuclear plant (in Spain) for transient tests and nuclear plant performance. Plant startup of the Rochester Gas and Electric Plant (transient tests and control and protection system evaluation).
1963 to 1964	Instructor for Civil Defense Radiological Measurements at University of Virginia.

TABLE 14.2.2-23

RESUME OF WESTINGHOUSE TRANSIENT ANALYST

Education:

B.A. - Harvard University; Engineering Science and Applied Physics - 1958
M.S. - George Washington University, Physics - 1962
Ph.D. - Harvard University; Applied Physics - 1969
Bettis Reactor Engineering School - 1960

Experience:

1966 to Startup	Westinghouse Nuclear Energy Systems Division - Penn Center. Lead Engineer for safety analysis, plant transient studies, control and protection system functional design for 3 loop pressurized water reactors. At SCE (Southern California Edison Project) participated in plant special tests. Plant startup of the Rochester Gas and Electric Plant (transient tests and control and protection system evaluation).
1958 to 1962	Naval Reactors, U.S. Atomic Energy Commission; Lieutenant, U.S. Navy, Approval of Test Procedures, Operating Procedures, Control and Protection Instrumentation Equipment Designs.

TABLE 14.2.2-24

RESUME OF WESTINGHOUSE PLANT STARTUP (CORE LOADING) SPECIALIST

Education:

High School Graduate
1 year Drexel Institute of Technology, Electrical Engineering
1 year U.S. Navy Electronics School
Graduate 1968 Capitol Radio Engineering Institute

Experience:

1 1/2 years	Westinghouse Plant Operations and Measurements Specialist - Participated in programs at Connecticut Yankee, San Onofre, Saxton, Indian Point Unit One, Yankee-Rowe, and Rochester Gas and Electric Ginna Station.
2 1/2 years	Westinghouse Astronuclear, NERVA Program, Jackass Flats, Nevada -- Test Engineer, Controls Group and Operations.
10 years	Westinghouse Reactor Evaluation Center -- Test Engineer, Critical Experiments and operator training Senior Reactor Operator.
2 years	Union Switch and Signal -- Electronics technician, Flight Simulators.

14.2.3 TEST PROCEDURES

Detailed, written procedures were prepared by the startup group under the direction of the Westinghouse Operations Manager. All tests and test procedures were under the approval and control of CP&L to ensure that proper emphasis was placed on safety during these tests. All tests were conducted in accordance with the approved test procedures.

14.2.4 CONDUCT OF TEST PROGRAM

CP&L, as the owner and plant licensee, has responsibility for nuclear safety and compliance with the operating license. CP&L carried out this responsibility through previously trained and licensed personnel supplemented by additional support personnel. All personnel on the site including contractor, vendor, or Westinghouse, observed applicable CP&L rules and regulations.

The Westinghouse Electric Corporation, as turnkey contractor, had contractual responsibility for the technical direction of the testing and startup program. Accordingly, Westinghouse startup personnel technically directed the startup program, and it was implemented by CP&L personnel.

Recognizing that Westinghouse was responsible for the technical direction of the startup program and that CP&L had ultimate responsibility for plant operations, Westinghouse and CP&L effected the following relationships between their personnel during the startup program:

a) Westinghouse, through the Operations Manager, technically managed the testing program to verify that results indicated the components and systems functioned as designed. Prior to execution of a test, the details of the test were discussed in detail by the CP&L Operating and Results Supervisor and the Westinghouse Operations Manager to ensure complete mutual understanding.

b) All orders to CP&L personnel were normally transmitted by CP&L supervisory personnel. Either a Westinghouse or a CP&L Shift Foreman could order a test to be terminated.

c) Regularly scheduled joint meetings were held to keep all parties completely informed and to schedule test operations for the ensuing week.

d) Each CP&L supervisor worked closely with his Westinghouse counterpart. Conflicts or differences of opinion were promptly resolved with the next higher level of management in both organizations.

