UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Carole,
Pls make c/pies
for D. Ross
S. Newberry
C. Graves
A. Schwencer
T. Marsch
Dchok

6.3

FEB 14 1978

Docket No. 50-346

50

LICENSEE: Toledo Edison Company

FACILITY: Davis-Besse Nuclear Power Station, Unit No. 1 (DB-1)

SUBJECT: SUMMARY OF MEETING ON NATURAL CIRCULATION TEST - (DB-1)

On February 7, 1978 representatives from the Toledo Edison Company (TECO), the Babcock & Wilcox Company and the Bechtel Corporation met with the NRC staff to present their bases for not needing to conduct a natural circulation test for DB-1. A list of attendees is provided in Enclosure 1.

At 2243 hours on November 29, 1977, DB-1 experienced a transient (temporary loss of 13.8 KV power) which tripped all four reactor coolant pumps, and for approximately 15 minutes until 2258 hours, reactor decay heat was removed by natural circulation. During the 15 minute period the data-recording reactimeter was in operation and TECO analyzed the data to see if natural circulation could be justified during the loss of station power transient.

TECO concluded from their analysis of the data that the transient did not satisfy the NRC test requirements for a natural circulation test. Because of (1) the imbalance of the once-through-steam generators (OTSG) during the transient, (2) the lack of data for the loop 1 hot leg temperature, and (3) the non-equilibrium state of the NSSS during the transient; TECO could not analyze and qualify the transient as a satisfactory natural circulation test.

The NRC staff concurred with TECO that the loss of site power transient did not confirm a steady-state natural circulation flow rate required for the natural circulation test.

TECO then reiterated their previous position that the elevated position of OTSG's for DB-1 would increase the natural circulation flow of DB-1 above that observed by test for Oconee No. 1. A summary of TECO's position is provided in Enclosure 2.

TECO stated that the test procedures for conducting a steady-state natural circulation test would include 14 hours at 5% of full power to reach stable Xenon conditions and an additional 8 hours for both phases of the test. Similar tests conducted in the past have required about three days.

TECO stated that the present coal supplies available for electric power generation in the state of Ohio have reached a critical point and DB-1 cannot be off-line and at reduced power for the time required

POOR ORIGINAL

8001160720 P

to run the natural circulation test without impacting load requirements for their grid system and increasing the use of rapidly diminishing coal supplies.

The NRC staff stated that the question of requiring DB-1 to run a natural circulation test had been considered prior to issuance of the Operating License for DB-1 when the NRC staff had concluded that DB-1 was not considered as a similar plant to the prototypic Oconee 1 since DB-1 was the first B&W 177 NSSS to use the elevated OTSG's.

Both the NRC staff and TECO indicated they would be in contact with each other in the near future regarding these matters.

Leon Engle
Leon Engle, Project Manager
Light Water Reactors Branch No. 1
Division of Project Management

Enclosures:
1. Attendance List
2. Summary of TECO
   Technical Position

FEB

ENCLOSURE 1

ATTENDANCE LIST

FOR

MEETING HELD ON FEBRUARY 7, 1978

WITH

THE TOLEDO EDISON COMPANY

DAVIS BESSE, UNIT NO. 1

DOCKET NO. 50-346

Nuclear Regulatory Commission

B. Clayton
L. Engle
C. Graves
J. Mazetis
P. O'Reilly
D. Riehm

Toledo Ediosn Company

C. Domeck
F. Miller
R. Sund

Babcock & Wilcox Company

R. Davis
J. Lauer
C. Tally

Bechtel Corporation

D. Dismokes

The ΔP which results in natural circulation flow can be expressed by the fol equation:

$$\Delta P = \sum L\rho = L_c\rho_c + 1\ \text{ft.}(\rho_{lm}) - 12\ \text{ft.}(\rho_{lm}) - L_h\rho_h$$

where ΔP = differential pressure available for natural circulation flow
- L_c = vertical distance from bottom of core to bottom of temperature transition zone in steam generator.
- ρ_c = density of cold leg water
- 1 ft = depth of temperature transition zone in steam generator
- ρ_{lm} = log mean density of water
- 12 ft = active core length (transition zone)
- L_h = vertical distance from top of core to top temperature transition zone in steam generator
- ρ_h = density of hot leg water

Lc (Oconee)	= 45 ft	Lh (Oconee)	= 34 ft
Lc (Davis-Besse)	= 68.6 ft	Lh (Davis-Besse)	= 57.6 ft
ρ_c	= 47.7 lb./ft^3	ρ_h	= 46.2 lb/ft^3

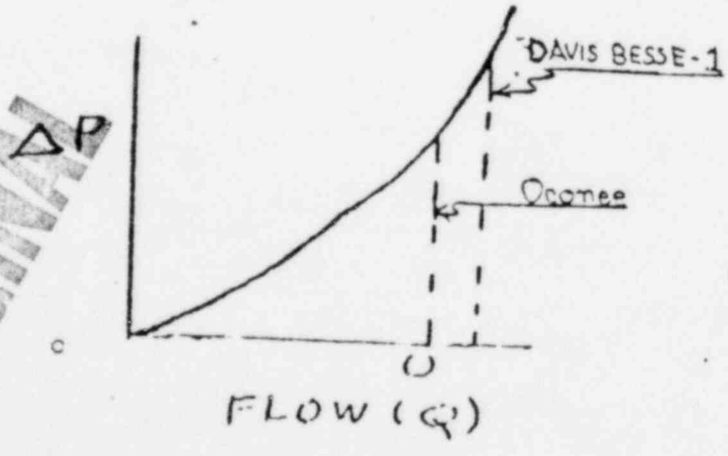
Comparing Oconee 1 and Davis-Besse 1:

$$\text{Increased } \Delta P = (23.6\ \text{ft})(\rho_c - \rho_h) = \frac{23.6\ (1.5)}{144}$$

$$= 0.25\ \text{lb/in}^2$$

The only difference between Oconee 1 and Davis-Besse 1 is in the tubed steam generators, which only tend to increase ΔP in Davis-Besse 1 and hence increase flow (Q).

