APPENDIX 14.2A

STARTUP TEST PROGRAM

GE TOPICAL REPORT 22A2130

TEST PROGRAM

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TITLE STARTUP TEST PROGRAM

INTRODUCTION

The startup test program for the Oyster Creek Nuclear Power Plant, Unit No. 1 of the Jersey Central Power and Light Company is specified in this document. Additions to the program may be authorized by the General Electric Site Manager. Deletions require approval from APED-San Jose. Detailed test procedures will be prepared to implement this program.

STARTUP TEST PHASES

The test program is composed of phases characterized by differences in plant and test conditions. Phase I consists of those tests which can be performed prior to loading fuel. This document deals with Phases II, III, IV, and V which include fuel loading and subsequent tests.

Phase I	Pre-Operational Tests
Phase II	Open Vessel Testing
Phase III	Initial Heatup
Phase IV	Power Tests
Phase V	Warranty Tests

TITLE STARTUP TEST PROGRAM

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Phase No.				Test	
II	III	IV	V	No.	Startup Test Title
X	X	X	X	1	Chemical and Radiochemical
X	X	X		2	Control Rod Drives
X				3	Fuel Loading
X				4	Shutdown Margin
X	X	X	X	5	Radiation Measurements
X				6	Vibration Measurements
X	X			7	Control Rod Sequence
X				8	SRM Performance
X	X			9	IRM Calibration
	X			10	Reactor Vessel Temperatures
	X	X		11	System Expansion
	X	X		12	Main Steam Isolation Valves
		X		13	Isolation Condenser
		X		14	Recirculation Pump
		X	X	15	Flow Control
		X		16	Turbine Generator Startup
		X		17	Turbine Trip
		X		18	Generator Trip
		X		19	Pressure Regulators
		X		20	Bypass Valves
		X		21	Feedwater Pumps
		X		22	Flux Response to Rods
		X		23	LPRM Calibration
		X		24	APRM Calibration
	X	X	X	25	Core Performance Evaluation
		X		26	Calibration of Rods
		X	X	27	Axial Power Distribution
		X		28	Rod Pattern Exchange
	X	X		29	Steam Separator-Dryer
			X	30	Electrical Output and Heat Rate

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Test No. 1 - Chemical and Radiochemical

Purpose

Monitor chemical and radioactivity conditions at assigned stations in the primary coolant, off-gas, exhaust, waste, and auxiliary systems to determine base levels and maintain proper conditions.

Description

Take a complete set of chemical and radiochemical samples to determine that all sample stations are functioning properly and to determine initial concentrations. Calibrate all radioactive effluent monitors and determine off-gas release rates; determine hydrogen, oxygen and air fractions of air ejector off-gas; make radiochemical determinations and activity balances during the high power continuous run.

Test No. 2 - Control Rod Drives

Purpose

Monitor hydraulic system and drive operation at temperatures and pressures from ambient to rated. Measure and record basic operating characteristics and adjust to assure proper operation under all conditions.

Description

Test and adjust the drive hydraulic system for proper pressure and flow regulation, and operating speed of drive mechanisms. Measure drive line friction on all drives at zero reactor pressure and at or near rated temperature and pressure. Measure normal scram time on all drives at zero and rated reactor pressure. Measure the scram times of four selected drives at two pressures between ambient and rated. Measure the scram times of the four drives with zero accumulator pressure at rated temperature and pressure.

Test No. 3 - Fuel Loading

Purpose

Load fuel safely and efficiently to the full core size.

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Description

Prior to fuel loading, control rods supported by dummy assemblies are installed and tested for operability. Temporary control curtains are inserted and a 10^7 neutron per second source is installed near the center of the core. At least three neutron detectors calibrated and connected to high flux scram trips, are located to produce acceptable signals during loading.

Fuel loading begins at the center of the core and proceeds radially to the fully loaded configuration such that no water holes occur. The following checks are performed as each cell is loaded.

1. Control Rod Operability Test - The rod in the cell to be loaded is completely withdrawn and then inserted.

2. Subcriticality Check - A high worth rod in the vicinity of the cell to be loaded is completely withdrawn to prove subcriticality and is then inserted.

3. Load Fuel - Load 2 fuel assemblies, remove 2 dummies and load 2 more fuel assemblies to complete the four assembly cell.

4. Repeat Subcriticality Check.

5. Repeat Control Rod Operability Test.

Shutdown margin demonstrations are performed periodically during fuel loading.