The test program was planned and scheduled as follows:

a) Upon notification by the Westinghouse Operations Manager, the CP&L Operations and Results Supervisor scheduled the test, ensuring that the systems associated with a particular test were ready for test, verified that any prerequisite tests had been satisfactorily completed, and that any special equipment for the test was available and checked out.

b) The CP&L Operations and Results Supervisor reviewed the content of the approved test for phase B and C tests and arranged for necessary personnel to be available at the scheduled time to record data and perform special tasks associated with the test. For first-of-a-kind and complex tests, he scheduled a walk-through practice run.

c) The CP&L Operations and Results Supervisor notified the Plant Superintendent that the test had been scheduled. A Startup Test Group

Activity Schedule was kept up-to-date by the Westinghouse Operations Manager. This schedule indicated the date and shift each test would be conducted.

In case a substantial procedure revision was required, the CP&L Plant Superintendent, the Westinghouse Operations Supervisor, and a Test Engineer, if designated, reviewed the change with the same approach as a new test procedure before the test could be continued. CP&L engineering and consultants and Westinghouse design personnel agreed on the general program, including the extrapolation and implication of previous results, and the resolution of anomalies. They also approved the resolution of disagreements among the senior operations personnel above.

If apparent deviations of test results from design predictions or acceptance criteria were revealed, or if other apparent anomalies developed, the plant was to be placed in a safe condition and relevant test data was reviewed. If the apparent discrepancy or anomaly were found to be real, the situation was to be reviewed by the Plant Operations Safety Committee to determine whether a question of plant safety was involved. If such were found to be the case, the effect of the discrepancy or anomaly on plant safety was evaluated at the appropriate level of review. If after evaluation it was determined that an unreviewed safety question existed, a detailed evaluation of the consequences of possible accidents under actual (as opposed to predicted) conditions was to be made. Similar testing under more stringent conditions could not resume until any question relating to reactor safety had been resolved satisfactorily. If no discrepancy or anomaly was found to exist, the test could be continued or repeated to verify test results.

14.2.5 REVIEW, EVALUATION, AND APPROVAL OF TEST RESULTS

Upon completion of a test, the CP&L Operations and Results Supervisor, assisted by appropriate CP&L engineers, reviewed the results, audited significant calculations, and made a specific recommendation to the Plant Superintendent as to the acceptability of the components of systems tested.

Before test results could be considered satisfactory, both the Westinghouse Operations Manager and the CP&L Plant Superintendent were required to sign the official copy of the test record.

14.2.6 INDIVIDUAL TEST DESCRIPTIONS

Table 14.2.6-1 lists preoperational tests and their objectives. The acceptance criterion for all components and systems was that the test results were acceptable when the test objectives were met within the design specification limits and within the applicable Technical Specification.

Table 14.2.6-2 lists and summarizes tests conducted during the initial criticality and power escalation phase.

TABLE 14.2.6-1

TESTS PRIOR TO REACTOR FUELING

SYSTEM OR TEST	TEST OBJECTIVE
1. Switchgear System (Electrical Tests)	To ensure continuity, circuit integrity, and the correct and reliable functioning of electrical apparatus. Electrical tests will be performed on transformers, switchgear, turbine-generator, motors, cables, control circuits, excitation switchgear, DC System, annunciator system, lighting distribution switchboard, communication system and miscellaneous equipment. Special attention will be directed to the following tests: a. 480 V switchgear breaker interlock test b. Unit loss of voltage auto-transfer test c. Critical power transfer test d. Test of protective devices e. Equipment automatic start tests f. Check exciter for proper voltage build up
2. Voice Communication Systems	To verify proper communication between all intra plant stations, for interconnection to commercial phone service and to balance and adjust amplifiers and speakers.
3. Service Water System	To verify, prior to critical operations, the design head-capacity characteristics of the service water pumps, that the system will supply design flowrate through all heat exchangers, and will meet the specified requirements when operated as an engineered safety feature.
4. Fire Protection System	To verify proper operation of the system by ensuring the design specifications are met for the fire service booster pump and the fire service pumps, checking that automatic start functions operate as designed, and that level and pressure controls meet specifications.
5. Instrument and Service Air Systems	To verify the operation of all compressors to design specifications, the manual and automatic operation of controls at design setpoints, design air-dryer cycle time and moisture content of discharge air, and proper air pressure to each instrument served by the system.

