Progress Energy BRUNSWICK NUCLEAR PLANT

PLANT OPERATING MANUAL

VOLUME XXI

ABNORMAL OPERATING PROCEDURE

UNIT
2

2AOP-03.0

POSITIVE REACTIVITY ADDITION

REVISION 9

1.0 SYMPTOMS

1.1 An unexpected or unexplained rise in reactor power, indicated by the following:

- Rising neutron flux level
- Positive reactor period
- Rod block
- *LPRM UPSCALE* (A-06 1-8) is in alarm
- *APRM UPSCALE* (A-06 2-8) is in alarm
- *OPRM PBA/CDA ALARM* (A-05 5-8) is in alarm
- *OPRM UPSCALE TRIP* (A-05 6-8) is in alarm.

2.0 AUTOMATIC ACTIONS

Possible reactor scram due to high neutron flux.

3.0 OPERATOR ACTIONS

3.1 Immediate Actions

NOTE: **IF** possible, when changing core flow with two reactor recirculation pumps operating, maintain pump speed and jet pump loop flow mismatch within the allowable limit. Operation outside the mismatch limits is addressed in Step 3.2.10.

3.1.1 **IF** necessary to prevent a reactor scram, **THEN** **REDUCE** reactor power in accordance with 0ENP-24.0, Form 2, Immediate Reactor Power Reduction Instructions. ☐

3.1.2 **IF** reactor recirculation pump speed is rising, **THEN** **PLACE** the affected pump(s) *SCOOP TUBE A(B) LOCK* switch to *TRIP*. ☐

CAUTION

When an automatic initiation occurs, an ECCS subsystem or RCIC System shall **NOT** be shut down **OR** placed in manual until at least two independent indications are verified for one of the following conditions:

- Adequate core cooling is ensured.
- The initiation signal was **NOT** valid.
- The system is **NOT** functioning properly in the automatic mode.

3.1.3 **IF** HPCI **OR** RCIC is injecting **AND** operation is **NOT** required, **THEN SECURE** the system as necessary. ☐

3.0 OPERATOR ACTIONS

3.2 Supplementary Actions

NOTE: Reactor recirculation pump speed and jet pump loop flow mismatch should be maintained within the following limits:

- 20% speed and jet pump loop flows within 10% (maximum indicated difference 7.5 $x10^6$ lbs/hr) with total core flow less than $58x10^6$ lbs/hr
- 10% speed and jet pump loop flows within 5% (maximum indicated difference 3.5 $x10^6$ lbs/hr) with total core flow greater than or equal to $58x10^6$ lbs/hr

NOTE: Process Computer Point U2CPWTCF, when validated, is the primary indication of total core flow, and should be used for stability region compliance. If U2CPWTCF is invalid, U2NSSWDP or Attachment 1 may be used as an alternate indication of total core flow based on Core Plate dp.

NOTE: As the stability region is approached, Process Computer Point B018, Total Core Flow, and recorder 2B21-PDR/FR-R613, located on H12-P603, will read lower than Process Computer Point U2CPWTCF.

NOTE: The following computer screens may be used for reference:
- 802, Power/Flow - OPRM Operable - TLO
- 803, Power/Flow - OPRM Inoperable - TLO
- 804, Power/Flow - OPRM Operable - SLO
- 805, Power/Flow - OPRM Inoperable - SLO
- 806, Power/Flow - OPRM Operable - FWTR
- 807, Power/Flow - OPRM Inoperable - FWTR.

NOTE: Operation outside the analyzed regions of the power to flow map should be minimized.

3.2.1 **PERFORM** the following to determine the current operating point on the applicable Power-Flow Map:

1. **IF** reactor recirculation pump speed **AND** jet pump loop flow mismatch is within the allowable limits, **THEN DETERMINE** the current operating point using the applicable Power-Flow Map, as specified by 0ENP-24.0. ☐

3.0 OPERATOR ACTIONS

2. **IF** reactor recirculation pump speed **OR** jet pump loop flow mismatch is **NOT** within the allowable limits, **OR** the plant is in single loop operation, **THEN PERFORM** the following:

NOTE: To compensate for signal noise, an average of several core DP readings should be used. Process Computer Point B017 or ERFIS point B21DA014 is the preferred method for obtaining this average.

a. **IF** a valid total core flow is **NOT** available from U2CPWTCF **OR** U2NSSWDP, **THEN DETERMINE** total core flow using Attachment 1. ☐

b. **DETERMINE** the current operating point using the applicable Power-Flow Map, as specified by 0ENP-24.0. ☐

3.2.2 **IF** OPRM System is operable **AND** the current operating point is in the Scram Avoidance Region, **THEN** use one of the following methods to immediately exit the region:

NOTE: Total core flow should **NOT** exceed 45 x 10^6 lbs/hr (58%) in single loop operation.

