QUESTION 5

FOR INFORMATION ONLY

Attachment 4

Form 34731 (10-81)
(Formerly SPD-1002-1)

DUKE POWER COMPANY
PROCEDURE PREPARATION
PROCESS RECORD

(1) ID No: PT/0/A/4150/11A
Change(s) 0 to
0 Incorporated

(2) STATION: McGuire

(3) PROCEDURE TITLE: Control Rod Worth Measurement: Rod Swap

(4) PREPARED BY: Michael S. Kitlan Jr. DATE: 4/4/84

(5) REVIEWED BY: ______ DATE: ______

Cross-Disciplinary Review By: ______ N/R: ______

(6) TEMPORARY APPROVAL (IF NECESSARY):

By: ______ (SRO) Date: ______

By: ______ Date: ______

(7) APPROVED BY: ______ Date: ______

(8) MISCELLANEOUS:

Reviewed/Approved By: ______ Date: ______

Reviewed/Approved By: ______ Date: ______

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(Formerly SPD-1002-1)

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(7) APPROVED BY: ______ Date: ______

(8) MISCELLANEOUS:

Reviewed/Approved By: ______ Date: ______

Reviewed/Approved By: ______ Date: ______

Form 34634 (4-81) SPD-1001-2

DUKE POWER COMPANY
NUCLEAR SAFETY EVALUATION CHECK LIST

(1) STATION: McGuire UNIT: 1 x 2 x 3 ____
OTHER:

(2) CHECK LIST APPLICABLE TO: ~~PT/0/A/4150/28~~ PT/0/A/4150/11 A
msk

(3) SAFETY EVALUATION - PART A

The item to which this evaluation is applicable represents:

Yes ____ No X A change to the station or procedures as described in the FSAR; or a test or experiment not described in the FSAR?

If the answer to the above is "Yes", attach a detailed description of the item being evaluated and an identification of the affected section(s) of the FSAR.

(4) SAFETY EVALUATION - PART B

Yes ____ No X Will this item require a change to the station Technical Specifications?

If the answer to the above is "Yes," identify the specification(s) affected and/or attach the applicable pages(s) with the change(s) indicated.

(5) SAFETY EVALUATION - PART C

As a result of the item to which this evaluation is applicable:

Yes ____ No X Will the probability of an accident previously evaluated in the FSAR be increased?

Yes ____ No X Will the consequences of an accident previously evaluated in the FSAR be increased?

Yes ____ No X May the possibility of an accident which is different than any already evaluated in the FSAR be created?

Yes ____ No X Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?

Yes ____ No X Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?

Yes ____ No X May the possibility of malfunction of equipment important to safety different than any already evaluated in the FSAR be created?

Yes ____ No X Will the margin of safety as defined in the bases to any Technical Specification be reduced?

If the answer to any of the preceding is "Yes", an unreviewed safety question is involved. Justify the conclusion that an unreviewed safety question is or is not involved. Attach additional pages as necessary.

(6) PREPARED BY: Michael S. Kitlan Jr. DATE: 4/4/84

(7) REVIEWED BY: ____________ DATE: ____________

(8) Page 1 of 1

DUKE POWER COMPANY
McGUIRE NUCLEAR STATION
CONTROL ROD WORTH MEASUREMENT:
ROD SWAP

1.0 Purpose

1.1 To verify that the reactivity worth of the Reference RCC bank, as determined through reactivity computer measurement data, is consistent with design predictions.

NOTE: The reference RCC bank is the bank which has the predicted highest reactivity worth of all control and shutdown banks when inserted into an otherwise unrodded core.

1.2 To verify that the reactivity worth of each control and shutdown bank (except the reference bank), as inferred from data following iso-reactivity interchange with the reference bank, is consistent with design predictions.