TABLE 14.2.6-1 (continued)

SYSTEM OR TEST	TEST OBJECTIVE
6. Nitrogen Storage System	To verify system integrity, valve operability, regulating and reducing station performance and the ability to supply nitrogen to interconnecting systems as required.
7. Reactor Coolant System Cleaning (Inspection)	To flush and clean the reactor coolant and related primary systems to obtain the degree of cleanliness required for the intended service. Provisions to maintain cleanliness integrity and protection from contamination sources will be made after system cleaning and acceptance. The system, component, or section of a system shall be considered clean when the flush cloth shows no grindings, fillings or insoluble particulate larger than 40 microns (lower limit of naked eye visibility). After systems have been flushed clean of particulate matter within the limit specified, the cleanliness integrity of the system will be maintained filled with water which meets the system cold chemistry requirement. After fill and pressurization and prior to hot operation, cold chemistry requirements will be maintained. Oxygen will be analyzed prior to exceeding 200°F and brought into specification prior to exceeding 200°F.
8. Reactor Containment Air Circulating System	To verify, prior to critical operation, the fan capacities; and the remote and automatic operation of system louvers and valves in accordance with the design specifications.
9. Feedwater System	To verify valve and control operability and set points, flushing and hydro as applicable, inspection for completeness and integrity. Functional testing will be performed when a steam supply is available.
10. Condensate Circulation Systems	To verify valve and control operability and set points, flushing and hydro as applicable, inspection for completeness and integrity. Functional testing will be performed when a steam supply is available.

TABLE 14.2.6-1 (continued)

SYSTEM OR TEST	TEST OBJECTIVE
11. Auxiliary Coolant System	To verify component cooling flow to all components, and to verify proper operation of instrumentation, controllers and alarms. Specifically each of the three loops, i.e., component cooling loop, residual heat removal loop, and spent fuel pit cooling loop, will be tested to ensure: a. All manual and remotely operated valves are operable manually and/or remotely b. All pumps perform their design functions satisfactorily c. All temperature, flow, level and pressure controllers function to control at the required setpoint when supplied with appropriate signals d. All temperature, flow, level and pressure alarms provide alarms at the required locations when the alarm setpoint is reached, and clear when the reset point is reached e. Design flow rates established through heat exhangers.
12. Chemical Feed System	To verify valve and control operability and setpoints, flushing and hydro as applicable, inspection for completeness and integrity. Functional testing will be performed when a steam supply is available.
13. Chemical and Volume Control System (CVCS)	To verify, prior to critical operation, that the CVCS functions as specified in the system description. More specifically that: a. All manual and remotely operated valves are operable manually and/or remotely b. All pumps perform to specifications c. All temperature, flow, level and pressure controllers function to control at the required setpoint when supplied with appropriate signal(s) d. All temperature, flow, level, and pressure alarms provide alarms at the required locations when the alarm setpoint is reached, and clear when the reset point is reached

TABLE 14.2.6-1 (continued)

SYSTEM OR TEST	TEST OBJECTIVE
	e. The reactor make-up control controls blending, dilution, and boration as designed
	f. The design seal water flow rates are attainable to each reactor coolant pump
	g. The boric acid evaporator package functions as specified.
14. Containment Spray	To verify performance of the containment spray pumps.
15. Safety Injection System (SIS)	To verify prior to critical operation, response to control signals and sequencing of the pumps, valves, and controllers of this system as specified in the system description, and check the time required to actuate the system after a safety injection signal is received. More specifically that:
	a. All manual and remotely operated valves are operable manually and/or remotely
	b. All pumps perform their design functions satisfactorily
	c. For each pair of valves to redundant flow paths, disabling one of the valves does not impair remote operation of the other
	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 requiring coincidence signals of safety injection and high containment pressure operate when supplied with these signals
	g. All level and pressure units are set at the specified points and provide alarms at the required location(s); and reset at the specified point
	h. The time required to actuate the system is within the design specifications.