NOTE: **IF** possible, when changing core flow with two reactor recirculation pumps operating, maintain pump speed and jet pump loop flow mismatch within the allowable limit. Operation outside the mismatch limits is addressed in Step 3.2.10.

CAUTION

IF operating in the Scram Avoidance Region, a reactor recirculation pump shall **NOT** be started to exit the region.

- **RAISE** core flow. ☐
- **INSERT** control rods in accordance with 0ENP-24.0, Form 2, Immediate Reactor Power Reduction Instructions. ☐

3.0 OPERATOR ACTIONS

R3

3.2.3 **IF** the temperature differential between the coolant within the dome and the bottom head drain can **NOT** be maintained less than 145°F during the performance of this procedure, **THEN INSERT** a manual reactor scram. ☐

3.2.4 **IF** OPRM System is inoperable, **THEN PERFORM** the following:

1. **IF** either of the following conditions are met, **THEN INSERT** a manual reactor scram:

   - The current operating point is in Region A ☐

NOTE: Instability may be indicated by any of the following:

- *OPRM PBA/CDA ALARM* (A-05 5-8) is in alarm
- *OPRM UPSCALE TRIP* (A-05 6-8) is in alarm
- A rise in baseline APRM noise level. SRM power level and period meters may also be oscillating at the same frequency
- LPRM and/or APRM upscale or downscale alarms being received
- Sustained reactor power oscillations with a peak to peak duration of less than 3 seconds.

R1

- Indications of thermal hydraulic instability exist **AND** the current operating point is in Region B, the 5% Buffer Region, or the OPRM Enabled Region. ☐

3.0 OPERATOR ACTIONS

CAUTION

IF operating in Region B, a reactor recirculation pump shall **NOT** be started to exit the region.

2. **IF** the current operating point is in Region B, **THEN** use one of the following methods to exit the region:

NOTE: Total core flow should **NOT** exceed 45 x 10^6 lbs/hr (58%) in single loop operation.

NOTE: **IF** possible, when changing core flow with two reactor recirculation pumps operating, maintain pump speed and jet pump loop flow mismatch within the allowable limit. Operation outside the mismatch limits is addressed in Step 3.2.10.

- **RAISE** core flow. ☐
- **INSERT** control rods in accordance with 0ENP-24.0, Form 2, Immediate Reactor Power Reduction Instructions. ☐

NOTE: Operating time in the 5% Buffer Region should be minimized.

3. **IF** the current operating point is in the 5% Buffer Region, **THEN INCREASE** monitoring nuclear instrumentation for thermal hydraulic instability. ☐

3.2.5 **NOTIFY** the duty Reactor Engineer. ☐

R1 3.2.6 **MONITOR** individual LPRM bar graphs from RBM ODAs or PPC for reactor power oscillations. ☐

R1 3.2.7 **MONITOR** the following for reactor power oscillations:

- APRMs ☐
- SRMs ☐
- SRM period meters ☐

3.0 OPERATOR ACTIONS

3.2.8 **MONITOR** core thermal parameters **AND ADJUST** the following per the Reactor Engineer's recommendations:

- Rod position ☐
- Reactor recirculation pump speed ☐

CAUTION

IF the OPRM system is inoperable, intentional entry into Region B is prohibited.

3.2.9 **IF** OPRM System is inoperable **AND** entry into the 5% Buffer Region is required, **THEN INCREASE** monitoring nuclear instrumentation for thermal hydraulic instability. ☐

3.2.10 **IF** reactor recirculation pump speed **OR** jet pump loop flow mismatch is outside the allowable limits, **THEN DECLARE** the pump with lower speed inoperable in accordance with Tech Spec 3.4.1 **AND THEN PERFORM** one of the following:

1. **IF** possible without violating thermal limits, **AND** while maintaining reactor power less than or equal to 100%, **THEN RAISE** the speed of the slower pump. ☐
2. **PERFORM** the following to attempt to lower the speed of the faster pump: ☐
   a. **LOWER** the demand signal to the affected reactor recirculation pump. ☐

CAUTION

The following two steps may require performance in rapid succession. Both steps should be reviewed and understood prior to unlocking the scoop tube.