2.0 References

2.1 Rod Bank Worth Measurements Utilizing Bank Exchange, WCAP-9863-A, May 1982.

2.2 Control Rod Worth Measurement, PT/0/A/4150/11

2.3 Post Refueling Controlling Procedure for Criticality, ZPPT, and Power Escalation Testing, PT/0/A/4150/21

2.4 Technical Specifications 3.4.1.1, 3.10.4, 3.10.3, and 3.10.2.

3.0 Time Required

3.1 8 hours, 1 engineer

4.0 Prerequisite Tests

Initial/Date

____/____ 4.1 PT/0/A/4150/10, ARO Boron Endpoint Measurement

5.0 Test Equipment

5.1 Reactivity Computer (with flux signal from top and bottom of one power range channel).

5.2 Two two-pen strip chart recorders. One chart recorder should have reactivity (on a scale of 10 pcm/inch, with 0 pcm being the center of the recorder sheet), and T_{avg} from one loop (on a scale of 1°F/inch for 556 to 558°F set up on one side of the recorder sheet). The other chart recorder should have flux (on a scale of 0 to the top end of the testing decade in amps) and pressurizer level (on a scale of 10% level/inch). Chart speeds should be 1 inch/min.

NOTE: The specifications in this step may be altered by the Test Coordinator as necessary to accommodate equipment limitations, as long as all four signals are recorded or trended.

6.0 Limits and Precautions

6.1 The NC system temperature is controlled preferably by steam dump to the condenser. Temperature control may alternatively be affected by steam generator blowdown.

6.2 Normally all reactor coolant pumps should be operating for maximum mixing in the NCS. If all reactor coolant pumps are not operating, the operating pumps should be those on the NCS charging loops (A and/or D). See Tech Spec 3.4.1.1 and 3.10.4 if all reactor coolant pumps are not operating.

6.3 The rod insertion limit and bank overlap sequence will be violated during this test. The operators should be made aware in advance and should anticipate the associated alarms. Technical Specification 3.10.2 and 3.10.3 allows for this.

6.4 Maintain the flux level in the zero power test range established in Reference 2.4.

6.5 Prior to switching the rod control selector switch from one bank to another, verify both groups of the bank (if the bank has two groups) are at the same position in order to avoid group misalignment.

7.0 Required Unit Status

Initial/Date

____/____ 7.1 The unit is just critical in the Startup Mode (Mode 2) at zero power with the flux level in the zero power test range established in PT/0/A/4150/21, "Post Refueling Controlling Procedure for Criticality, ZPPT, and Power Escalation Testing."

____/____ 7.2 Record in the log the unit to which this test applies.

8.0 Prerequisite System Conditions

NOTE: The following steps may be signed off in any order.

____/____ 8.1 The reactor coolant system temperature is 557°F +1, -5°F.

NOTE: Maintain NCS temperature within ±1°F of established temperature during the test.

____/____ 8.2 The difference between NC loop, pressurizer, and VCT boron concentrations is less than 20 ppm. List on Enclosure 13.3.

NOTE: Do not use the boronometer.

____/____ 8.3 Xenon worth rate is changing less than ±.1 pcm/min.

____/____ 8.4 Test equipment is set up per Section 5.0.

____/____ 8.5 All available pressurizer heaters are on as needed, in order to improve mixing by maximizing the pressurizer spray.

____/____ 8.6 All control and shutdown banks are fully withdrawn except Control Bank D which is at a position greater than about 215 steps withdrawn.

____/____ 8.7 The Rod Control Selector switch is in Bank Select Mode set on Control Bank D.

____/____ 8.8 Complete Enclosure 13.1 with the predicted data. See Enclosure 13.9 for an explanation of nomenclature used in this test.

____/____ 8.9 Trend the points listed in Enclosure 13.2 every 15 minutes or less on the OAC.

9.0 Test Method

The RCC bank with the highest predicted value of reactivity worth is measured using the dilution technique per PT/0/A/4150/11. This bank serves as a reference. The integral worth of the remaining RCC banks is implied from the difference in the critical rod position of the reference bank with and without the insertion of bank being tested. The implied integral worths are then compared to predicted rod worths.