TABLE 14.2.6-1 (continued)

SYSTEM OR TEST	TEST OBJECTIVE
16. Fuel Handling and Refueling Equipment Systems	To show that the system design is capable of providing a safe and effective means of transporting and handling fuel from the time it reaches the plant until it leaves the plant. In particular the tests will be designed to verify that: a. The major structures required for refueling such as the reactor cavity, refueling canal, spent fuel storage and decontamination facilities are in accordance with the design specifications b. The major equipment required for refueling such as the manipulator crane, spent fuel pit bridge and fuel transfer system, operate in accordance with the design specifications c. All auxiliary equipment and instrumentation function properly.
17. Reactor Containment High Pressure Test	To verify prior to critical operation, the tructural integrity and leak tightness of the containment.
18. Cold Hydrostatic Tests	To verify the integrity and leak tightness of the Reactor Coolant System and related primary systems with the performance of a hydrostatic test at the specified test pressure with no visible leakage, nor distortion.
19. Radiation Monitoring System	To verify the calibration, operability, and alarm setpoints of all radiation level monitors, air particulate monitors, gas monitors and liquid monitors which are included in the Operational Radiation Monitoring System and the Area Radiation Monitoring System.
20. Nuclear Instrumentation System	To ensure that the instrumentation system is capable of monitoring the reactor leakage neutron flux from source range through 120 percent of full power and that protective functions are operating properly. In particular the tests will be designed to verify that:

TABLE 14.2.6-1 (continued)

SYSTEM OR TESTTEST OBJECTIVE	
	a. All system equipment, cabling, and interconnections have been properly installed b. The source range detector and associated instrumentation respond to neutron level changes and that the source range protection (high flux level reactor trip) as well as alarm features and audible count rate operate properly c. The intermediate range instrumentation reactor protective and control features high level reactor trip and high level rod stop signals operate properly and that permissive signals for blocking source range trip and source range high voltage off operate properly d. The power range instrumentation operates properly and that the protective features such as the overpower trips, permissive and dropped-rod functions operate with the required redundancy and separation through the associated logic matrices, and nuclear power signals to other systems are available and operating properly e. All Auxiliary Equipment such as the comparator and startup rate channel, recorders, and indicators operate as specified f. All instruments are properly calibrated and all set points and alarms are properly set.
21. Radioactive Waste Disposal System	To verify satisfactory flow characteristics through the equipment; to demonstrate satisfactory performance of pumps and instruments; to check for leak-tightness of piping and equipment, and to verify proper operation of alarms, instrumentation and controls. More specifically that: a. All piping and components are properly installed as per design specifications b. All manual and automatic valves are operable

TABLE 14.2.6-1 (continued)

SYSTEM OR TEST	TEST OBJECTIVE
	c. All instrument controllers operate to control process at required values
	d. All process alarms are operable at required locations
	e. All pumps perform their design functions satisfactorily
	f. All pumps indication & controls are operable at designated stations
	g. The Waste Gas Compressor packages operate as specified
	h. The Gas Analyzer operates as specified
	i. The Waste Boiler operates as specified
	j. The Hydrogen & Nitrogen supply packages sufficient for all modes of operation.
22. Sampling Systems	To verify that a specified quantity of representative fluid can be obtained safely and at design conditions from each sampling point. In particular the test will be designed to verify that:
	a. All system piping and components are properly installed
	b. All remotely and manually operated valving operates in accordance with the design specifications
	c. All sample containers and quick-disconnect couplings function properly, and as specified.
23. Hot Functional Tests	The Reactor Coolant Systems will be tested to check heatup (using pump heat) and cooldown procedures; to demonstrate satisfactory performance of components prior to installation of the core; to verify proper operation of instrumentation, controllers and alarms; and to provide operating conditions for checkout of auxiliary systems.