   b. **UNLOCK** the scoop tube. ☐
   c. **IF** the reactor recirculation pump speed does **NOT** lower, **THEN LOCK** the scoop tube. ☐
   d. **EVALUATE** local operation of the scoop tube from the Baily positioner in accordance with the applicable section of 2OP-02. ☐

3.0 OPERATOR ACTIONS

3.2.11 **IF** reactor recirculation pump speed **OR** jet pump loop flow mismatch is outside the allowable limits, **AND** the allowable mismatch can **NOT** be restored, **AND** the Unit SCO determines to **SECURE** the affected pump, **THEN**; ☐

a. **ESTABLISH** conditions that will **NOT** place the core in an undesirable position on the applicable Power-Flow Map after securing the pump. ☐

b. **SECURE** the affected pump in accordance with 2OP-02. ☐

3.2.12 **RESTORE** reactor power to less than or equal to 100%. ☐

3.2.13 **MONITOR** off-gas radiation **AND NOTIFY** E&RC to take coolant samples to determine if fuel element failure has occurred. ☐

3.2.14 **IF** feedwater heating has been lost, **THEN REFER** to the following Operating Procedures:

- 2OI-03.2 note MM, to evaluate feedwater temperature for operation with applicable Power/Flow map and MCPR restrictions ☐
- 2OP-35, to evaluate feedwater heater performance ☐
- 2OP-32, to remove feedwater heaters from service and confirm operations within design values. ☐

R2 3.2.15 **INITIATE** a Condition Report for any control rod found out of intended position. ☐

4.0 GENERAL DISCUSSION

Positive reactivity insertion will cause an increase in reactor thermal power. Some of the causes of cold water addition are loss of feedwater heating, raising the speed of a reactor recirculation pump, control rod drop, and inadvertent HPCI or RCIC initiation. The severity of this transient is determined by how long the abnormally high power level is sustained, especially on a loss of feedwater heating.

The OPRM system provides alarms and automatic trips as applicable. If the OPRM System is inoperable, then Tech Specs require an alternate method to detect and suppress thermal hydraulic instability oscillations in accordance with BWR Owner's Group Guidelines for Stability Interim Corrective Action, June 6 1994. This requires three stability monitoring regions (Region A - manual scram, Region B immediate exit, and 5% Buffer).

5.0 REFERENCES

R1 5.1 NEDO-32465-A, Licensing Topical Report: Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applicability GE Nuclear Energy, August 1996

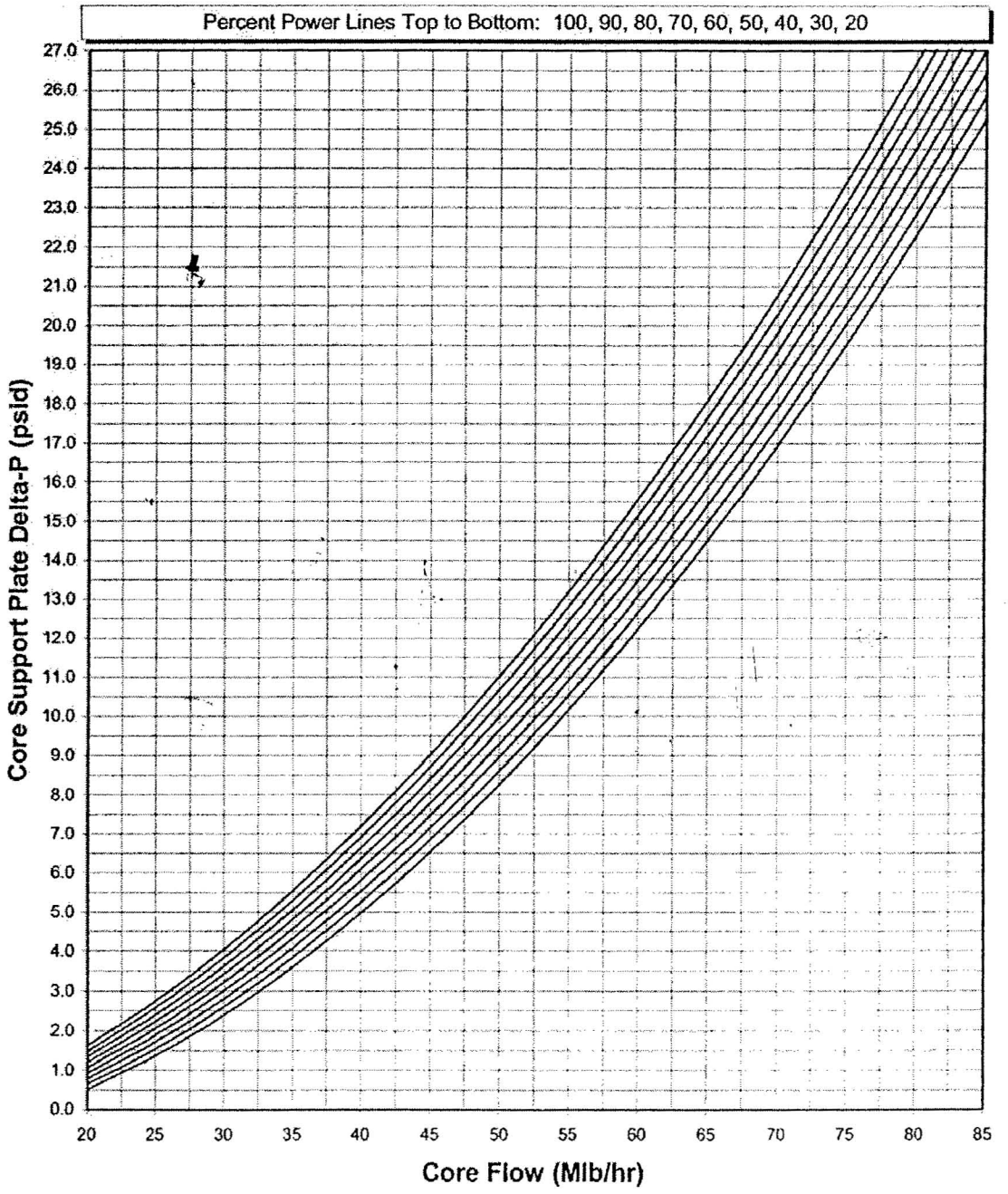
R2 5.2 SOER 84-2, Control Rod Mispositioning