10.0 Data Required

10.1 The following conditions for the approximate time of criticality before and after each bank exchange, recorded on Enclosure 13.5:

Time

NCS Tavg

NCS Boron Concentration

Just critical height of reference bank

10.2 Nuclear design predictions on Enclosure 13.1.

10.3 Boron concentration information for the NCS and pressurizer on Enclosure 13.3.

10.4 A copy of the rod positions and rod worths for the reference bank from Enclosure 13.1 of PT/0/A/4150/11 when this test is complete.

10.5 The calculated, implied integral worth (W_x^I) for each RCC bank except the reference bank. List data on Enclosure 13.7.

10.6 The percent difference between inferred and predicted worths for each individual RCC banks (ε_1) and for the sum of all banks (ε_2) on Enclosure 13.8.

11.0 Acceptance Criteria

11.1 The absolute value of the percent difference between measured and predicted integral worth for the reference bank is ≦15% (from Enclosure 13.8 $(\varepsilon_1)_1$ ≦15%).

11.2 From Enclosure 13.8, the calculated value ε_2 ≦10%.

11.3 For all RCC banks other than the reference bank; either:

a) From Enclosure 13.8, ε_{1_x} ≦30% for each bank or

b) $W_x^I - W_x^P$ ≦200 pcm for each bank, whichever is greater.

12.0 Procedure

Initial/Date

NOTE: See Enclosure 13.9 for an explanation of all nomenclature used in this test.

____/____ 12.1 Request NCS and Pressurizer samples to be taken at approximately 15-20 minute intervals until all banks are measured.

NOTE: The Boronometer may not be used for NC loop concentrations.

NOTE: Notify Chemistry that the unused portions of the samples should be retained in appropriately labeled containers, for possible future re-analysis, until all acceptance criteria are met or as specified by the test coordinator.

12.2 Measure the integral reactivity worth of the reference bank as follows:

NOTE: The reference bank is defined as that bank which is predicted to have the highest worth, of all control and shutdown banks, when inserted into an otherwise un-rodded core (see Enclosure 13.1 for the identity of this bank). In this procedure, the banks will be referred to by the bank number, the reference bank being number 1. If the reference bank is currently positioned at less than 228 steps withdrawn (i.e., if it is Control Bank D), continue with step 12.2.5. Mark steps 12.2.1 to 12.2.4 NA. If the reference bank is positioned at 228 steps withdrawn, continue on at Step 12.2.1.

____/____ 12.2.1 Insert the reference bank 1 until the indicated reactivity is approximately -10 pcm.

____/____ 12.2.2 Withdraw the bank inserted below 228 until the indicated reactivity is approximately +10 pcm.

____/____ 12.2.3 Repeat steps 12.2.1 and 12.2.2 until the previously inserted bank is fully withdrawn.

____/____ 12.2.4 Adjust the position of the reference bank 1 until the reactor is just critical. Record this position in the test log.

____/____ 12.2.5 Perform Control Rod Worth Measurement per PT/0/A/4150/11 on the reference Bank 1.

____/____ 12.2.6 Attach a completed copy of PT/0/A/4150/11 Enclosure 13.1 to this procedure.

____/____ 12.2.7 Record the total reference bank rod worth from PT/0/A/4150/11 Enclosure 13.1 on Enclosure 13.7 and 13.8 as shown.

____/____ 12.2.8 Ensure the reactor is critical at the same reference bank position as was obtained at the end of PT/0/A/4150/11.

12.4 Measure the reactivity worth of the remaining control and shutdown banks, relative to the reference Bank 1, as follows:

NOTE: The relative worth of each RCC bank is obtained from the critical position of the reference bank (initially nearly fully inserted) after full insertion of the bank being measured (initially fully withdrawn), at constant RCS boron concentration.

NOTE: Perform rod swap measurements on Control Bank D last if possible.

____/____ 12.4.1 Record the initial critical bank configuration on Enclosure 13.4 and 13.5 for the reference bank. Also record the initial NC boron concentration and average T_{avg} on Enclosure 13.5.