For the system curve that applies to both Oconee 1 and Davis-Besse 1



$$\Delta P_{DB-1} > \Delta P_{OCONEE}$$

$$\therefore Q_{DB-1} > Q_{OCONEE}$$

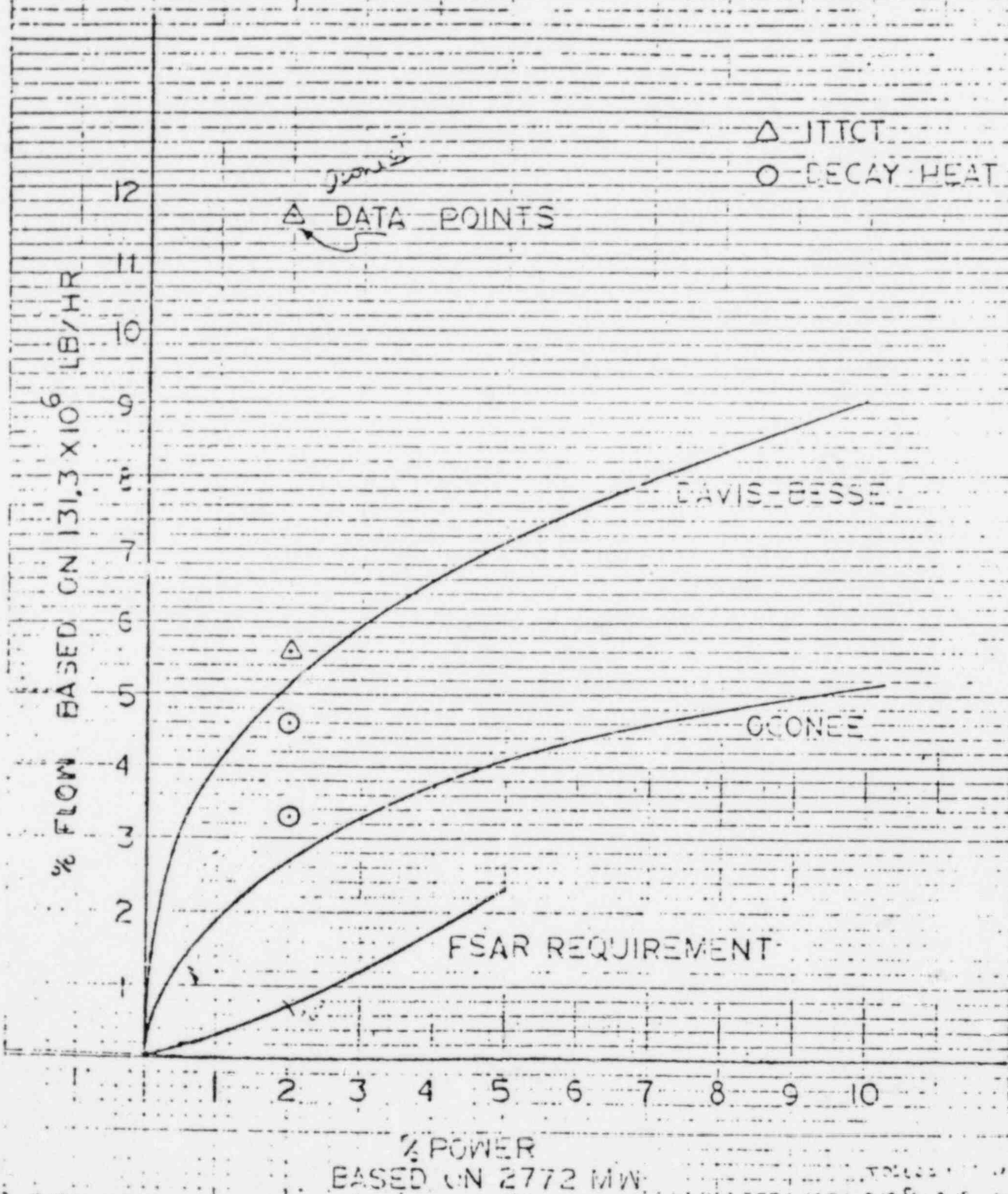
Attachment 2, Graph 1, shows calculated and actually measured Oconee 1 natural circulation flows, compared to FSAR requirement. Graph 1 also shows calculated flow for Davis-Besse 1.

November 29, 1977 transient data shows that during 15 minutes that reactor coolant pumps were idle, heat was being removed (loop Tb and TC decreasing).

GRAPH #1

NATURAL CIRCULATION

50% CF-OPERATE-RANGE



MM-312 R
File

Babcock & Wilcox

Power Generation Division

P.O. Box 1260, Lynchburg, Va. 24
Telephone: (703) 384-5111

July 16, 1975

SOM #055 620-0014
12B13; SIP 14/028; TP

Mr. J. G. Evans, Station Superintendent
Davis-Besse Nuclear Power Station
5501 North State Route #2
Oak Harbor, Ohio 43449

Subject: Justification for Deletion of the NSSS Natural Circulation Test

Dear Jack:

Our Engineering Department has completed an in depth analysis of the NSSS natural circulation characteristics of Davis-Besse Unit I. The analysis was based on the Duke Power Company Oconee I natural circulation test results and an analytical extrapolation of results by comparison of Oconee I and Davis-Besse Unit I designs. As a result of this analysis, it was concluded that Davis-Besse Unit I will exhibit more natural circulation flow than Oconee I due to the elevated position of the steam generators with respect to the reactor vessel.

In lieu of the Oconee I natural circulation test results and the analysis by our Engineering Department the following is recommended:

1. The natural circulation steam generator water level setpoint, Integrated Control System FW 20.4 and FW 21.9, should be reduced from 95% to 50% on the operating range instrumentation. 50% is the setpoint used in the Oconee I natural circulation test and the engineering analysis.

2. The natural circulation test at Davis-Besse Unit I need not be conducted per Regulatory Guide 1.68, Appendix A, Part D.1a (November, 1973) which states as follows:

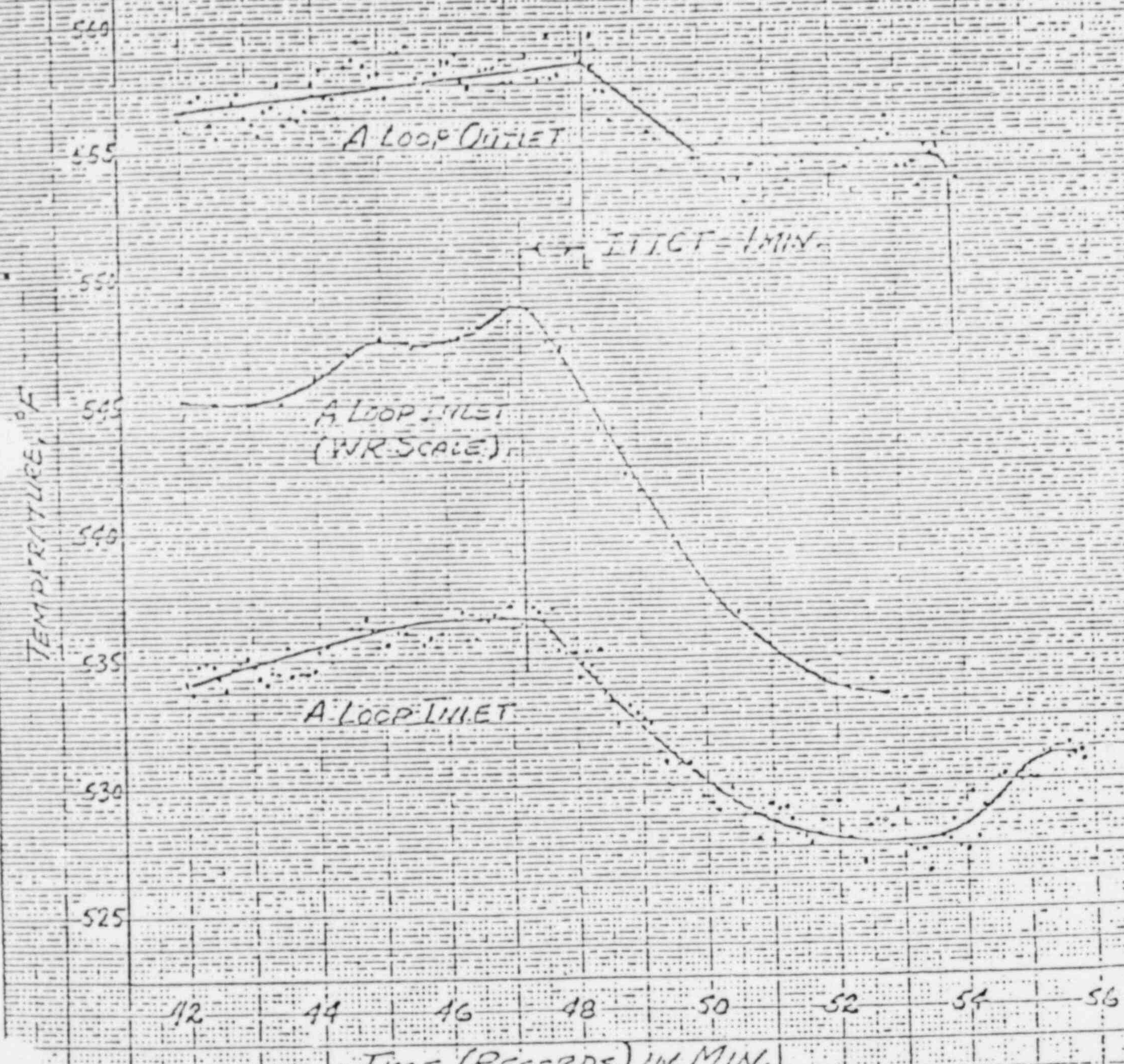
   "Natural circulation tests to confirm sufficient cooling capacity. Comparison of adequate flow data with the performance of previously tested plants of like design may be substituted for this test."