R3 5.3 General Electric Service Information Letter No. 251/251, Supplement 1

6.0 ATTACHMENTS

1 Estimated Total Core Flow vs. Core Support Plate Delta-P

Estimated Total Core Flow vs. Core Support Plate Delta P for B2C18



REVISION SUMMARY

Revision 9 incorporates EC 60117 which deleted the select rod insert from Unit 2.

Revision 8 incorporates EC 62929 by updating the title of the core d/p attachment to B2C18.

Revision 7 adds jet pump loop flow limits to allowable recirc pump speed mismatch criteria.

Revision 6 addresses concerns identified in AR 180915 by addition of a step to allow the operators the option to use local operation of the scoop tube to control speed of the malfunctioning pump. Notes were added/revised to clarify operation of the reactor recirculation pumps with speeds outside the mismatch limits. A step was added to establish conditions that would not place the core in an undesirable condition following removal of the pump, if a decision has been made to secure the affected pump.

Revision 5 incorporates EC 46653 (child 62488) by adding PPC point U2NSSWDP as an alternate for determining total core flow. This revision also adds a caution that an idle recirc pump may not be restarted to exit the scram avoidance region.

Revision 4 incorporates EC 50100 by updating annunciator A-05 5-8 noun name to 'OPRM PDA/CDA ALARM' and EC 56472 by updating the core flow-core d/p figure for the current fuel cycle, update map numbers and add reference to 2OI-03.2 for evaluation of FW temperatures.

Revision 3 – Incorporated ED 55156 which adds computer screens 811 and 812 to Note prior to Step 3.2.1and corrected nomenclature for screens 806, 807, 808, and 809.

Revision 2 – Format changes to meet the requirements of 0AP-005 and Microsoft Word XP. This change does NOT implement an intent change. Additional administrative changes classified as "editorial": are bolding action verbs, italicizing components, change of cover page logo, removal of the "bar code" from the cover page, and adding place keeping aids.

Revision 1 incorporates EC 46720 Power Range Neutron Monitoring and EC 49331 B2C16 Reload cord Design (figure 1).

Revision 0 separates the Unit 2 information steps from 0AOP-03.0.

(UNIT 2 IC-14)

FORM 2
Page 1 of 1

Immediate Reactor Power Reduction Instructions

REACTOR ENGINEER ON CALL: UNIT **TWO**.

Night Pager 910-412-0900 **Day Pager 910-412-0899**

	Name	/ EXT /	Home Phone
Duty RE:	John McKernan	/ X-2061 /	910-457-2061
Backup RE:	Jackie Gee	/ X-2061 /	910-457-2061

IMMEDIATE ACTION

Approx Rx Power 77%

REDUCE core flow to **47 mlb/hr**

THEN reposition control rods per attached 0GP-12 sheets.