(√) ___ ___ ___ ___ ___
3 4 5 6 7
___ ___
8 9

____/____ 12.4.2 Insert bank 2 (identify this bank on top of Enclosure 13.5; i.e., Bank 2 is S/D E or Cont. B, etc.) until the reactivity indicated by the reactivity computer is approximately -20 pcm.

(√) ___ ___ ___ ___ ___
3 4 5 6 7
___ ___
8 9

____/____ 12.4.3 Withdraw the reference Bank 1 until the indicated reactivity is approximately +20 pcm.

NOTE: Maintain the flux within the zero power test range established in Reference 2.4.

(√) ___ ___ ___ ___ ___
3 4 5 6 7
___ ___
8 9

____/____ (√) ___ ___ ___ ___ ___ 3 4 5 6 7 ___ ___ 8 9	12.4.4	Repeat Steps 12.4.2 and 12.4.3 until bank 2 is fully inserted. Keep the indicated reactivity within ±20 pcm.
____/____ (√) ___ ___ ___ ___ ___ 3 4 5 6 7 ___ ___ 8 9	12.4.5	Adjust the position of reference bank 1 until the reactor is just critical. Record the final critical configuration data on Enclosure 13.5. Also record the final NC Boron Concentration and average T_{avg} on Enclosure 13.5. NOTE: If time permits, measure the differential reactivity worth of reference Bank 1 with the reactivity computer by sequential bank insertions and withdrawals around the critical position. Record information in the test log if this is performed. (Analysis may be performed at a later time.)
____/____ (√) ___ ___ ___ ___ ___ 3 4 5 6 7 ___ ___ 8 9	12.4.6	Insert the reference Bank 1 until the indicated reactivity is approximately -20 pcm.
____/____ (√) ___ ___ ___ ___ ___ 3 4 5 6 7 ___ ___ 8 9	12.4.7	Withdraw bank 2 until the indicated reactivity is approximately +20 pcm.
____/____ (√) ___ ___ ___ ___ ___ 3 4 5 6 7 ___ ___ 8 9	12.4.8	Repeat Steps 12.4.6 and 12.4.7 until bank 2 is fully withdrawn.
____/____ (√) ___ ___ ___ ___ ___ 3 4 5 6 7 ___ ___ 8 9	12.4.9	Adjust the position of reference Bank 1 until the reactor is just critical. Record the critical configuration data on Enclosures 13.4 and 13.5.

____/____ 12.4.10 Repeat Steps 12.4.2 through 12.4.9 for the remaining, unmeasured control and shutdown banks numbered 3 through 9 instead of bank 2. The banks may be measured in any order except that Control Bank D should be measured last. Identify the bank beside the bank number on Enclosures 13.4, 13.6, 13.7 and 13.8.

NOTE: If a Control Bank D-in ITC measurement is to be made, perform Steps 12.5, 12.5.1 and 12.5.2. If not, proceed directly to Step 12.5.3 and mark Steps 12.5, 12.5.1 and 12.5.2 as N/A.

____/____ 12.5 After all rod measurements have been made, again swap Control Bank D for the reference bank 1.

____/____ 12.5.1 By NC Boron Adjustment, reposition Control Bank D and the reference Bank 1 such that Control Bank D is almost fully inserted into the core and the reference bank 1 fully withdrawn from the core. (It is acceptable to have Control Bank D fully inserted and the reference bank 1 almost fully withdrawn.)

____/____ 12.5.2 Perform PT/0/A/4150/12B, Moderator Temperature Coefficient of Reactivity During Startup Mode.

____/____ 12.5.3 By NC boron adjustment, reposition control and shutdown banks to the desired normal operating configuration of Control Bank D at about 215 steps withdrawn. Do not go out of Bank Control.

12.6 Perform the following steps once Control Bank D is about 215 steps withdrawn.

____/____ 12.6.1 Go to the Master Cycler Cabinet and reset the Bank Overlap Digital Counter to 000 by pushing the reset button.