In order to support item 2 above, the following information should be useful in deleting the requirement for a natural circulation test.

GRAPH I

OCONEE I NATURAL CIRCULATION TEST - WITH DECAY HEAT

5/2/74



	I	A	F	INIT.	DATE
ECN					
JES					
FRM					
RVB					
LAH					
WHS					
CRD					
RES					
GLH					
SGJ					
HLD					
ASD					
CLM					
BB					
JKW					
FSM					
TEH					
MDC					
AST					
TWR					
RLS					
RMA					

Davis-Besse Nuclear Power Station

Unit No. 1

Procedure TP 800.04

Natural Circulation Test

Record of Approval and Changes

NUCLEAR SAFETY RELATED

Prepared by JAMES F. ALLI ______ 6-28-77

Submitted by ______ Section Head ______ 7/2/77 Date

Recommended by ______ SRB Chairman ______ 7/12/77 Date

QA Approved by ______ Manager of Quality Assurance ______ 7-26-77 Date

Approved by ______ Station Superintendent ______ 7/27/7 Date

Revision No.	SRB Recommendation	Date	QA Approved	Date	Sta. Supt. Approved	Date
1		11/8/77		11/28/77		11/2

Please Return Previous Revision to the Davis-Besse Office Supervisor, Stop 2103

TEST PERFORMANCE

Test Completed ______ Test Leader ______ Date

Recommended by ______ Section Head ______ Date

Recommended by ______ SRB Chairman ______ Date

1. PURPOSE

The purpose of this procedure is to verify that on loss of all forced reactor coolant flow, natural circulation will begin to provide adequate core cooling for all possible levels of decay heat generation. The procedure provides two methods of measuring primary flow rate under natural circulation conditions.

The test is performed in two phases. Since under natural circulation conditic Tc will change significantly from the value at which power range instrumentati was calibrated, it will be necessary to measure the effect of a change in Tc c indicated neutron flux. This is accomplished in Phase I. Phase II is the natural circulation test itself. With reactor power at 2 - 4% FP, Auxiliary Feedwater flow is established to the OTSG's. While maintaining the reactor critical, the operating RC pumps are tripped. When steady state conditions are established, primary flow will be measured by calculation using reactor ΔT and by measurement of loop transit time.

2. EQUIPMENT NEEDED

2.1 Reactimeter

2.2 Brush Recorder (6 Channel) Equip. No.____________

2.3 Digital Voltmeter Equip. No.____________

3. REFERENCES

3.1 Davis-Besse Final Safety Analysis Report, Section 15.2.5.

3.2 Power Escalation Controlling Procedure, TP 800.00.

3.3 Reactor Protective System Operating Procedure, SP 1105.02.

3.4 Physics Test Manual (B&W) TG 000.23.

3.5 TECo Nuclear Quality Assurance Manual.

3.6 AD 1801 series on the Conduct of the Preoperational & Startup Test Program.

3.7 Auxiliary Feedwater System Operating Procedure, SP 1106.06.

3.8 Power Operations, PP 1102.04.

(TS) 3.9 Davis-Besse Technical Specifications:

TS 3.10.3 Special Test Exception - Reactor Coolant Loops
TS 3.4.1 Limiting Condition for Operation - Reactor Coolant Loops
TS 3.2.5 Limiting Condition for Operation - DNB Parameters
TS 3.1.1.4 Limiting Condition for Operation - Minimum Temperature for Criticality

TS 3.1.1.2 Limiting Condition for Operation - Boron Dilution
TS 3.7.1.3 Limiting Condition for Operation - Condensate Storage Tank

3.10 SP 1103.15, Reactivity Balance.

3.11 ST 5030.11, RPS Power Range Calibration

3.12 TP 800.05, Reactivity Coefficients at Power

3.13 IC 2000.03, Setting RPS Overpower Trip Bistable Setpoints.

3.14 ST 5030.02, RPS Monthly Check

4. TIME & PERSONNEL REQUIRED

4.1 Each Phase of this test will require approximately 4 hours to complete. Note that this does not include the time required to establish the required plant conditions, notably Xenon conditions, which will require on the order of [illegible]1 hours at ~5% FP.

4.2 Personnel Required

Phase I - Reactor Operator at Diamond Station
Reactor Operator controlling feedwater
Reactimeter Operator
Test Leader

Phase II - Reactor Operator for Primary Plant Controls
Reactor Operator at Diamond Station
Reactor Operator at feedwater controls
Reactimeter Operator
Brush Recorder Operator
1 Equipment Operator at Auxiliary Feed Pumps
I&C Technicians to jumper RPS, Measure NNI voltages, etc.
Test Leader
Shift Foreman in Control Room

5. LIMITATIONS & PRECAUTIONS

5.1 When on natural circulation, manually trip the reactor and start one reactor coolant pump in each loop if any of the following limits are reached:

PARAMETER	HIGH LIMIT	LOW LIMIT
Indicated Reactor Power (NI5,6,7, or 8)	5% FP*	—
Reactor Coolant Pressure (PRS RC2B2, RC2A2)	2300 PSIG	1990 PSIG
Pressurizer Level (LRS RC14)	280 IN.	50 IN.
OTSG Pressure (PI SP12B or PI SP 12A)	1020 PSIG	

Any Incore T/c (T511 - T562)	650 F	--
Th (TI RC3B1, RC 3A1)	600 F	--
CST Level (Tank in Service)	--	10 FT.

* Corrected (See Section 7.1)

5.2 When on natural circulation, manually trip the reactor and begin feeding using a main feed pump if at any time an auxiliary feed pump is lost or auxiliary feedwater flow is lost for any other reason.

(TS) 5.3 Do not change reactor coolant boron concentration during the time reactor coolant pumps are off. (TS 3.1.1.2)

5.4 While on natural circulation, pressurizer spray will be unavailable, therefore pressure control of the RCS will be slow at best. The means available are changing OTSG level using auxiliary feedwater, pressurizer heater control, letdown & makeup, and (in an emergency) electromatic relief. Monitor temperature and pressurizer level trends and take action well in advance to minimize primary pressure excursions.

6. PREREQUISITIES

6.1 Prerequisites for PHASE I.

6.1.1 The plant is at ~15% FP per PP 1102.04, Power Operations.

Verified________________ Date__________

6.1.2 RCS boron concentration is ± 30 ppmb of the value at which Phase II will be run.

Verified________________ Date__________

NOTE: Phase II will be conducted at 2 - 4% FP, approximately equilibrium Xe, with GP. 6/7 60-80% WD.

6.1.3 Feedwater demand stations FIC ICS 32B/32A are in HAND. Feedwater demand is on Low Level Limit.

Verified________________ Date__________

1 6.1.4 Pressurizer Level is ~200"; Makeup tank level is ~85", and there are 2 letdown coolers in service.

Verified________________ Date__________

6.1.5 The reactimeter is set up to record data per Attachment 1.

Verified________________ Date__________

6.1.6 Reactor Power Imbalance is 0 ± 0.5% FP.

Verified_______________Date_______

6.1.7 Group 6/7 position is 70-80% WD.

Verified_______________Date_______

6.1.8 The NSS heat balance program in the Plant Computer has been checked and is computing core thermal power accurately.