Power- Flow Map Stability Region in Effect (See Attached Map)

Figure 13 OPRM Operable, Two Loop Operation, 2923 MWt

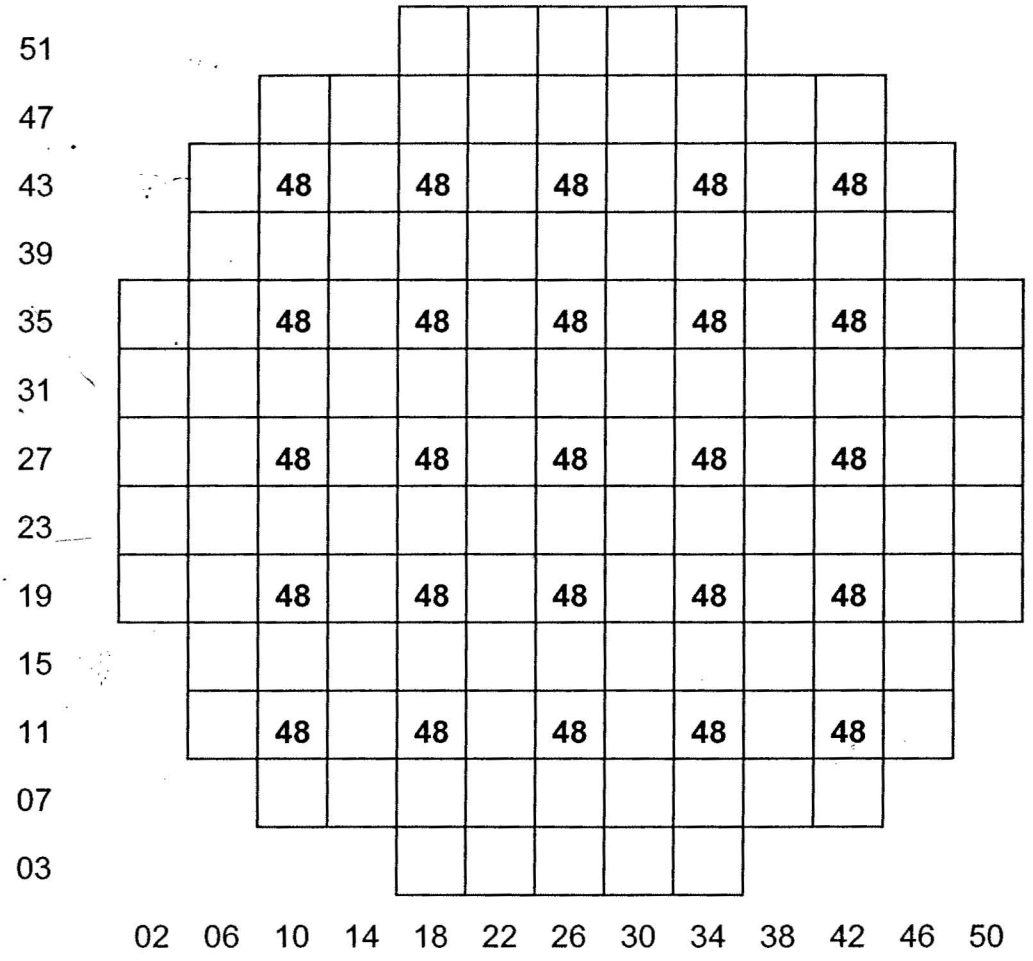
WARNINGS AND GENERAL COMMENTS:

1. More restrictive MCPR limits will be imposed at less than 40% rated thermal power. Additional penalties will also be imposed at less than 26% rated thermal power. The Core Operating Limits Report should be referenced for specific penalties.
2. Reduce core flow prior to moving control rods.
3. Core flow may be increased as needed to remain above RWM constraints until a compatible rod pattern is achieved.
4. Monitor core thermal limits (CMFLCPR, CMFLPD, CMAPRAT) by performing 1(2)PT-01.11 as needed.

RE Today

ATTACHMENT 1
Page 1 of 3
Control Rod Movement

The purpose of this attachment is to document rod pattern prior to power change.
Complete the rod pattern or attach Display 810 edit.