Test No. 4 - Shutdown Margin

Purpose

Demonstrate that the reactor is adequately shutdown with the strongest single control rod fully withdrawn.

Description

This test will be done at ambient temperature with fresh fuel in the xenon-free condition. Subcriticality will be demonstrated with the strongest rod fully withdrawn and a second adjacent rod at a position calculated to be equal to a shutdown margin specified to account for credible reactivity changes during core lifetime.

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TITLE STARTUP TEST PROGRAM

Test No. 5 - Radiation Measurements

Purpose

Assure that safe and acceptable radiation levels exist in accessible locations. Provide data to evaluate shielding calculations and activity buildup.

Description

Take gamma radiation level measurements at significant locations throughout the plant under reactor operating conditions. Where appropriate to location, take thermal and fast neutron dose rate measurements. Take radiation level measurements after the reactor is shutdown to confirm accessibility. Extensive surveys will be taken at hot standby, 50% and 100% power. Limited surveys will be made after first reaching each test power level.

Test No. 6 - Vibration Measurements

Purpose

Determine the vibration characteristics of reactor internals and recirculation loops induced by recirculation flow.

Description

Vibratory responses will be recorded at various recirculation flow rates at temperatures below 150°F using strain gages on fuel channels and control rod guide tubes, accelerometers on the flow baffle and recirculation loops and linear differential transducers on the upper shroud and steam separator.

Test No. 7 - Control Rod Sequence

Purpose

Establish acceptable control rod withdrawal sequences.

Description

The reactor is made critical by withdrawing control rods in a specified sequence. Reactivity addition rates are measured near cold critical for two or three rods in each of two sequences. Record critical rod position versus temperature during heatup.

TITLE STARTUP TEST PROGRAM

Test No. 8 - SRM Performance

Purpose

Demonstrate that the operational sources, startup instrumentation, and rod withdrawal sequence provide adequate information to the operator during a normal startup.

Description

The operational neutron sources are installed and startup channel count-rate data are taken during rod withdrawals to critical and compared with stated criteria on signal and a signal-to-noise ratio.

Test No. 9 - IRM Calibration

Purpose

Power calibrate the IRM instrumentation based on thermal data obtained during initial heatup.

Description

Heat the reactor system using the recirculation pumps. Then heat the system at about 20°C/hr by nuclear power. Determine reactor thermal power from the rate of system heating while at constant reactor power. Determine system heat capacity and estimate system heat losses.

Test No. 10 - Reactor Vessel Temperatures

Purpose

Assure that thermal stress on the reactor pressure vessel is not excessive during startup and shutdown.

Description

Monitor temperature readings from thermocouples at various locations on vessel during vessel heatup and cooldown. Specify allowable heating and cooling rates based on measured vessel temperature gradients and vessel restrictions.

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Test No. 11 - System Expansion

Purpose

Determine that thermal expansion of various equipment and piping of the NSSS and auxiliaries is not restricted.

Description

Observe and record the horizontal and vertical positions of major equipment and piping in the NSSS to assure components are free to move as designed. Adjust as necessary for freedom of movement.

Test No. 12 - Main Steam Isolation Valves

Purpose

Determine the operational characteristics of the main steamline isolation valves and the effects on the plant of isolation valve closure.

Description

Determine the leak tightness and closure times for each of the valves at different steam flow rates. Determine reactor heat losses following isolation valve closures and record reactor pressure, steamline pressure, steam flow, power, feedwater flow and reactor water level.

Test No. 13 - Isolation Condenser

Purpose

Determine the performance characteristics of each of the two isolation condensers individually.

Description

Determine the time delay before operation, the heat removal rate and the leak tightness of the systems.

TITLE STARTUP TEST PROGRAM

Test No. 14 - Recirculation Pump Trips

Purpose

Evaluate reactor system steady state and transient responses to recirculation pump trips at rated temperature and pressure.

Description

Trip one recirculation pump at 50% power and five pumps simultaneously at 50, 75 and 100% power. All trips are from the full flow condition. Record reactor pressure, steam and feedwater flow and neutron flux at steady state conditions and during the transients.

Test No. 15 - Flow Control

Purpose

Determine the plant and instrument power responses to recirculation flow control.

Description

Recirculation flow rate will be decreased and increased at chosen rates from full flow near 50, 75 and 100% power and from chosen flow rates in the full power rod pattern to determine power responses. Ramp load increases and decreases will be made to satisfy the specified warranty on plant load following capability.