____/____ 12.6.2 Reset the Bank Overlap Counter to 345 plus the present Control Bank D position by pushing the button to count up from 000 to the desired value (one push of the button is one digit change on the display).

____/____ 12.6.3 Place rod control to manual.

NOTE: This completes the data acquisition section of this test.

____/____ 12.7 If boron samples are no longer needed to be gathered, notify Chemistry.

____/____ 12.8 Compute the average reference bank critical position on Enclosure 13.4.

12.9 Compute the inferred worth for each control and shutdown bank (except the reference bank 1) as follows:

____/____ 12.9.1 Using the data from Enclosure 13.4, and the worth measurement data for the reference bank from Enclosure 13.1 of PT/0/A/4150/11, compute the value of $(\Delta\rho_1)_x$ as described below.

$$(\Delta\rho_1)_x = \left[W_R^M \right]_o^{(h_x^M)_o \text{ avg}}$$

where:

$\left[W_R^M \right]_o^{(h_x^M)_o \text{ avg}}$ is the measured integral worth of the reference bank from 0 steps to $(h_x^M)_o$ avg from Enclosure 13.1 of PT/0/A/4150/11.

and $(h_x^M)_o$ avg is the average of the initial and return critical positions of the reference bank before and after interchange with bank x as given on Enclosure 13.4.

Fill in all blanks and complete the calculations on Enclosure 13.4 in the appropriate column.

____/____ 12.9.2 Using the data from Enclosure 13.5, the worth measurement data for the reference bank from Enclosure 13.1 of PT/0/A/4150/11 and the design data of Enclosure 13.1, compute the value of $\alpha_x\ (\Delta\rho_2)_x$ as described below:

$$\alpha_x(\Delta\rho_2)_x = \alpha_x \left[W_R^M \right]_{h_x^M}^{228}$$

where: $\left[W_R^M \right]_{h_x^M}^{228}$ is the measured integral worth of the reference bank from h_x^M to the fully withdrawn position from PT/0/A/4150/11, Enclosure 13.1.

h_x^M is the measured critical position of the reference bank after interchange with bank x from Enclosure 13.5.

and

α_x is a correction factor from Enclosure 13.1 to account for the influence of bank x on the worth of the reference bank.

Fill in all blanks and complete the calculations on Enclosure 13.6.

____/____ 12.9.3 Compute the inferred integral worth of each bank x, W_x^I, as indicated on Enclosure 13.7.

____/____ 12.9.4 Compute the percent difference between inferred and predicted worths for each individual RCC bank and the sum of all banks described below.

$$(\varepsilon_1)_x = \left[\frac{W_x^I - W_x^P}{W_x^P}\right] \times 100, \text{ in } \%$$

$$\varepsilon_2 = \left[\frac{\sum_{i=1}^{N} W_i^I - \sum_{i=1}^{N} W_i^P}{\sum_{i=1}^{N} W_i^P}\right] \times 100, \text{ in } \%$$

Fill in all blanks and summarize the calculations on Enclosure 13.8.

____/____ 12.10 Verify all acceptance criteria have been met.

____/____ 12.11 Inform Chemistry to discard the Chemistry samples they have saved, once all results of this test are acceptable.

13.0 Enclosures

13.1 Nuclear Design Predictions for Rod Interchange Measurements

13.2 PAO Data

13.3 Log of Boron Concentrations

13.4 Calculation of $(\Delta\rho_1)x$

13.5 Critical Configuration Data

13.6 Calculation of $\alpha_x(\Delta\rho_2)x$

13.7 Calculation of Inferred Integral Bank Worths

13.8 Comparison of Inferred Bank Worths with Design Predictions

13.9 Nomenclature

Control Rod Worth Measurement: Rod Swap
Enclosure 13.1
Nuclear Design Predictions
for Rod Interchange Measurements

McGuire Unit _____ Cycle _____

Bank No. (x)	Bank Identity +	W_x^P (pcm)	(b) h_x^P (steps)	(c) α_x
(a) 1 (Reference)				
2				
3				
4				
5				
6				
7				
8				
9				

(a) Reference bank - the bank with the highest predicted integral worth.