Verified_______________Date_______

6.1.9 The following parameters are on computer trend recorders on the operator's console.

MN FW Flow (Loop 1)	F674
MN FW Flow (Loop 2)	F682
GEN. MW	J427

Verified_______________Date_______

6.2 Prerequisites for PHASE II

6.2.1 The plant is in power escalation testing per TP 800.00, Power Escalation Sequence.

Verified_______________Date_______

6.2.2 The following testing has been completed at 15% FP:

TP 800.05, Reactivity Coefficients at Power
TP 800.08, ICS Tuning at Power
TP 800.22, NSS Heat Balance
TP 800.02, NI Calibration at Power

Verified_______________Date_______

1 6.2.3 Reactor Power is at 2-4% FP per PP 1102.04 with one main feedwate pump and 2 RC pumps in operation. The Main FW Pump is on Main Steam. Mini-feed to both S/G's is in operation.

Verified_______________Date_______

6.2.4 Xenon concentration is approaching equilibrium, such that calculated reactivity change between the start of the test and test completion will be less than .04% $\Delta k/k$. (Ref. Reactivity Balance Calculation, SP 1103.15)

Verified_______________Date_______

6.2.5 Heat Balance & NI Calibration (ST 5030.11, RPS Power Range Calibration) have been completed at 4% FP at the boron concentration at which the test will be run.

Verified________________ Date________

6.2.6 A minimum of 47 incore thermocouples (TE 1M01 - TE 1 M14) are operable.

Verified________________ Date________

6.2.7 Moderator temperature coefficient has been measured per TP 800.05 Reactivity Coefficients at Power, and is predicted to be no more positive than 0.0% $\Delta k/k$ ^{o}F at the power level and boron concentration at which this test will be run.

NOTE: The core must have been expended ~4 EFPD before the temperature coefficient is negative.

6.2.8 Pressurizer Level is approximately 150". Pressurizer & Makeup tank are within ± 30 ppmb of RCS concentration. There are 2
1 letdown coolers in service.

Verified________________ Date________

6.2.9 The reactimeter & Brush Recorders are set up and calibrated to record data as specified in Attachment 3.

Verified________________ Date________

6.2.10 The Plant Computer is set up to record data as specified in Attachment 4.

Verified________________ Date________

6.2.11 The ICS Configuration is as follows:

STATION		STATUS
HS ICS 1	Unit Master	Track
	Turbine	Tripped
HIC ICS 13	S/G - RX Master	Hand
HIC ICS 20	RX Demand	Track
HC NI 44	Diamond	Manual
FIC ICS 32B FIC ICS 32A	F/W Demand	Hand (0%)
HIC ICS 30	Δ Tc	Hand (50%)
HIC ICS 36A HIC ICS 36B	Main Feed Pumps (one)	Auto
FIC ICS 35B FIC ICS 35A	Main FW Valves	Auto
FIC ICS 33B FIC ICS 33A	S/U FW Valves	Auto

6.2.12 The RPS high flux trip has been reset per IC 2000.03, Setting of RPS Overpower Trip Bistable Setpoints, to 10% FP on all 4 RPS Channels. (TS 3.10.3)

Verified________________ Date________

6.2.13 Both condensate storage tanks are filled with secondary makeup quality water to a level of > 30'.

Verified________________ Date________

1 6.2.14 The Auxiliary Feedwater System, including both pumps, is operabl per SP 1106.06, Auxiliary Feedwater System. The Aux boiler is fi up to normal operating pressure.

Verified________________ Date________

1 6.2.15 Boron concentration in the RCS is + 30 ppmb of that when Phase I was completed. Batch calculations have been performed for additi to the Makeup Tank.

Verified________________ Date________

(TS) 6.2.16 The high flux trip portion of ST 5030.02, RPS Monthly Check, must be completed within 12 hours of starting Phase II. (TS 4.10.3.2)

Verified________________ Date________

7. PROCEDURE

7.1 PHASE I - The purpose of Phase I is to measure the effect of reduced temperatures on indicated neutron flux. This data will be used to produce a correction to indicated power which can be used during the natural circulation test.

7.1.1 Verify all prerequisites of 6.1 are complete.

Verified________________ Date________

7.1.2 Obtain Shift Foreman's permission to begin this Phase.

Time_____ Shift Foreman__________ Verified________________ Date________

7.1.3 Adjust imbalance to 0 ± .5% using the APSR's.

Verified________________ Date________

7.1.4 Shift Reactor Demand Station HIC ICS 20 & Diamond Station to MANUAL. Maintain reactor power at 15% controlling rods in MANUAL.

Verified________________ Date________

1 7.1.5 Station another reactor operator at the feedwater demand stations to control feedwater. Place pressurizer level control (LIC RC-14) [illegible]

7.1.6 Start the trend recorders on the operator's console.

Verified________________ Date________

7.1.7 Begin recording data on the reactimeter at 1 second intervals. Begin recording data on Attachment 2 at 1 minute intervals. Obtain NSS heat balance calculation from plant computer. (Record a minimum of 5 minutes of steady state data).

Verified________________ Date________

7.1.8 Using feedwater demand stations FIC ICS 32B/32A in HAND, SLOWLY increase feedwater demand to lower Tav ~5°F.

NOTE: This is an increase of only ~4" SUR level and will reduce pressurizer level ~25".

Do not move control rods unless necessary to turn steadily increasing or decreasing power.

Verified________________ Date________

7.1.9 With Tav steady, balance feedwater flow so that total feed flow is the same as recorded in step 7.1.6, 7. It may at this point be necessary to adjust reactor power using control rods in Manual to achieve desired Tav & FW flow.

Verified________________ Date________

7.1.10 Wait for conditions to stabilize & request NSS heat balance from the plant computer. Verify that Calculated MWth equals that determined in step 7.1.7 ± 20 MWth.

Verified________________ Date________

7.1.11 Stop recording data on the reactimeter ("O" Switch), allow the recorder to complete its last record, then resume recording data.

Verified________________ Date________

7.1.12 Record 5 minutes of data on Attachment 2.

Verified________________ Date________

7.1.13 Repeat steps 7.1.7 - 7.1.12 at ~5° increments until Tav = 559 ± 1 F.

Verified________________ Date________

7.1.14 SLOWLY reduce FW demand until FW demand is on low level limit.

Verified________________ Date________

7.1.15 Return the ICS to the lineup specified by the Shift Foreman.

Verified________________ Date________

7.1.16 Stop recording data on the reactimeter and data sheets.

Verified________________ Date________

7.1.17 Inform the Shift Foreman that this Phase is complete.

Verified________________ Date________

7.1.18 Delog reactimeter data and determine correction factor for indic power using the method on Attachment 8.

Verified________________ Date________

7.2 PHASE II - Natural Circulation Measurement

7.2.1 Verify that all prerequisites for Phase II, Section 6.2, have be completed.

Verified________________ Date________

7.2.2 Obtain the Shift Foreman's permission to begin this Phase.

Time_____ Shift Foreman__________ Verified________________ Date________

7.2.3 Start taking data on the reactimeter at 0.1 second intervals. Start the Brush Recorder at 25mm/min.

Verified________________ Date________

1 7.2.4 Manually start Auxiliary Feed Pumps 1-1 & 1-2 per SP 1106.06, Auxiliary Feedwater System, by opening MS 106 (HIS 106A) & MS 107 (HIS 107A) (C5717). With Mode Switches HIS 520B & HIS 521B (C57 in MANUAL, adjust speed to ~2000 rpm.

NOTE: Be prepared to add water to the MU tank as required.