Test No. 16 - Turbine Generator Startup

Purpose

To verify proper operation of the turbine generator system.

Description

The turbine generator unit will be brought up to speed. Vibration, expansion, and the temperature distributions will be monitored. Component operation will be checked and adjustments made in the settings of the turbine generator unit and bypassed controls.

TITLE STARTUP TEST PROGRAM

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Test No. 17 - Turbine Trip

Purpose

Determine reactor and bypass system response to turbine trip.

Description

Neutron flux, feedwater flow and temperature, vessel water level and pressure will be monitored following turbine trips. Response of selected control stop, and bypass valves will be recorded.

Test No. 18 - Generator Trip

Purpose

Determine reactor response and turbine overspeed following a generator trip.

Description

After tripping the main generator breaker, measure turbine overspeed characteristics and neutron flux and system pressure rise.

Test No. 19 - Pressure Regulators

Purpose

Determine the response of the reactor and the turbine governor system to the operating pressure regulator and the backup pressure regulator.

Description

A step change will be made to the operating pressure regulator set point and the response of the system will be measured. The backup regulator will be tested by increasing the operating pressure regulator set point rapidly until the backup regulator takes over control. The response of the system will be measured and evaluated and regulator settings will be optimized.

Test No. 20 - Bypass Valves

Purpose

Demonstrate the ability of the pressure regulator to minimize the reactor pressure disturbance during an external change in the steam flow.

Description

One of the turbine bypass valves will be tripped open by a test switch. The

transient will be measured and evaluated and final adjustments to the pressure regulator made.

Test No. 21 - Feedwater Pumps

Purpose

Determine the effect of changes in subcooling on core power initiated by changes in the feedwater system.

Description

Record transients as reactor water level is decreased rapidly from a high level and then increased rapidly from a low level. Below 75% power, record transients as one of three operating feedwater pumps is tripped off and then turned on.

Test No. 22 - Flux Response to Rods

Purpose

Demonstrate stability in the power-void loop with increasing reactor power and to determine the effect of control rod movement on reactor stability.

Description

The rectified mean neutron flux noise from a centrally located LPRM will be measured at various steady state power levels. A centrally located rod will be moved and the signals from nearby LPRM chambers recorded and analyzed for stability.

Test No. 23 - LPRM Calibration

Purpose

Calibrate the local power distribution monitoring system.

Description

The calibration procedure begins with neutron flux distribution measurements by the TIP system and results in a set of correction factors used to reset amplifier gains. Calibrations will be performed at 25, 50 and 100% power.

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Test No. 24 - APRM Calibration

Purpose

To calibrate the power level monitoring system

Description

A heat balance will be made at least once each shift and after each major power level change. The APRM system will be adjusted as necessary to be consistent with the heat balance data.

Test No. 25 - Core Performance Evaluation

Purpose

Determine core power level, maximum heat flux, and minimum critical heat flux ratio at various power levels.

Description

Plant and in-core instrumentation, conventional heat balance techniques, and core performance worksheets and nomograms are used. Determine core power level, maximum heat flux, recirculation flow rate, hot channel coolant flow, minimum critical heat flux ratio, fuel assembly power and steam qualities at existing power levels and assumed overpower conditions. This is performed above 10% power and at various pumping conditions.

Test No. 26 - Calibration of Rods

Purpose

Obtain reference relationships between control rod motion and reactor power in standard sequences.

Description

Single rods and groups of four symmetric rods are moved in discrete steps, and electrical power and steam flow are recorded at each step. Up to four groups of rods will be evaluated consistent with Rod Worth Minimizer requirements. Monitor response of LPRM and APRM systems to rod motion.

TITLE STARTUP TEST PROGRAM

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Test No. 27 - Axial Power Distribution

Purpose

Obtain axial power distributions at various conditions of rod pattern, power, recirculation flow rate, and subcooling.

Description

Axial flux distribution measurements will be made with TIP system before and after significant changes are made in chosen parameters.

Test No. 28 - Rod Pattern Exchange

Purpose

Perform a representative change in basic rod pattern at a high reactor power level.

Description

The control rod pattern is exchanged by control rod insertions and withdrawals in a planned sequence. This will be done at a reduced power starting from rated power in one control rod withdrawal sequence and will end with the reactor at rated power in a rod pattern in the alternate withdrawal sequence.

Test No. 29 - Steam Separator-Dryer

Purpose

Determine carryunder and carryover characteristics of the steam separator-dryer.

