

START-UP PROCEDURE 90.4

UNIT NO. 2

EFFECT OF S/G SECONDARY SIDE ISOLATION ON NATURAL CIRCULATION

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OBJECTIVES

- 1.1 Determine the effect of Steam Generator Isolation on Natural Circulation conditions.
- 1.2 Verify that natural circulation can provide sufficient flow to remove decay heat after a partial loss of heat sink.
- 1.3 Verify that natural circulation can be re-established in the primary loop after the Steam Generator is returned to service.
- 1.4 To provide operator experience with natural circulation operations. As many licensed operators as practical shall perform or observe this procedure.
- 1.5 To provide a vehicle for conducting an isothermal temperature coefficient measurement at reduced T_{avg} . This measurement is not an objective if the special test program per se. However, the opportunity to make this measurement will be taken, at the discretion of the T/E, in conjunction with the W NTD/Nuc Ops engineer present.

REFERENCE

- 2.1 SUP 90.0 Natural Circulation Special Tests Sequencing Document
- 2.2 SUP's 90.3/90.5, Natural Circulation with Decreasing Pressure.
- 2.3 SUP 90.9A, "Forced Circulation Cooldown".
- 2.4 SUP 80.1, "NSSS Startup Sequence".
- 2.5 Unit 2 Technical Specification
- 2.6 Salem Operating Instructions
 - 2.6.1 OI II-1.3.1, "RCP Operation", Rev. 1.
- 2.7 Westinghouse P.L.S. for NSSS, Rev. 7.

PREREQUISITES

- 3.1 Brush recorders (or equivalent) are connected as per section 8.2 and calibrated.
- 3.2 The W reactivity computer is operable recording reactivity, flux, and T_h and T_c (wide range) as outlined in section 8.3.
- 3.3 The P-250 trend recorder is in operation recording the parameters listed in Appendix A.
- 3.4 SUP's 90.3 and 90.5 have been completed and the saturation meter is operational, and calibrated by virtue of these test completions.
- 3.5 The Test Engineer has briefed all personnel involved in the conduct of the test.
- 3.6 Station QA has been notified of the start of this test.
- 3.7 The special operator instructions given in SUP 90, Section 9.1.4 are posted conspicuously in the control room.
- 3.8 The S/G Lo-Lo and lo level reactor trip setpoints have been reset to 5%.
- 3.9 The NIS power range high flux (low setpoint). Trip setpoint has been reset to .583 volts and the intermediate range high flux trip has been reset to 28 μ a. These setpoints are equivalent to 7% RTP.

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INITIAL CONDITIONS

- ___ 4.1 The reactor is critical at HZP test condition as per the low power physics testing program, approximately 5×10^{-6} ICA
- ___ 4.2 Bank D at approximately 160 steps with rod control in Bank D select.
- ___ 4.3 All four RCP's are operating
- ___ 4.4 Feedwater to the Steam Generators is supplied by the Auxiliary Feed System with level maintained at about 33% (N.R.).
- ___ 4.5 Steam Generator chemistry conditions are established to permit securing blow-down for the duration of the test.
- ___ 4.6 Steam pressure is maintained as directed by the Test Engineer, using condenser steam dump in the steam pressure mode of control, at 1005 psig.
- ___ 4.7 The Pressurizer Level control is in automatic maintaining level at about 22%.
- ___ 4.8 Charging and Letdown are in normal service.
- ___ 4.9 Incore T/C presentation showing hottest T/C (Test 41) is displayed on the P-250 video screen.
- ___ 4.10 The boron concentration of the pressurizer and RCS are within 20 ppm.
- ___ 4.11 Three RCS boron analyses taken at 20 minute intervals are equal to within 10 ppm.
- ___ 4.12 Reactivity as displayed on the W reactivity computer is approximately zero and constant.
- ___ 4.13 Pressurizer pressure control (P-ref) setpoint reduced to 2100 psig.

ENVIRONMENTAL CONDITIONS

5.1 Atmospheric steam dump may be required during the performance of this procedure.

6.0 ACCEPTANCE CRITERIA

- 6.1 Sufficient natural circulation can be maintained in the active primary loops to maintain stable temperatures following partial loss of heat sink.
- 6.2 Natural Circulation can be restored to inactive loops when the associated Steam Generators are returned to service.
- 6.3 The posted maintenance criteria established in SUP 90.0, para 9.1.4 are maintained throughout this test.