Verified________________ Date________

1 7.2.5 Trip the SFRCS in the Loss of RC Pump Mode by pressing & latchin HIS 4869E & HIS 4870E (C5721). This will align each Auxiliary Feed Pump to its respective steam generator. Place press. level control in HAND (LIC RC-14).

Verified________________ Date________

1 7.2.6 Slowly & evenly increase auxiliary feed pump speed using HIS 520 and HIS 521A to raise steam generator level to ~100" on the S/U Range. The S/U Feedwater Valves will shut as level is increased This will cause a cooldown of about 9°F from 543°F and a corresponding 45" drop in pressurizer level which is desired. Insure that mini-feed is in operation.

Verified________________ Date________

7.2.7 Maintain SG level at 100" on the SUR using the Aux FW pumps. Verify that both the S/U and Main Feedwater Valves are shut. S the SUFP then bring on the Aux Boiler and shift the Aux steam he to the Aux boiler. Shift the Main FW pump to the Aux steam head and shift gland steam to the Aux Steam header. Decrease Main FW pump as directed by the Shift Foreman.

Verified________________ Date________

7.2.8 Allow temperature and pressures to stabilize and reverify the following initial conditions:

Reactor Power	2-4% FP (Corrected*)
Xe Condition	(As specified in step 6.2.4)
Boron concentration	(As specified in step 6.2.15)
Pressurizer Level	100 - 150"
2 LD Coolers in service	

* Correct indicated power for temperature using correction determined in Phase I (See Attachment 8).

Verified________________ Date________

7.2.9 Defeat loss of flow trips in the Reactor Protective System by completing Attachment 5.

Verified________________ Date________

7.2.10 Using digital voltmeter measure compensated loop flow voltage in NNI at compensated flow multiplier output.

	NNI LOCATION	PIN
LOOP 1	7-6-5	7
LOOP 2	4-3-9	7

Record 5 minutes of flow voltages at 30 second intervals. Recor voltages on Attachment 9.

Verified________________ Date________

7.2.11 Begin trending computer data as specified in Attachment 4.

Verified________________ Date________

1 7.2.12 Trip the running reactor coolant pumps after observing the Notes of this step and step 7.2.13.

NOTE: Flow coastdown time will be approximately 30 seconds. As flow coasts down, reactor Δ T will increase and should stabilize around 30-40°F. with flow sustained by natural circulation. With negative moderator coefficient, reactor power should be stable, but response to temperature transients will be sluggish due to low flow.

Primary temperature will tend to increase due to the reduced flow, with corresponding increase in pressurizer level.

7.2.13 Carefully monitor RCS temperatures, pressures, pressurizer level and reactor power. Minimize the effects of the primary temperatu increase by over feeding the steam generators and allowing level to increase to a maximum of 50% OR The primary pressure transient may also be mitigated by increasing letdown flow.

1 Manually trip the reactor and start two RC pumpsin each loop if auxiliary feedwater flow is lost or if any of the following limit: are reached:

PARAMETER	HIGH LIMIT	LOW LIMIT
Indicated Reactor Power (NI5,6,7 or 8)	5% FP *	--
Reactor Coolant Pressure (PRS RC2B2, RC2A2)	2300 PSIG	1990 PSIG
Pressurizer Level (LRS RC14)	280 IN.	50 IN.
OTSG Pressure (PI SPRB or PI SP12A)	1020 PSIG	--
Any Incore T/c (T511 - T562)	650 F	--
Th (TI RC3B1, RC3A1)	600 F	--
CST Level (Tank in Service)	--	10 FT.
1 RCS Tave		525°F

* Corrected (See Section 7.1)

Verified_______________ Date_________

7.2,14 Move control rods only as required to keep reactor power between 1 & 4% FP (Corrected).

Verified_______________ Date_________

7.2.15 Allow Th, Tc and RCS pressure to stabilize. Verify that natural circulation has begun by observing that reactor ΔT has stabilize in each loop. This may take up to ½ hour. Expected natural circulation flow is on the order of 7% which will result in a reactor ΔT of about 30°F.

Verified_______________ Date_________

7.2.16 Gently adjust reactor power and steam generator level to achieve stable conditions at 40% OR level and 2-4% FP corrected.
NOTE; Intermediate Range level may provide a more accurate scale
1 for controlling reactor power.

Verified_______________ Date_________

7.2.17 Record data for at least 10 minutes after reactor ΔT and reactor power have been stabilized.

Verified_______________ Date_________

7.2.18 Shift Loop 1 Turbine Bypass Valve to HAND (PIC ICS 12B) and open it ~5% to reduce 1-1 OTSG pressure by ~50 PSIG. Do not exceed 100 F/Hr. cooldown rate (~20 psig/min.)

NOTE: If the Reactor is tripped while a Turbine Bypass Valve is in HAND, return the valve to the CLOSED position and return to AUTO if directed by the Shift Foreman.

Verified________________ Date________

7.2.19 Monitor Brush Recorder traces. The temperature drop should be detected on the Loop 1 Th trace in about 1 minute.

Verified________________ Date________

7.2.20 Continue to maintain reactor power 2-4% FP corrected using control rods in Manual.

Verified________________ Date________

7.2.21 When the temperature drop is detected on the Loop 1 Th Trace, shift Loop 2 Turbine Bypass Valve to HAND (PIC ICS 12A) and open

1 it ~5% to reduce 1-2 OTSG pressure by ~50 PSIG. Do not exceed 100 F/Hr cooldown rate (~20 psig/min.)

NOTE: Do not allow Tav to go below 525 F.

Verified________________ Date________

7.2.22 Continue taking data until the temperature change is detected on the Loop 2 Th Trace in the Brush Recorder. This should take approximately one minute.

Verified________________ Date________

7.2.23 Return Turbine Bypass Valve H/A stations in AUTO and allow Tav to increase back to equilibrium value for turbine header pressure of 870 psig. This will be about 534 F.

Verified________________ Date________

7.2.24 Clear the trip on the SFRCS Manual Trip HIS 4869E & HIS 4870E by releasing the hold-in trip buttons. This will allow the SFRCS to reset when RC pumps are started.

Verified________________ Date________

7.2.25 Manually trip the reactor. Verified________________ Date________

1 7.2.26 Start two RC pumps in each loop, then verify Auxiliary Feed Pump Mode Switches HIS 520B & HIS 521B (C5709) in MANUAL and back Auxiliary Feed Pumps down to minimum speed.

Verified________________ Date________

7.2.27 Carry out Reactor Trip Procedure, EP 1202.04.

Verified________________ Date________

1 7.2.28 As steam generators steam down, verify S/U Feedwater Valves open and control on Low Level Setpoint. Bring the running Main FW pu up to speed and stop the SUFP as directed by the Shift Foreman.

Verified________________ Date________

1 7.2.29 Return the Auxiliary Feedwater System to Standby Operation per SP 1106.06, Auxiliary Feedwater System.

Verified________________ Date________

7.2.30 Stop taking data on reactimeter, recorder and computer.

Verified________________ Date________

7.2.31 Remove jumpers installed on RPS in Step 7.2.8.

Verified________________ Date________

(TS) 7.2.32 Reset high flux trip as directed by PES Test Coordinator. (TS 3.10.3)

Verified________________ Date________

7.2.33 Inform Shift Foreman that this portion of the test is complete.

Verified________________ Date________

7.2.34 Calculate natural circulation flow per Attachment 6.

Verified________________ Date________

8. ACCEPTANCE CRITERIA

8.1 Natural circulation flowrate determined by either method in Attachment 6 equals or exceeds the minimum specified by Attachment 7.