Unit **TWO** Date Today Time Now Reviewed by Reactor Engineer R Engineer

Unit **TWO** Date Today Time Now Reviewed by Unit SCO SR Operator

RE Today

ATTACHMENT 1
Page 2 of 3
Control Rod Movement

Page 1 of 4

SRO Initials: SRO

Control Rod	Correct Rod Selected and Verified****	If Applicable, 0PT-14.1 Completed***	Control Rod Position	Licensed Operator	Overtravel Check*	Full Out Position Check**	Second Licensed Operator
10-43	/	N/A	48 To 00		N/A	N/A	
42-43	/	N/A	48 To 00		N/A	N/A	
42-11	/	N/A	48 To 00		N/A	N/A	
10-11	/	N/A	48 To 00		N/A	N/A	
	/						
26-27	/	N/A	48 To 00		N/A	N/A	
	/						
	/						
	/						

(10)

(2)

APPROX Rx Powe.

→67%

→65%

*WHEN a control rod is withdrawn to the Full Out position, either **MAINTAIN** the continuous withdrawal signal for at least 3 to 5 seconds **OR APPLY** a separate notch withdrawal signal, **AND PERFORM** the following rod coupling integrity check:

- **CONFIRM** *ROD OVER TRAVEL (A-05 4-2)* annunciator does **NOT** alarm. (SR 3.1.3.5)
- **CONFIRM** rod full out light is not lost.
- **CONFIRM** rod position indication on the four-rod display indicates position 48.
- **CONFIRM** *ROD DRIFT (A-05 3-2)* annunciator does **NOT** alarm.

**VERIFY the rod reed switch position indicator corresponds to the control rod position indicated by the Full Out reed switch.

***Applicable for control rods moved from intermediate to fully withdrawn position. Technical Specification SR 3.1.3.2 must be completed for these rods if **NOT** performed within the previous seven days. This surveillance requirement is **NOT** required to be performed until seven days after the control rod is withdrawn and thermal power is greater than the LPSP of RWM.

****Concurrent Verification of rod selection required prior to rod movement.

ATTACHMENT 1
Page 2 of 3
Control Rod Movement

Page 2 of 4

SRO Initials: SRO

Control Rod	Correct Rod Selected and Verified****	If Applicable, 0PT-14.1 Completed***	Control Rod Position	Licensed Operator	Overtravel Check*	Full Out Position Check**	Second Licensed Operator
18-35	/	N/A	48 To 00		N/A	N/A	
34-35	/	N/A	48 To 00		N/A	N/A	
34-19	/	N/A	48 To 00		N/A	N/A	
18-19	/	N/A	48 To 00		N/A	N/A	
	/						
10-27	/	N/A	48 To 00		N/A	N/A	
26-43	/	N/A	48 To 00		N/A	N/A	
42-27	/	N/A	48 To 00		N/A	N/A	
26-11	/	N/A	48 To 00		N/A	N/A	

APPROX Rx Power

(3) → 51%

(4) → 40%

*WHEN a control rod is withdrawn to the Full Out position, either **MAINTAIN** the continuous withdrawal signal for at least 3 to 5 seconds **OR APPLY** a separate notch withdrawal signal, **AND PERFORM** the following rod coupling integrity check:

- **CONFIRM** *ROD OVER TRAVEL (A-05 4-2)* annunciator does **NOT** alarm. (SR 3.1.3.5)
- **CONFIRM** rod full out light is not lost.
- **CONFIRM** rod position indication on the four-rod display indicates position 48.
- **CONFIRM** *ROD DRIFT (A-05 3-2)* annunciator does **NOT** alarm.

**VERIFY the rod reed switch position indicator corresponds to the control rod position indicated by the Full Out reed switch.

***Applicable for control rods moved from intermediate to fully withdrawn position. Technical Specification SR 3.1.3.2 must be completed for these rods if **NOT** performed within the previous seven days. This surveillance requirement is **NOT** required to be performed until seven days after the control rod is withdrawn and thermal power is greater than the LPSP of RWM.