(b) Reference bank critical position after interchange with bank x.

(c) Ratio of integral worth of the reference bank from h_x^P to the fully withdrawn position with and without x in the core.

\+ Control Bank C, Shutdown Bank E, etc.

NOTE: See Enclosure 13.9 for a complete listing of nomenclature used in this test.

Recorded By ____________________ Date ____________________
This data came from (list source): ____________________
____

Control Rod Worth Measurement: Rod Swap
Enclosure 13.2
PAO Data

A0821	Boric Acid Makeup Blended Flow
P1390	Control Bank A Position
P1391	Control Bank B Position
P1392	Control Bank C Position
P1393	Control Bank D Position
P1546	Shtudown Bank A Position
P1547	Shutdown Bank B Position
P1548	Shutdown Bank C Position
P1549	Shutdown Bank D Position
P1550	Shutdown Bank E Position
A0632	Intermediate Range Channel N35
A0633	Intermediate Range Channel N36
A0819	Loop A T_{avg}
A0825	Loop B T_{avg}
A0831	Loop C T_{avg}
A0837	Loop D T_{avg}
A1058	Loop A ΔT
A1070	Loop B ΔT
A1082	Loop C ΔT
A1094	Loop D ΔT
A1118	Pressurizer Pressure
A0602	Boronometer
A1124	Pressurizer Level
P1461	NC Avg. T_{avg}
P0828	Avg. Incore T/C Temperature
A0603	Boric Acid Flow to Blender
A1064	NC Loop A NR Cold Leg Temperature
A1076	NC Loop B NR Cold Leg Temperature
A1088	NC Loop C NR Cold Leg Temperature
A1100	NC Loop D NR Cold Leg Temperature

Control Rod Worth Measurement: Rod Swap
Enclosure 13.3
Log of Boron Concentrations

Date	Time Sample Taken	NCS Boron Concentrations			Comments	Recorded By
		+VCT	NCS	Press.		

McGuire Unit ___________
Cycle _____

NOTE: VCT sample needed only once at start of the test. Mark this block as N/A after this.

Control Rod Worth Measurement: Rod Swap
Enclosure 13.4
Calculation of $(\Delta\rho_1)_x$

Unit ____ Cycle ____

Date ________________

Bank (x)		$(h^M_x)_o$ (steps)			++ $(\Delta\rho_1)_x$
No.	Ident.	+Initial	*Return	**Average	(pcm)
2					
3					
4					
5					
6					
7					
8					
9					

+Step 12.4.1 - reference bank initial critical position.

*Step 12.4.9 - reference bank final critical position upon exchange with bank x (bank x if out of core).

++Step 12.9.1 **Step 12.8

Recorded By ______________________

____

Unit _____
Cycle _____
Date ______________

Control Rod Worth Measurement: Rod Swap
Enclosure 13.5
Critical Configuration Data

Time	NC T_{avg}	NC Boron Conc.	Reference Bank Position (steps)		RCC Bank Positions							
(hrs.)	(°F)	(ppm)	$(h_x^M)_o$	(h_x^M)	No. 2 ( )	No. 3 ( )	No. 4 ( )	No. 5 ( )	No. 6 ( )	No. 7 ( )	No. 8 ( )	No. 9 ( )
			+	N/A	228	228	228	228	228	228	228	228
			N/A	*	0	228	228	228	228	228	228	228
			**	N/A	228	228	228	228	228	228	228	228
			N/A	*	228	0	228	228	228	228	228	228
			**	N/A	228	228	228	228	228	228	228	228
			N/A	*	228	228	0	228	228	228	228	228
			**	N/A	228	228	228	228	228	228	228	228
			N/A	*	228	228	228	0	228	228	228	228
			**	N/A	228	228	228	228	228	228	228	228
			N/A	*	228	228	228	228	0	228	228	228
			**	N/A	228	228	228	228	228	228	228	228
			N/A	*	228	228	228	228	228	0	228	228
			**	N/A	228	228	228	228	228	228	228	228
			N/A	*	228	228	228	228	228	228	0	228
			**	N/A	228	228	228	228	228	228	228	228
			N/A	*	228	228	228	228	228	228	228	0
			**	N/A	228	228	228	228	228	228	228	228