Verified________________ Date________

9. RESULTS DISTRIBUTION

9.1 B & W Site Operations Manager

9.2 TECo Power Engineering & Construction Division

REACTIMETER DATA FOR PHASE I

Set up the reactimeter to record the following data:

PARAMETER	RANGE	SIGNAL RANGE	SUTP NO.
Generated MW	0-1000 MW	1-100 MV	22
MU Tank Level	0-100"	-10 + 10 VDC	35
Int. Range Flux (NI3)	10^{-11}-10^{-3}a.	0- + 10 VDC	40
Int. Range Flux (NI4)	10^{-11}-10^{-3}a.	0- + 10 VDC	41
Power Range Flux (NI5)	0 - 125% FP	0 - + 10 VDC	42
Power Range Flux (NI6)	0 - 125% FP	0 - + 10 VDC	43
Power Range Flux (NI7)	0 - 125% FP	0 - + 10 VDC	44
Power Range Flux (NI8)	0 - 125% FP	0 - + 10 VDC	45
Loop 2 Th	520 - 620 F	-10 - + 10 VDC	50
Loop 1 Th	520 - 620 F	-10 - + 10 VDC	51
Press. Level (Comp.)	0 - 320"	-10 - + 10 VDC	52
NR RCS Pressure	1700 - 2500 PSIG	0 - + 10 VDC	53
Loop 2 Tc (1-2-1)	520 - 620 F	-10 - + 10 VDC	58
Loop 2 Tc (1-2-2)	520 - 620 F	-10 - + 10 VDC	60
Loop 1 Tc (1-1-1)	520 - 620 F	-10 - + 10 VDC	62
Loop 1 Tc (1-1-2)	520 - 620 F	-10 - + 10 VDC	64
S/U FW Flow Loop 2	0 - $1.5.10^6$ #/Hr	-10 - + 10 VDC	70
S/U FW Flow Loop 1	0 - $1.5.10^6$ #/Hr	-10 - + 10 VDC	71
MN FW Flow Loop 2	0 - 7.10^6 #/Hr	-10 - + 10 VDC	75
MN FW Flow Loop 1	0 - 7.10^6 #/Hr	-10 - + 10 VDC	76
Feedwater Temp.	0 - 600 F	-10 - + 10 VDC	74
Group 6/7 Position	0 - 100 %	0 - 5 VDC	3
OTSG 2 Outlet Press.	0 - 1200 PSIG	-10 - + 10 VDC	72

D 0022

THE TOLEDO EDISON COMPANY

POWER-PRODUCTION DEPT.

TEST READINGS

OF

Station ____________

Test of ____________

Test No. ____________

Date ____________

Time ____________

Sheet No. 1 of 2

Page No. ____________

Observers ____________

Int. No. / Time	FI SP 3B LOOP 1 S/U FW FLOW	FI SP 3A LOOP 2 S/U FW FLOW	FI SP 4B LOOP 1 MN FW FLOW	FI SP 4A LOOP 2 MN FW FLOW	JI 6003 GEN MW						NSS HEAT BALANCE PLANT COMPUTER FUNCT. 9 GROUP 22	R!

THE TOLEDO EDISON COMPANY

POWER PRODUCTION DEPT.

TEST READINGS

OF

Int ____________

Test of ____________

Test No. ____________

Date ____________

Time ____________

Sheet No. 2 of 2

Page No. ____________

Observers ____________

NOTE: If Tave drops below 532°F record all readings at 15 Min. intervals.

Int. No. / Time	NI-3 Int. Range Flux (Amps)	NI-4 Int. Range Flux (Amps)	NI-5 Pwr. Range (% FP)	NI-6 Pwr. Range (% FP)	NI-7 Pwr. Range (% FP)	NI-8 Pwr. Range (% FP)	TT4B1 LOOP 1 NR Tc °F	TT4B3	TT4A1 LOOP 2 NR Tc °F	TT4A3		

REACTIMETER & RECORDER DATA FOR PHASE II

Set up the reactimeter to record the following data:

PARAMETER	RANGE	SIGNAL RANGE	SUTP NO.
RCS Compensated Flow Loop 1	0 - 90.10^6	-10 - + 10 V	48
RCS Compensated Flow Loop 2	0 - 90.10^6	-10 - + 10 V	47
MU Tank Level	0 - 100"	-10 - + 10 VDC	35
Power Range Flux (NI 5)	0 - 125% FP	0 - + 10 VDC	42
Power Range Flux (NI 6)	0 - 125% FP	0 - + 10 VDC	43
Power Range Flux (NI 7)	0 - 125% FP	0 - + 10 VDC	44
Power Range Flux (NI 8)	0 - 125% FP	0 - + 10 VDC	45
Loop 2 Th	520 - 620 F	-10 - + 10 VDC	50
Loop 1 Th	520 - 620 F	-10 - + 10 VDC	51
Press Level (Comp.)	0 - 320"	-10 - + 10 VDC	52
NR RCS Pressure	1700 - 2500 PSIG	0 - + 10 VDC	53
Loop 2 T_c (1-2-1)	50 - 650 F	-10 - + 10 VDC	59
Loop 2 T_c (1-2-2)	50 - 650 F	-10 - + 10 VDC	61
Loop 1 T_c (1-1-1)	50 - 650 F	-10 - + 10 VDC	63
Loop 1 T_c (1-1-2)	50 - 650 F	-10 - + 10 VDC	65
Group 6/7 Position	0 - 100%	0 - 5 VDC	3
OTSG 2 Outlet Press	0 - 1200 PSIG	-10 - + 10 VDC	72
OTSG 1 Outlet Press	0 - 1200 PSIG	-10 - + 10 VDC	73
OTSG 2 Operate Level	0 - 100%	-10 - + 10 VDC	77
OTSG 1 Operate Level	0 - 100%	-10 - + 10 VDC	79
OTSG 2 S/U Level	0 - 250"	-10 - + 10 VDC	78
OTSG 1 S/U Level	0 - 250"	-10 - + 10 VDC	80

REACTIMETER & RECORDER DATA FOR PHASE II

2. Set up Brush Recorders as follows:

A. Recorder No. 1

TRACE	PARAMETER	RANGE	SUTP !
1	Loop 2 Th	520 - 620 F	50
2	Loop 1 Th	520 - 620 F	51
3	Loop 2 T_c (1-2-1) (WR)	450 - 650 F	59
4	Loop 2 T_c (1-2-2) (WR)	450 - 650 F	61
5	Loop 1 T_c (1-1-1) (WR)	450 - 650 F	63
6	Loop 1 T_c (1-1-2) (WR)	450 - 650 F	65

NOTE: This recorder must be positioned in the Control Room so that the Test Leader can see it.