Description

Samples will be taken from the inlet and outlet of the steam dryers, and the inlet to the steamline at hot standby, 50, 75, and 100% power at chosen water levels and recirculation flow rates. Carryover will be determined from Na-24 activities in these samples and in the reactor water. Carryunder will be determined from measured flows and temperatures by heat balances.

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Test No. 30 - Electrical Output and Heat Rate

Purpose

Demonstrate that the plant net electrical output and net heat rate requirements are satisfied.

Description

Operate continuously for 100 hours at or above 515 MWe net output at conditions prescribed in the plant net electrical output warranty. Demonstrate over a 2 hour period, at conditions prescribed in the plant net heat rate warranty, that the net heat rate is not greater than 10,600 Btu/kwh.

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TITLE STARTUP TEST PROGRAM

Phase I - Preoperational Tests

Tests	Those tests for which meaningful and adequate measurements can be obtained without fuel loaded are scheduled as preoperational tests.
Final Stages Prior to Fuel Loading	Install drives, curtains, blades, dummies, and vibration sensors, checkout reactor protection system.

Phase II - Open Vessel Tests

Temp. °F		Test Title	Description
Ambient	1.	Chemical and Radiochemical	Establish base measurements and calibrate monitors. Maintain water purity throughout test program.
"	2.	Control Rod Drives	Perform timing, coupling, position indicator and functional checks.
"	5.	Radiation Measurements	Background measurements.
"	3.	Fuel Loading	Install test source and temporary in-vessel detectors. Load fuel demonstrating adequate shutdown margin periodically.
"	4.	Shutdown Margin	Verify required shutdown margin.
"	6.	Vibration	Install separator and separator vibration sensors. Perform vibration tests. Remove separator and all vibration sensors.
"	2.	Control Rod Drives	Timing, scram, and friction tests.
"	7.	Control Rod Sequences	Measure notch worths of in-sequence rods for both sequences.

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TITLE STARTUP TEST PROGRAM

Temp. °F		Test Title	Description
Ambient	8.	SRM Performance	Install operational sources. Calibrate SRM and IRM. Determine SRM response to rod withdrawal for both sequences.
"		Outage	Install separator dryer and dryer test equipment, vessel head, drywell head, check reactor auxiliaries, reactor protection system checkout.

Phase III - Heatup Tests

Temp. °F		Test Title	Description
Ambient to Rated	9.	IRM Calibration	Heat with combinations of pumps and nuclear power to obtain power calibration of IRM.
"	7.	Control Rod Sequence	Record rod position versus temperature.
"	10.	Reactor Vessel Temperature	Continuously monitor vessel temperatures to assure compliance with requirements.
"	11.	System Expansion	Continuously monitor expansion to assure free motion.
"	2.	Control Rod Drives	Scram test 4 drives periodically.
Rated	25.	Core Performance Evaluation (CPE)	Heat balance.
"	29.	Steam Separator-Dryer	System checkout.
"	5.	Radiation Measurements	Surveys.
"	2.	Control Rod Drives	Timing, scram and friction tests.

TITLE STARTUP TEST PROGRAM

Phase IV - Power Tests

MWt		Test Title	Description
Rated Temp.		Increase Power	To 200 MWt with nuclear heat.
200	25.	Core Performance Evaluation (CPE)	Heat balance.
"	23.	LPRM Calibration	Preliminary calibration.
"	24.	APRM Calibration	Preliminary calibration.
"	13.	Isolation Condenser	Determine performance of each condenser separately.
"		Increase Power	To 400 MWt.
400	25.	CPE	Heat balance.
"	24.	APRM Calibration	Set to power level.
"	5.	Radiation Measurements	Limited survey.
"	27.	Axial Power Distribution	TIP traces.
"	25.	CPE	MCHFR evaluation.
"	23.	LPRM Calibration	Detailed calibration.
"	24.	APRM Calibration	After LPRM adjustments.
"	26.	Calibration of Rods	Power and steam flow response.
"	19.	Pressure Regulators	Response to step change and test of takeover of backup regulator.
"	20.	Bypass Valves	Trip one open.
"	21.	Feedwater Pumps	Set point changes.
"	22.	Flux Response to Rods	Noise and transient measurements