****Concurrent Verification of rod selection required prior to rod movement.

ATTACHMENT 1
Page 2 of 3
Control Rod Movement

Page 3 of 4

SRO Initials: SRO

Control Rod	Correct Rod Selected and Verified****	If Applicable, 0PT-14.1 Completed***	Control Rod Position	Licensed Operator	Overtravel Check*	Full Out Position Check**	Second Licensed Operator
10-35	/	N/A	48 To 12		N/A	N/A	
18-43	/	N/A	48 To 12		N/A	N/A	
34-43	/	N/A	48 To 12		N/A	N/A	
42-35	/	N/A	48 To 12		N/A	N/A	
42-19	/	N/A	48 To 12		N/A	N/A	
34-11	/	N/A	48 To 12		N/A	N/A	
18-11	/	N/A	48 To 12		N/A	N/A	
10-19	/	N/A	48 To 12		N/A	N/A	
	/						
	/						

APPROX Rx. Power → 31%

(5)

*__WHEN__ a control rod is withdrawn to the Full Out position, either **MAINTAIN** the continuous withdrawal signal for at least 3 to 5 seconds **OR APPLY** a separate notch withdrawal signal, **AND PERFORM** the following rod coupling integrity check:
- **CONFIRM** *ROD OVER TRAVEL (A-05 4-2)* annunciator does **NOT** alarm. (SR 3.1.3.5)
- **CONFIRM** rod full out light is not lost.
- **CONFIRM** rod position indication on the four-rod display indicates position 48.
- **CONFIRM** *ROD DRIFT (A-05 3-2)* annunciator does **NOT** alarm.

**__VERIFY__ the rod reed switch position indicator corresponds to the control rod position indicated by the Full Out reed switch.

***Applicable for control rods moved from intermediate to fully withdrawn position. Technical Specification SR 3.1.3.2 must be completed for these rods if **NOT** performed within the previous seven days. This surveillance requirement is **NOT** required to be performed until seven days after the control rod is withdrawn and thermal power is greater than the LPSP of RWM.

****Concurrent Verification of rod selection required prior to rod movement.

ATTACHMENT 1
Page 2 of 3
Control Rod Movement

Page 4 of 4

SRO Initials: SRO

Control Rod	Correct Rod Selected and Verified****	If Applicable, 0PT-14.1 Completed***	Control Rod Position	Licensed Operator	Overtravel Check*	Full Out Position Check**	Second Licensed Operator
18-27	/	N/A	48 To 12		N/A	N/A	
26-19	/	N/A	48 To 12		N/A	N/A	
34-27	/	N/A	48 To 12		N/A	N/A	
26-35	/	N/A	48 To 12		N/A	N/A	
	/						
	/						
	/						
	/						
	/						

APPROX Rx Power → 26%

(6)

*WHEN a control rod is withdrawn to the Full Out position, either **MAINTAIN** the continuous withdrawal signal for at least 3 to 5 seconds **OR APPLY** a separate notch withdrawal signal, **AND PERFORM** the following rod coupling integrity check:

- **CONFIRM** *ROD OVER TRAVEL (A-05 4-2)* annunciator does **NOT** alarm. (SR 3.1.3.5)
- **CONFIRM** rod full out light is not lost.
- **CONFIRM** rod position indication on the four-rod display indicates position 48.
- **CONFIRM** *ROD DRIFT (A-05 3-2)* annunciator does **NOT** alarm.

**VERIFY the rod reed switch position indicator corresponds to the control rod position indicated by the Full Out reed switch.

***Applicable for control rods moved from intermediate to fully withdrawn position. Technical Specification SR 3.1.3.2 must be completed for these rods if **NOT** performed within the previous seven days. This surveillance requirement is **NOT** required to be performed until seven days after the control rod is withdrawn and thermal power is greater than the LPSP of RWM.

****Concurrent Verification of rod selection required prior to rod movement.

ATTACHMENT 1
Page 3 of 3
Control Rod Movement

Other Instructions : CONTINUE shutdown using attached 0GP-10, A2 Sequence, Step 52, Item 426.