COMPUTER DATA - PHASE II

1. Program an alarm point for incore thermocouple temperatures T511 - T562 in th plant computer with setpoint 645 F.

2. Place the following parameters on trend recorders on the Operator's Console:

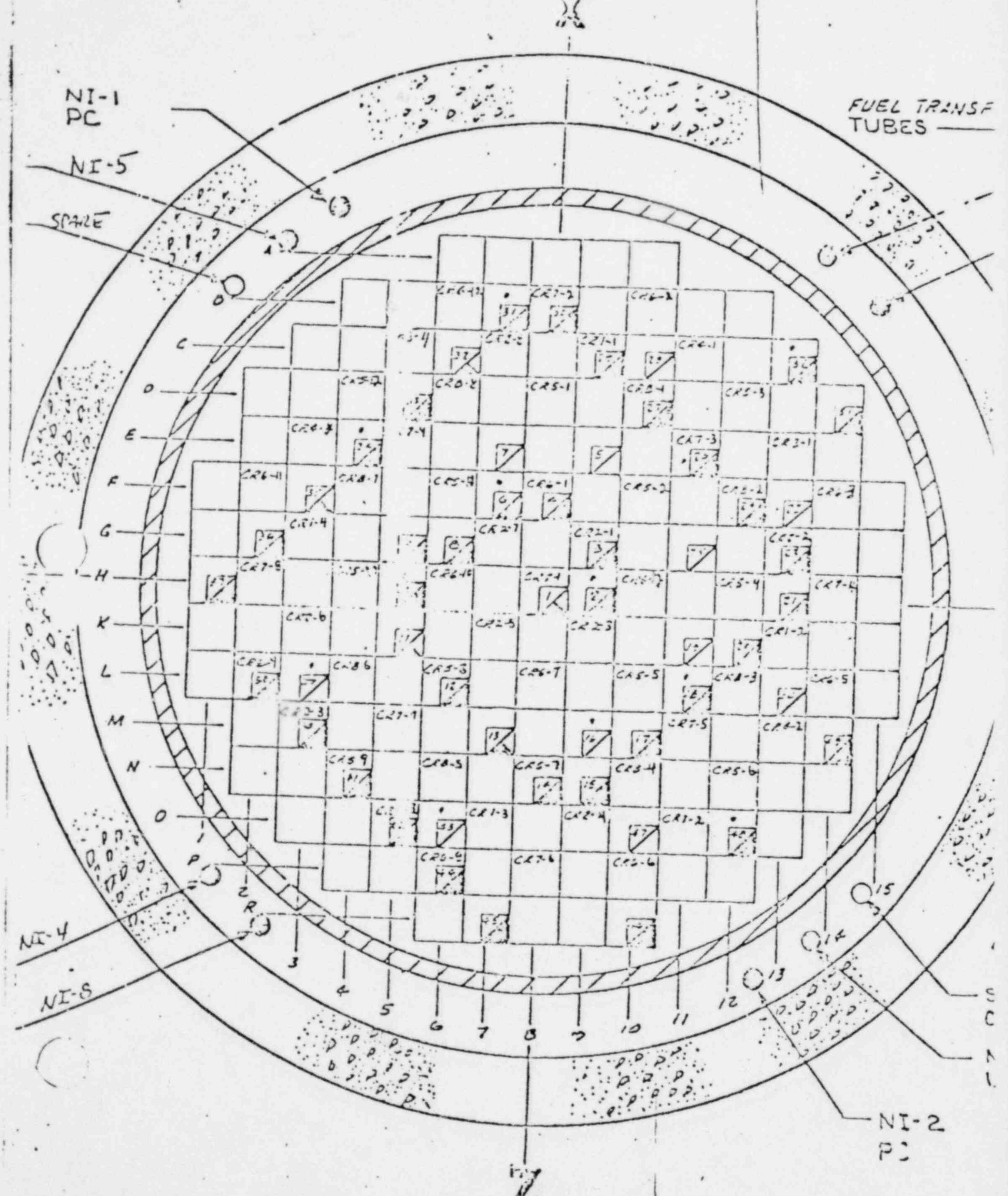
Loop 1 Th	T 721
Loop 2 Th	T 730
Loop 1 Tc (WR)	T 781
Loop 1 Tc (WR)	T 801
Loop 2 Tc (WR)	T 821
Loop 2 Tc (WR)	T 841
Loop 1 Comp. Flow	F 727
Loop 2 Comp. Flow	F 732

3. Place the following incore thermocouples on the line printer to print at 1 minute intervals:

CORE LOCATION	PT. ID. NO.
H - 9	T 541
F - 7	T 531
M - 9	T 542
L - 11	T 552
E - 11	T 549
L - 3	T 515
P - 6	T 528
C - 13	T 556
O - 12	T 555
B - 7	T 529
E - 4	T 517
H - 5	T 521
L - 6	T 526
G - 11	T 550
E - 9	T 539
G - 2	T 512
N - 4	T 518
R - 7	T 533
N - 9	T 543
C - 10	T 544

(Refer to the next page for core map.)

ATTACHMENT


X
NI-1
PC
FUEL TRANSF
TUBES
NI-5
SPARE
NI-4
NI-8
NI-2
PC
3
4
5
6
7
8
9
10
11
12
13
14
15

PROCEDURE FOR DEFEATING RPS LOSS OF FLOW TRIPS FOR NATURAL CIRCULATION TEST

1. Obtain keys for RPS Cabinets from the Shift Foreman.

2. Defeat Power/Pumps trip by installing jumpers as follows:

RPS CHANNEL	LOCATION	PINS	JUMPER INSTALLED/DATE	JUMPER REMOVED/DATE
1	1-3-8	17 - 18	/	/
2	1-3-8	17 - 18	/	/
3	1-4-8	17 - 18	/	/
4	1-4-8	17 - 18	/	/

3. Defeat Flux/Flow trip by installing jumpers as follows:

RPS CHANNEL	LOCATION	PINS	JUMPER INSTALLED/DATE	JUMPER REMOVED/DATE
1	1-4-14	17 - 18	/	/
2	1-4-14	17 - 18	/	/
3	1-5-14	17 - 18	/	/
4	1-5-14	17 - 18	/	/

4. Lock RPS Cabinets and return keys to Shift Foreman.

1

Verified_______________ Date________

CALCULATION OF NATURAL CIRCULATION FLOWRATE

METHOD NO. 1 - REACTOR ΔT

This method is based on the relationship between primary flow, heat input & entha q (BTU/HR) = $W \cdot \Delta h$, and assumes that for the range tested, $\Delta h = \Delta T$.

1. Average compensated loop flow voltages (Vm) which were recorded on Attachment Using the average voltage for each loop, compute compensated loop flow (Wf):

	Vm	$\frac{Vm + 10}{20}$	$Wf = \left(\frac{Vm + 10}{20}\right)(90.10^6)\ lb_m/hr$ @ 608° T_h
LOOP 1			
LOOP 2			

2. Delog reactimeter and average 1 min. of RCS temperature data just prior to RC pump trip (Step 7.2.12).

3. Using these averaged temperatures, determine reactor ΔT just prior to RC pump trip (Δ Tf):

$$\Delta T_f = \frac{T_h(1) + T_h(2)}{2} - \frac{Tc(1a) + Tc(1b) + Tc(2a) + Tc(2b)}{4}$$

$$= \_\_\_\_\_\_\_\_\_\_ {}^\circ F$$

4. Using the reactimeter data taken after steady state natural circulation has been established (Step 7.2.17), average 10 minutes of RCS temperature data.

5. Determine natural circulation reactor ΔT using the data averaged in Step 4:

$$\Delta T_n = \frac{T_h(1) + T_h(2)}{2} - \frac{T_c(1a) + T_c(1b) + T_c(2a) + T_c(2b)}{4}$$

$$= \_\_\_\_\_\_\_\_\_\_ {}^\circ F.$$

6. Using reactimeter data for time just prior to RC pump trip, average the power range levels for the 1 min. prior to the pump trip.

NI5______ NI6______ NI7______ NI8______ % FP

7. Determine the average power level prior to pump trip:

$$P_f = \frac{NI5 + NI6 + NI7 + NI8}{4} = \_\_\_\_\_\_\_\_ \%\ FP$$

8. Using the same period of time as step 4 above, average the power range levels for the 10 minute period:

NI5______ NI6______ NI7______ NI8______ % FP

9. Using the correction factors developed in Section 7.1, correct the power rang levels in Step 8 to the T_c prior to the pump trip.