SPECIAL TEST EQUIPMENT

7.1 Three Brush 260 (or equivalent) chart recorders, connected per section 8.0

<u>Recorder No.</u>	<u>S/N</u>	<u>Cal. Date</u>
<u>1</u>	<u> </u>	<u> </u>
<u>2</u>	<u> </u>	<u> </u>
<u>3</u>	<u> </u>	<u> </u>

7.2 Westinghouse reactivity computer

Recorder #1	<u> </u>	<u> </u>
Recorder #2	<u> </u>	<u> </u>
Recorder #3	<u> </u>	<u> </u>
Recorder #4	<u> </u>	<u> </u>
Recorder #5	<u> </u>	<u> </u>
X-Y plotter	<u> </u>	<u> </u>

DATA COLLECTION

- 8.1 All data acquired as a result of performance of this procedure shall be recorded at the appropriate step, or attached data sheets, or affixed as appropriate.
- 8.2 Brush recorder data point. Mark each chart with test No., Date/Time, Recorder Number, Chart Speed. Mark portions of the traces with the step no. to which they are associated, as the test progresses.

8.2.1	<u>Recorder No. 1</u>	<u>Inst.</u>	<u>Parameter</u>	<u>Range</u>
	Channel No. 1	FT-414	RCS Loop Flow 21	0-10%
	Channel No. 2	FT-424	RCS Loop Flow 22	0-10%
	Channel No. 3	FT-434	RCS Loop Flow 23	0-10%
	Channel No. 4	FT-444	RCS Loop Flow 24	0-10%
	Channel No. 5	PT-474	Pressurizer Pressure	1600-2400 psig
	Channel No. 6	LT-461	Pressurizer Level	0-100%

8.2.2	<u>Recorder No. 2</u>	<u>Inst.</u>	<u>Parameter</u>	<u>Range</u>
	Channel No. 1	FA-1087	Aux. Feedwater Flow to S/G 21	0-300 gpm
	Channel No. 2	LT-517	S/G 21 Level	0-10%
	Channel No. 3	PT-516	S/G 21 Pressure	700-1200 psig
	Channel No. 4	FA-1091	Aux. Feedwater Flow to S/G 22	0-300 gpm
	Channel No. 5	LT-527	S/G 22 Level	0-70%
	Channel No. 6	PT-526	S/G 22 Pressure	800-1200 psig

8.2.3	<u>Recorder No. 3</u>	<u>Inst.</u>	<u>Parameter</u>	<u>Range</u>
	Channel No. 1	FA-1095	Aux. Feedwater Flow to S/G 23	0-300 gpm
	Channel No. 2	LT-537	S/G Level	0-100%
	Channel No. 3	PT-536	S/G 23 Pressure	700-1200 psig
	Channel No. 4	FA-1097	Aux. Feedwater Flow to S/G 24	0-300 gpm
	Channel No. 5	LT-547	S/G 24 Level	0-100%
	Channel No. 6	PT-546	S/G 24 Pressure	700-1200 psig

8.3 Reactivity Computer Chart Recorders

8.3.1	Recorder #1	Channel A	P-Computer Output
		Channel B	N-44 excore detector current
8.3.2	Recorder #2	Channel A	Loop 21 T _c TE-413B 510-610°F
		Channel B	Loop 21 T _h TE-413A 510-610°F
8.3.3	Recorder #3	Channel A	Loop 22 T _c TE-423B 510-610°F
		Channel B	Loop 22 T _h TE-423A 510-610°F
8.3.4	Recorder #4	Channel A	Loop 23 T _c TE-433B 510-610°F
		Channel B	Loop 23 T _h TE-433A 510-610°F

8.3.5 Recorder #5 Channel A Loop 24 T_c TE-443B 510-610°F
Channel B Loop 24 T_h TE-443A 510-610°F

8.3.6 X-Y plotter
X - input connected to loop 21 wide-range T_c (TE-413B)
Y - input connected to p - computer output.

- 8.4 Copies of the reactivity computer trace and saturation meter recorder will be marked and attached as data.
- 8.5 P-250 trend typewriter data covering the duration of this test will be attached. (See Appendix A for data points)
- 8.6 P-250 computer printouts of the incore thermocouple maps taken during the performance of the test will be attached.
- 8.7 P-250 computer printouts of the single pass partial core maps used during the test for core power determination will be attached as data.
- 8.8 A record of licensed operators participating and observing this test is attached as Appendix B.
- 8.9 Data acquisition steps need not be re-performed for multiple test performances done for training purposes. Place NA on the initial lines for these steps. However, flux map and incore T/C map printouts shall be taken during training runs, and shall be marked as training runs. It is recommended that the test engineer leave all other data acquisition systems (e.g. reactivity computer recorder) operative during the training runs as well.