TABLE 14.2.6-1 (continued)

SYSTEM OR TEST	TEST OBJECTIVE
	The Chemical and Volume Control System will be tested to determine that water can be charged at rated flow against normal Reactor Coolant System pressure; to check letdown flow against design rate for each pressure reduction station; to determine the response of the system to changes in pressurizer level; to check procedures and components used in boric acid batching and transfer operations; to check operation of the reactor makeup control; to check operation of the excess letdown and seal water flowpath; and to verify proper operation of instrumentation, controllers and alarms.
	The Sampling System will be tested to determine that a specified quantity of representative fluid can be obtained safely and at design conditions from each sampling point.
	The Auxiliary Coolant System will be tested to evaluate its ability to remove heat from reactor coolant; to verify component cooling flow to all components; and to verify proper operation of instrumentation, controllers and alarms.
	The Safety Injection System will be tested to check the time required to actuate the system after a safety injection signal is received; to check that pumps and motor operated valves are properly sequenced; and to verify proper operation of instrumentation, controllers and alarms.
	The Radioactive Waste Disposal System will be tested to verify satisfactory flow characteristics through the equipment; to demonstrate satisfactory performance of pumps and instruments; to check for leak-tightness of piping and equipment; and to verify proper operation of alarms.
	The Ventilation System will be tested to adjust proper flow characteristics of ducts and equipment; to demonstrate satisfactory performance of fans, filters, and coolers; and to verify proper operation of instruments and alarms.

TABLE 14.2.6-1 (continued)

SYSTEM OR TESTTEST OBJECTIVE	
24. Primary and Secondary System Safety Valves Tests	To test and set pressurizer and boiler safety and relief valves to ensure each valve lifts, relieves excess pressure and reseats.
25. Turbine Steam Seal and Blowdown Systems	To verify valve and control operability and setpoints, flushing and hydro as applicable, inspection for completeness and integrity. Functional testing will be performed when a steam supply is available.
26. Emergency Diesel Electric System	To demonstrate that the system is capable of providing power for operation of vital equipment under power failure conditions. In particular the tests will be designed to verify that: a. All system components have been properly installed b. The emergency diesel function according to the design specification under emergency conditions c. The emergency units are capable of supplying the required power to vital equipment under emergency conditions d. All redundant features of the system function according to the design specifications.
27. Reactor Coolant and Protection System	To verify calibration, operability and trip and alarm settings of reactor coolant and protection system. To test its operability in conjunction with other systems.
28. IVSW and Isolation Systems	To verify systems integrity, valve operability and system ability to perform design functions.
29. Penetration T Pressurization System	o verify system integrity, operability and ability for pressurization.

TABLE 14.2.6-2

INITIAL CRITICALITY AND POWER ESCALATION TESTS

Test	Conditions	Objectives	Acceptance Criteria
RCC Unit Drop Tests	a) Cold, Shutdown b) Hot, Shutdown	To measure the scram time of RCC units under full flow and no flow conditions	Droptime less than value assumed in Safety Analysis
Thermocouple/RTD Intercalibration	Various temperatures during system heatup at zero power	To determine in-place isothermal correction constants for all core exit thermocouples and reactor coolant RTD's	Sensors showing excessive deviations from average will be removed from service
Nuclear Design values Check Tests	All two dimensional RCC control group configurations at hot, zero power	To verify that nuclear design predictions for endpoint boron concentrations, isothermal temperature coefficients and power distributions are valid	*FFD and SAR limiting for $\delta\rho/\delta T$, $F \Delta H$
RCC Control Group values Calibration	All RCC control groups at hot, zero power	To verify that nuclear design predictions for control group differential worths with and without partial length RCC units are valid	FFD and SAR limiting for $\delta\rho/\delta h$, $\Delta\rho/h$
Power Coefficient Measurement	0% to 100% of full power	To verify that nuclear design predictions for differential power coefficients are valid	FFD and SAR limiting values for $\delta\rho/\delta q$
Automatic Control System Checkout	Approximately 20%	To verify the control system response characteristics for the: a) Steam generator level control system b) RCC automatic control system c) turbine control system	No safety criteria applicable

* Final Facility Description and Safety Analysis Report

TABLE 14.2.6-2 (continued)