+Step 12.4.1 - initial critical bank position *Step 12.4.5 - final critical bank position **Step 12.4.9

Recorded By ______________________________

Control Rod Worth Measurement: Rod Swap
Enclosure 13.6
Calculation of $\alpha_x(\Delta\rho_2)_x$

Unit _____ Cycle _____

Date ________________

Bank (x)		$^+h_x^M$	(1) $\left[W_R^M\right]\frac{228}{h_x^M}$	(2) $^*\alpha_x$	(1) x (2) $\alpha_x(\Delta\rho_2)_x$
No.	Ident.	steps	(pcm)		(pcm)
2					
3					
4					
5					
6					
7					
8					
9					

+from Enclosure 13.5

*from Enclosure 13.1

Recorded By ________________

____

Control Rod Worth Measurement: Rod Swap
Enclosure 13.7
Calculation of Inferred Integral Bank Worths

Unit _____ Cycle _____ Step 12.2.7 W_R^M = _________ pcm
Date __________________

Bank (x)		$^{+}(\Delta\rho_1)_x$	$^{*}\alpha_x(\Delta\rho_2)_x$	W_x^I (a)
No.	Ident.	(pcm)	(pcm)	(pcm)
2				
3				
4				
5				
6				
7				
8				
9				

(a) $W^I = W_R^M - (\Delta\rho_1)_x - \alpha_x(\Delta\rho_2)_x$
+from Enclosure 13.4

*from Enclosure 13.6

Recorded by ______________________

Control Rod Worth Measurement: Rod Swap
Enclosure 13.8
Comparison of Inferred Bank Worths
With Design Predictions

Unit _____ Cycle _____
Date ___________________

Bank (x)		$^{++}W_x^I$	$^{*}W_x^P$	$(\varepsilon_1)_x$
No.	Ident.	(pcm)	(pcm)	(%)
1 reference		+		
2				
3				
4				
5				
6				
7				
8				
9				

$\sum W_x^I$ (pcm)	$\sum W_x^P$ (pcm)	ε_2 (%)

+Step 12.2.7: Record the measured worth of the reference bank here.

*from Enclosure 13.1

++from Enclosure 13.7

Recorded By ____________________

____

Control Rod Worth Measurement: Rod Swap
Enclosure 13.9
Nomenclature

1. W_x^P — Predicted reactivity worth of each control and shutdown bank when inserted individually into an otherwise unrodded core.

2. W_x^I — The calculated, implied rod bank worths of bank x from rod exchange

3. W_R^M — Measured rod bank worth of reference bank

4. α_x — A correction factor which accounts for the effect of bank x on the partial integral worth of the reference bank, equal to the ratio of the integral worth of the reference bank from h_x^P to the fully withdrawn position with and without x in the core.

5. $(\Delta\rho)_x$ — The measured integral worth of the reference bank from h_x^M to the fully withdrawn position.

6. h_x^P — The predicted critical position of the reference bank after interchange with bank x starting with reference bank at 0, bank x fully withdrawn.

7. h_x^M — The measured critical position of the reference bank after interchange with bank x.

8. $\left[W_R^M\right]_o^{(h_x^M)_{o\ avg}}$ — Is the measured integral worth of the reference bank from 0 steps to $(h_x^M)_{o\ avg}$

9. $(h_x^M)_{o\ avg}$ — Is the average of the initial and return critical positions of the reference bank before and after interchange with bank x.

10. $\left[W_R^M\right]_{h_x^M}^{228}$ — Is the measured integral worth of the reference bank from h_x^M to the fully withdrawn position.