PRECAUTIONS

- 9.1 Observe the precautions, limitations, and special operator instructions given in SUP-90.0, sections 9.1.4, and 9.4 (ref. 2.1)
- 9.2 Do not exceed a primary to secondary differential pressure of 1600 psi.
- 9.3 Maintain lithium concentration in the RCS at the high end of the allowable range (2.0 - 2.2 ppm).
- 9.4 Avoid sudden changes in Auxiliary Feed Flow to operating Steam Generators.
- 9.5 If plant parameters fail to stabilize or if responses exceed predictions substantially, terminate the test.
- 9.6 Have Auxiliary Spray in service prior to tripping RCP's. Spray flow can be controlled with the spray valve and/or by adjusting charging flow control.
- 9.7 Caution should be exercised in maintaining the desired power level due to flux shadowing of the excore detectors by the decreased T_c . The expected magnitude of this effect is an approximate 1% decrease in indicated flux per °C drop in T_c .
- 9.8 It is expected that polarity changes in moderator temperature coefficient as temperature is reduced will be observed isothermal temperature coefficient, however is expected to remain negative.
- 9.9 Do not allow T_{avg} to be reduced below 485°F.
- 9.10 Control bank D shall be inserted no deeper than 100 step withdrawn. Maintain rod control in "D Bank Select"
- 9.11 Do not restart RCP's unless the reactor is shutdown. For the purpose of this procedure, shutdown is defined as control bank D at zero steps.

INSTRUCTIONS

10.1 Cooldown

NOTE:

The pressure in the steam generator isolated in this test will rise to saturation pressure for T_H existing at that time. For this reason, plant conditions must be adjusted so that T_{av} is about 515°F.

- 10.1.1 Start the brush recorders on slow speed, noting date, time, recorder no., parameter range, test no., and run no. use slow chart speed (5 mm/min).
- 10.1.2 Start the P-250 digital trend recording parameters listed in Appendix A. Start the reactivity chart recorders, including the X-Y plotter.
- 10.1.3 Initiate a cooldown by increasing the rate of steam dump to obtain a cooldown rate of about 30°F/hour.

CAUTION:

Avoid sudden changes in Auxiliary Feed Flow rate or Steam Generator level.

NOTE:

Use control rods as necessary to maintain core power approximately constant. If boron addition becomes necessary to avoid reaching the rod insertion to 100 steps, use spray to keep the pressurizer boron concentration within 20 ppm of RCS concentration.

- 10.1.4 Upon reaching a T_{av} of 515°F, terminate the cooldown and allow the RCS to come to an equilibrium condition. Adjust Auxiliary Feed Flow to maintain S/G levels at about 33%.
- 10.1.5 Place pressurizer level control in manual and increase level and maintain approximately 26%.
- 10.1.6 Increase reactor power to approximately 1%. Use the single pass flux map procedure, ΔT indication and primary calorimetrics in addition to NI's to determine core power level. Note precaution 9.7.
- 10.1.7 Perform primary calorimetric using data sheet #1 from SUP 90.0 and calibrate power range NI's to reflect the calculated value, if deemed necessary by the T/E.

10.2 Establish Natural Circulation

- 10.2.1 Place pressurizer heaters in manual, off. Establish Auxiliary Spray flow to the pressurizer, and manually maintain pressure at about 2000 psig, using heaters and spray.

NOTE:

As natural circulation is established, pressurizer level will be allowed to rise as T_{avg} increases to maintain constant RCS water mass. Pressurizer level is expected to rise to approximately 35%.

- 10.2.2 Simultaneously trip all Reactor Coolant Pumps.
- 10.2.3 Adjust the setpoint of the steam pressure regulator for the steam dump controller to maintain steam pressure at about 765 psig.
- 10.2.4 Adjust the setpoints on all four atmospheric relief valves, 21-24 MS10's, to maintain steam pressure below 1025 psig when the Steam Generator is isolated.

10.3 Steam Generator Isolation

- 10.3.1 Isolate Steam Generator #21 by shutting 21MS167, and securing Auxiliary Feed Flow by shutting 21AF21.

CAUTION:

Do not exceed primary to secondary differential pressure of 1600 psi.

- 10.3.2 Isolate blowdown on S/G 21 by shutting 21GB4.
- 10.3.3 Re-establish equilibrium conditions, adjusting the feed flow to the remaining three S/G's so that their levels are held at about 33%.

CAUTION:

Avoid sudden changes in Auxiliary Feed Flow to operating Steam Generators.

- 10.3.4 When Natural Circulation has stopped in loop 21, verify that conditions have stabilized in the other three loops. The following parameter responses are expected.

T_H in all loops increase about 4°f above 4 loop temperature.

T_C in loop 21 increase to T_H

Pressurizer level will increase about 3%

Pressurizer pressure increase slightly, due to level increase

Incore T/C's will increase about 5°f

21 S/G steam pressure will increase, to as high as 1020 psig

CAUTION:

If plant parameters fail to stabilize, (this should take at least 30 minutes) or if the response exceeds predictions significantly, terminate this test.

Proceed to step 10.3.11.

Record the maximum ΔT observed in operating loops _____°F

Do I/C T/C map T/E evaluate for sufficient data.