Date/Time Completed _____

Performed By (Print)	Initials
_____	_____
_____	_____
_____	_____
_____	_____

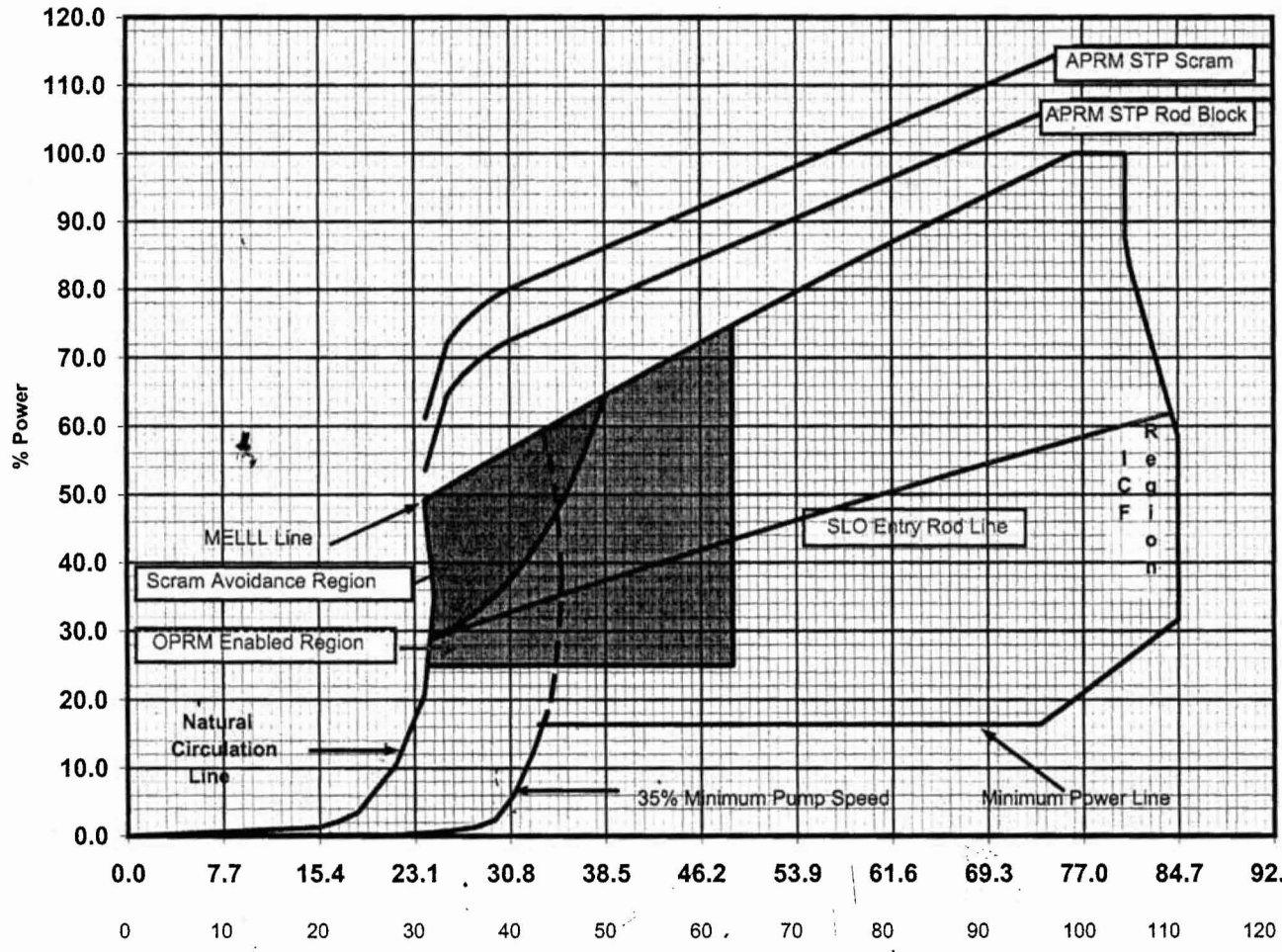
Reviewed By: _____
Unit SCO

RE Today

Figure 13
Stability Option III Power/Flow Map

OPRM Operable, Two Loop Operation, 2923 MWt

This Figure supports Improved Technical Specification 3.3.1.1 and the Technical Requirements Manual Specification 3.3



Power %	Minimum (MELLL) Core Flow, Mlbs/hr	Maximum (ICF) Core Flow, Mlbs/hr
100	76.19	80.47
99	75.04	80.47
98	73.89	80.47
97	72.75	80.47
96	71.61	80.47
95	70.49	80.47
94	69.36	80.47
93	68.25	80.47
92	67.13	80.47
91	66.03	80.47
90	64.93	80.47
89	63.83	80.47
88	62.74	80.47
87	61.66	80.51
86	60.58	80.60
85	59.50	80.70
84	58.43	80.79
83	57.37	80.90
82	56.31	81.05
81	55.25	81.21
80	54.20	81.36
79	53.16	81.52
78	52.12	81.67
77	51.08	81.83
76	50.05	81.98
75	49.02	82.13
74	48.00	82.29
73	46.98	82.44
72	45.96	82.60
71	44.95	82.75
70	43.94	82.91
69	42.94	83.06
68	41.94	83.21
67	40.95	83.37
66	39.96	83.52
65	38.97	83.68
64	37.99	83.83
63	37.01	83.99
62	36.04	84.14
61	35.06	84.29
60	34.10	84.45
59	33.13	84.60
58	32.17	84.70