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TITLE STARTUP TEST PROGRAM

MWt		Test Title	Description
400	12.	Main Steam Isolation Valves	Functional tests.
"	16.	Turbine Generator Startup	Begin here or earlier with pressure above 600 psi.
"		Increase Power	To 800 MWt.
800	25.	CPE	Heat balance.
"	24.	APRM Calibration	Set to power level.
"	27.	Axial Power Distribution	TIP traces.
"	25.	CPE	MCHFR.
"	23.	LPRM Calibration	Detailed calibration.
"	24.	APRM Calibration	After LPRM adjustments.
"	26.	Calibration of Rods	Power and steam flow response.
"	19.	Pressure Regulator	Response to step change and test of takeover of backup regulator.
"	20.	Bypass Valve	Trip one open.
"	21.	Feedwater Pumps	Set point change.
"	22.	Flux Response to Rods	Noise and transient measurements.
"	14.	Recirculation Pumps	Trip 1 of 5 operating pumps; trip 5 of 5 operating pumps, restart 5.
"	15.	Flow Control	Trace load following curve.
"	29.	Steam Separator-Dryer	Carryover and carryunder tests.
"	5.	Radiation Measurements	Complete survey.
"	17.	Turbine Trip	Record transients.
"	18.	Generator Trip	Record transients.

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TITLE STARTUP TEST PROGRAM

MWt		Test Title	Description
800		Increase Power	To 1200 MWt.
1200	25.	CPE	Heat balance.
"	24.	APRM Calibration	Set to power level.
"	27.	Axial Power Distribution	TIP traces.
"	25.	CPE	MCHFR.
"	19.	Pressure Regulator	Response to step change and test of takeover of backup regulator.
"	20.	Bypass Valves	Trip one open.
"	21.	Feedwater Pumps	Set point change and trip.
"	22.	Flux Response to Rods	Noise and transient measurements.
"	14.	Recirculation Pumps	Trip 5 of 5 operating pumps, restart 5.
"	15.	Flow Control	Trace load following curve.
"	29.	Steam Separator-Dryer	Carryover and carryunder tests.
"	17.	Turbine Trip	Record transients.
"	18.	Generator Trip	Record transients.
"	12.	Main Steam Isolation Valves	Functional tests.
"		Increase Power	To 1600 MWt.
1600	25.	CPE	Heat balance.
"	24.	APRM Calibration	Set to power level.
"	27.	Axial Power Distribution	TIP traces.
"	25.	CPE	MCHFR.

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TITLE STARTUP TEST PROGRAM

MWt		Test Title	Description
1600	23.	LPRM Calibration	Detailed calibration.
"	24.	APRM Calibration	After LPRM calibration.
"	26.	Calibration of Rods	Power and steam flow response.
"	19.	Pressure Regulator	Step change and backup takeover.
"	20.	Bypass Valves	Trip one open.
"	21.	Feedwater Pumps	Set point change.
"	22.	Flux Response to Rods	Noise and transient measurements.
"	29.	Steam Separator-Dryer	Carryover and carryunder measurements.
"	5.	Radiation Measurements	Complete survey.
"	1.	Chemical and Radiochemical	Complete complement of measurements.
"	14.	Recirculation Pumps	Trip 5 of 5 operating pumps, restart 5.
1600 to 640	15.	Flow Control	Trace flow control curve in full power rod pattern.
1200	19.	Pressure Regulator	*Step change and backup takeover.
"	20.	Bypass Valves	*Trip one open.
"	21.	Feedwater Pumps	*Set point change.
"	22.	Flux Response to Rods	*Noise and transient measurements.
"	27.	Axial Power Distribution	*TIP traces.
"	29.	Steam Separator-Dryer	*Carryunder measurement.
"		Increase Power	To 1600 MWt by returning to full flow.
1600	2.	Control Rod Drives	Scram time measurements.

* Full power rod pattern at reduced flow rate.

TITLE STARTUP TEST PROGRAM

MWt		Test Title	Description
1600	17.	Turbine Trip	Record transients.
"	18.	Generator Trip	Record transients.
"	28.	Rod Pattern Exchange	Exchange patterns at reduced power.
"	27.	Axial Power Distribution	TIP traces following pattern exchange.
"	25.	CPE	MCHFR.
"	12.	Main Steam Isolation Valves	Functional tests.

Phase V - Warranty Tests

MWt		Test Title	Description
1600	25.	CPE	Heat balance and MCHFR.
"	24.	APRM Calibration	Set to power level.
"	30.	Electrical Output and Heat Rate	Warranty measurements.
"	5.	Radiation Measurements	Limited radiation measurements.
"	15.	Flow Control	Load following warranty.