- 10.3.5 Close 22MS167, 22GB4, and 22AF21, isolating No. 22 Steam Generator.

CAUTION:

Do not exceed a primary to secondary pressure differential of 1600 psi. Avoid sudden change in Auxiliary Feed Flow to 23 and 24 Steam Generators, while maintaining levels at about 33%.

- 10.3.6 Allow natural circulation conditions to stabilize. When flow has stopped in loop 22, verify that conditions have stabilized in the remaining two loops. The following parameter changes are expected:
 T_H in all loops increase about 6°F above 3 loop temperature.
 T_C in loop 22 will increase to T_H
Pressurizer level will increase about 5%
Pressurizer pressure will increase slightly
Incore T/C's will increase 6-10°F
Record the maximum ΔT observed in the operating loops _____°F

CAUTION:

Observe Precautions 9.2. Expected ΔT (as calculated by $T_H - T_C$) in operating loops is about 26°F. If parameters fail to stabilize or exceed predictions significantly, terminate the test.
Proceed to step 10.3.7.

- 10.3.7 Perform an incore T/C map, and, at the T/E's discretion, a full incore flux map. When the Test Engineer is satisfied that sufficient data has been collected, slowly reduce the setpoint on the 22MS10 valve. Begin steaming, and feeding 22 Steam Generator slowly, reducing Steam Generator pressure.
- 10.3.8 When Steam Generator 22 pressure is approximately equal to steam header pressure, open the steam stop bypass valve, 22MS18, and then open 22MS167. Steam Generator 22 blowdown may be re-established as required by Chemistry.
- 10.3.9 Close the 22MS10, stopping atmospheric relief.

NOTE:

This action will cause Steam Generator 23 and 24 to reduce their steam production. Adjust Auxiliary Feed flows to maintain S/G levels at about 33%.

- ___ 10.3.10 Allow Natural Circulation conditions to stabilize.
- ___ 10.3.11 Repeat steps 10.3.7 through 10.3.10 for Steam Generator No. 21.
- ___ 10.3.12 Stop chart recorders and P-250 digital trend recorder, and verify that they are all properly labelled per para 8.2.
- ___ 10.3.13 Insert control Bank D to zero step using manual rod control in Bank D select until the reactor is shutdown.
- ___ 10.3.14 Restart all four RCP's in accordance with reference 2.5.1, beginning with #23, 21, 22, then 24.
- ___ 10.3.15 Restore pressurizer pressure control to automatic, with the setpoint for Pref reset to 2235 psig. Return pressurizer level controls to Auto.
- ___ 10.3.16 Restore to normal the reactor protection system modified per prerequisites 3.5, 3.6, and 3.7 unless further testing is required. In this case, N/A the step and proceed to establish initial conditions for the next test.
- ___ 10.3.17 Record the names of licensed operators (RO's and SRO's) participating in or observing the test in Appendix B, as appropriate.
- ___ 10.3.18 Retrieve and attach recorder traces, P-250 printouts per paragraph 8.2-8.7 (see also para. 8.9)

11.0 TEST COMPLETION

11.1 Comments

11.2 Changes to SPM

11.3 Signature

_____ T/E _____ Date

_____ S/S _____ Date

_____ QA/QC _____ Date

_____ STA _____ Date

APPENDIX A
P-250 DIGITAL TREND PARAMETERS

<u>PARAMETER</u>	<u>COMPUTER POINT</u>
Pressurizer Pressure Channel 1	P0480A
Pressurizer Level Channel 1	L0480A
RCS Loop 21 Hot Leg Temperature	T0419A
RCS Loop 21 Cold Leg Temperature	T0406A
RCS Loop 22 Hot Leg Temperature	T0439A
RCS Loop 22 Cold Leg Temperature	T0426A
RCS Loop 23 Hot Leg Temperature	T0459A
RCS Loop 23 Cold Leg Temperature	T0446A
RCS Loop 24 Hot Leg Temperature	T0479A
RCS Loop 24 Cold Leg Temperature	T0466A
Steam Generator 21 Pressure	P0400A
Steam Generator 21 Narrow Range Level	L0400A
Steam Generator 22 Pressure	P0420A
Steam Generator 22 Narrow Range Level	L0420A
Steam Generator 23 Pressure	P0440A
Steam Generator 23 Narrow Range Level	L0440A
Steam Generator 24 Pressure	P0460A
Steam Generator 24 Narrow Range Level	L0460A
Power Range Channel 1 (Quadrant 1)	N0049A
Power Range Channel 2 (Quadrant 2)	N0050A
Power Range Channel 3 (Quadrant 3)	N0051A
Power Range Channel 4 (Quadrant 4)	N0052A
Hottest Incore Thermocouple	U0090A
Pressurizer Surge Line Temperature	T0482A

NOTE: At the discretion of the Test Engineer, a redundant computer point may be substituted where available.