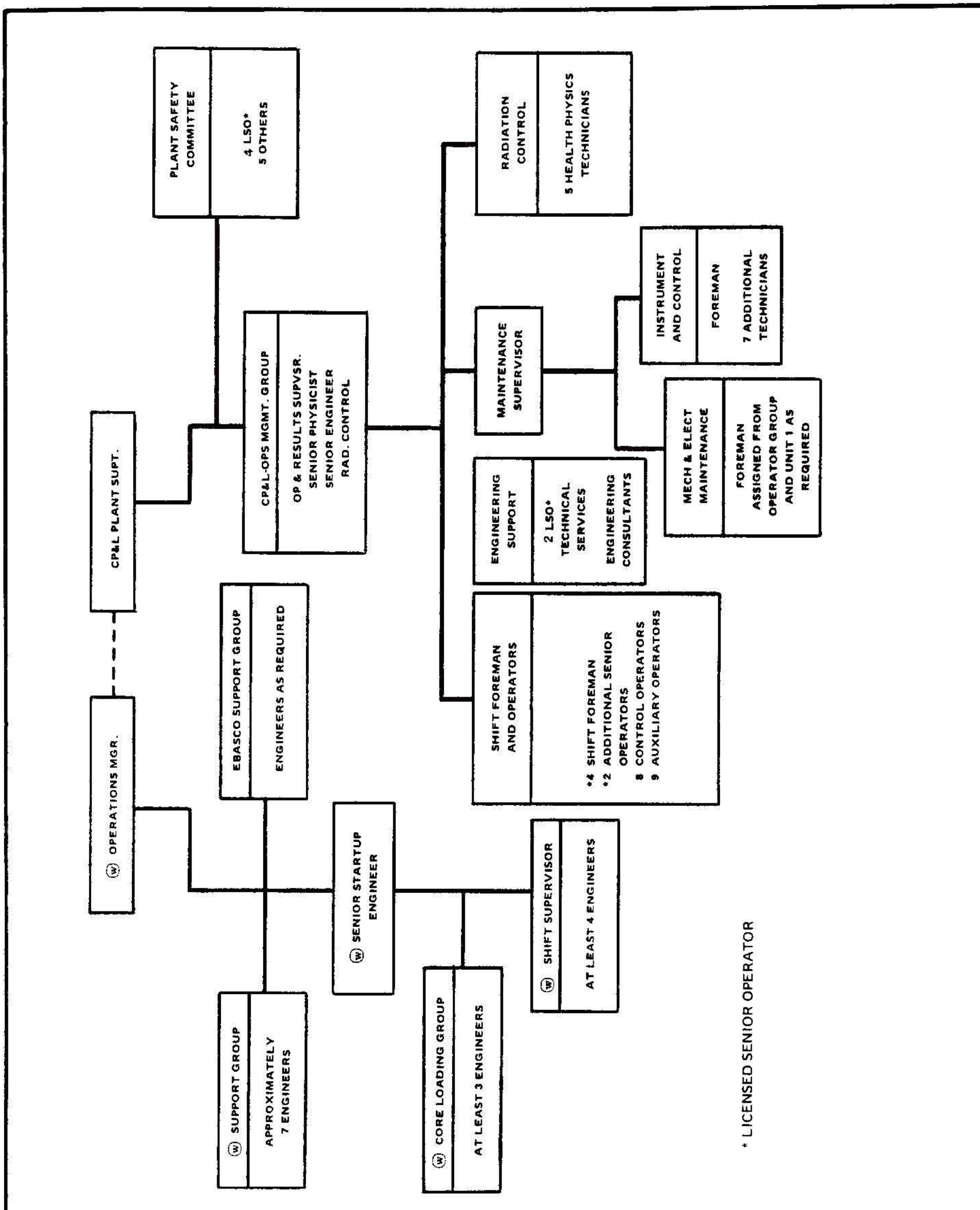
Test	Conditions	Objectives	Acceptance Criteria
Power Range Instrumentation Calibration	During static and/or transient conditions at: 30% 70% 90% 100%	To verify that all power range instrumentation consisting of: power range nuclear channels in-core flux mapping system core exit thermocouple system reactor coolant RTD's is responsive to changes in reactor power level and power distribution and to intercalibrate the several systems	Verify that allowable errors sited in Technical Specifications can be met
Load Swing Test	+10% steps at: - 40 - 50% -100%	To verify reactor control system performance	No safety criteria applicable
Plant Trip override	Full Load Rejection from: - 30%	To verify reactor control performance	Power operation of steam dump and feedwater
Pressurizer Effectiveness Test	Hot, shutdown	To verify that pressurizer pressure can be reduced at the required rate by pressurizer spray actuation	No safety criteria applicable
Circulation Tests (nuclear heat)	-7% of rated power both RCS pumps off	To verify that natural circulation is established	Enough natural circulation to remove long-term residual heat
Circulation Test (partial cooldown)	Shutdown-both RCS pumps off-one steam generator isolated	To verify ability to cooldown with natural circulation	Partial cooldown completed

TABLE 14.2.6-2 (continued)

Test	Conditions	Objectives	Acceptance Criteria
Minimum Shutdown Verification	Hot, zero power	To verify the nuclear design prediction of the minimum shutdown boron concentration with one "stuck" RCC unit	Verify stuck rod shutdown criteria
Pseudo Ejection values Test	Hot, zero power	To verify nuclear design predictions of effects on core reactivity and power distribution of ejection of one RCC unit from a fully inserted control group	FFD and SAR limiting for $F\Delta H$, reactivity insertion
Pseudo Ejection Test	-70% of rated power	To verify nuclear design predictions of effects on core reactivity and power distribution of ejection of one RCC unit from typical operating configuration.	FFD and SAR limiting values for $F\Delta H$, reactivity insertion
Power Redistribution Follow	-70% of rated power	To verify that excore nuclear instrumentation adequately monitors changes in core power distribution under transient xenon conditions.	FFD and SAR symmetric offset/F_3 correlation
Static RCC Drop Test	-70% of rated power	To verify that a single RCC unit inserted fully or part way below the control bank can be detected by excore nuclear instrumentation and core exit. Thermocouples under typical operating conditions and to provide bases for adjustment of protection system set points	Inserted rod detectable with instrumentation plant
RCC Insertion Test	-70% of rated power	To determine the effect of a single fully inserted RCC unit on core reactivity and core power distribution under typical operating conditions as bases for setting turbine runback limits	See next step

TABLE 14.2.6-2 (continued)

Test	Conditions	Objectives	Acceptance Criteria
Dynamic RCC Drop Test	-70% of rated power	To verify automatic detection of dropped rod, and subsequent automatic rod stop and turbine cutback	Required power reduction and rod withdrawal block accomplishment
Load Reduction Test	-50% reduction from -70% -50% reduction from 100%	To verify reactor control system	No safety criteria applicable
P/L Group Operational Maneuvering	-90%	To verify that the part-length RCC maneuvering scheme is effective in containing and suppressing spatial xenon transients	FFD and SAR limiting values for F_3, $F\Delta H$
Load Cycle Test	-40% to -85%	To verify that all plant systems are capable of sustaining load follow operations without encountering unacceptable operational limits through a typical weekly cycle	FFD and SAR limiting values for F_3, $F\Delta H$, shutdown margin
Turbo-Generator Startup Tests	Pre- and Post-Synchronization	To verify that the turbo-generator unit and associated controls and trips are in good working order and ready for service	Successful completion of all mechanical and electrical and control functional checks
Turbo-Generator	Power level sufficient for turbine auxiliaries to be operating	To verify normal trouble free performance of the turbo-generator at low power	Performance within manufacturers limitations
Control Valve Tests	-70% of rated power	To verify capability of exercising control valves at significant load and evaluate function of valves and controls	Normal trouble free operation
Acceptance Run	100 hours at rated full power	To verify reliable steady state full power capability	100 hours reliable equilibrium plant operation at full power



H. B. ROBINSON
UNIT 2
Carolina Power & Light Company
UPDATED FINAL
SAFETY ANALYSIS REPORT

H. B. ROBINSON UNIT 2

STARTUP AND TEST ORGANIZATION

FIGURE
14.2.2 - 1

14.3 RESULTS OF STARTUP TEST PROGRAMS

The startup test program for the unit was conducted satisfactorily, and the results compiled into a comprehensive report. This report was submitted to the AEC March 3, 1972 (Letter from E.E. Utley to Dr. P. A. Morris).