NI5________ NI6________ NI7________ NI8________ % FP

10. Using the corrected power levels in Step 9, determine the average power level after natural circulation flow is established:

$$P_n = \frac{NI5 + NI6 + NI7 + NI8}{4} = \_\_\_\_\_\_\_\% \ FP$$

11. Calculate natural circulation flowrate:

$$W_n \ (lbm/hr) = \left(W_f \ (Loop\ 1) + W_f \ (Loop\ 2)\right)\left(\frac{\Delta T_f}{\Delta T_n}\right)\left(\frac{P_n}{P_f}\right)$$

12. Calculate natural circulation flowrate as % of 100% flow at 608°F:

$$\frac{W_n \ (100)}{131.10^6} = \_\_\_\_\_\_\_\_\_\% \ Flow$$

METHOD 2 - INDUCED TEMPERATURE TRANSIENT TIME

This method was a direct measurement of the time for a temperature perturbation to travel from the T_c instrument to the T_h instrument.

1. Plot the following reactimeter data taken during steps 7.2.18 - 7.2.22 versus time:

LOOP 1: T_h (1), T_c (1a), T_c (1b)

LOOP 2: T_h (2), T_c (2a), T_c (2b)

2. From the plots in step 1, determine the time between the temperature drop at the T_c instruments and the T_h instruments in each loop. (NOTE: This time should be on the order of 1 minute.)

Δt (loop 1) = ________Min.

Δt (loop 2) = ________Min.

3. Calculate the natural circulation flowrate using each loop Δt:

	Δt (min.)	$W_n = \frac{44,040}{\Delta t}$ (Gal/min)
LOOP 1		
LOOP 2		

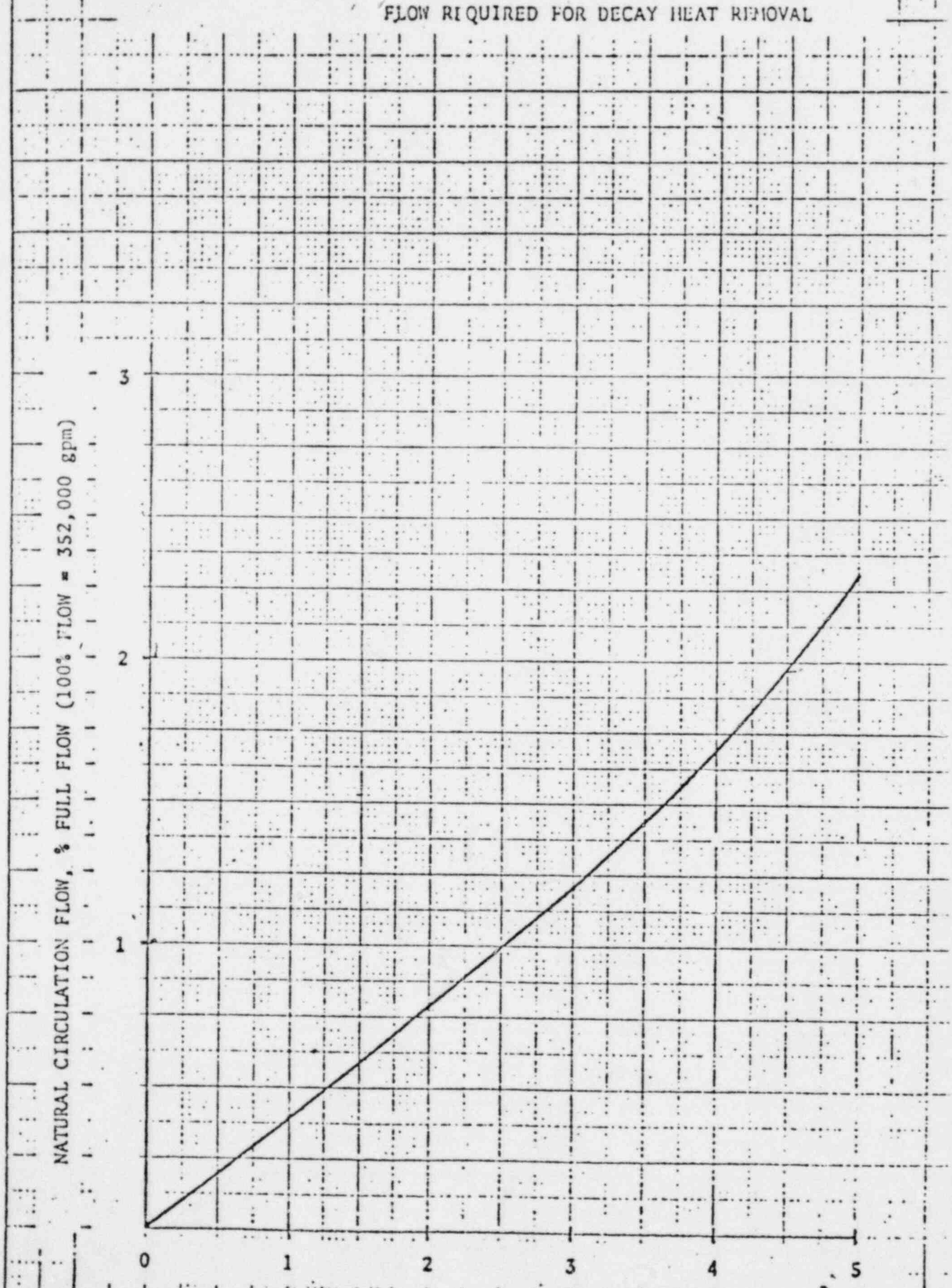
Where 44,040 = Volume of RCS (in gal.) between T_c & T_h instruments.

4. Average the flowrates obtained using Loop 1 & Loop 2 Δt:

$$\frac{W_n\ (1) + W_n\ (2)}{2} = W_n\ (\text{av.}) = \_\_\_\_\_\_\_\_\ \text{GPM}$$

5. Determine natural circualtion flow as a % of rated flow:

$$\frac{W_n\ (\text{av.})\ (100)}{352{,}000\ \text{gpm}} = \_\_\_\_\_\_\_\_\ \%\ \text{flow}$$

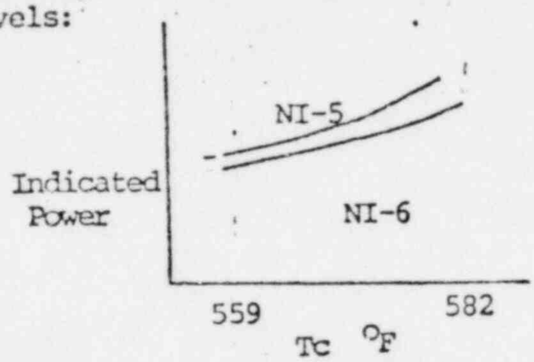

FLOW REQUIRED FOR DECAY HEAT REMOVAL
NATURAL CIRCULATION FLOW, % FULL FLOW (100% FLOW = 352,000 gpm)
3
2
1
0
1
2
3
4
5

DETERMINATION OF CORRECTION FACTOR FOR INDICATED POWER

1. Using reactimeter data from Section 7.1, select temperature & NI Power Data for each temperature plateau of Section 7.1. Be sure to select data where power level by heat balance and feedwater flows are constant. This has been "marked" on the reactimeter data file by starting a new block of data when conditions have stabilized (See step 7.1.11).

2. For the selected data records, average the four Tc values to obtain an average Tc at a given time.

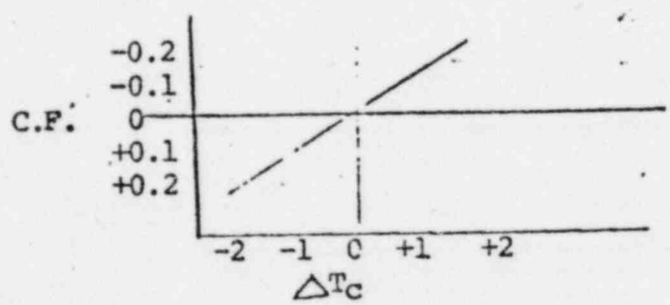
3. Plot the average Tc for each plateau versus the corresponding NI3, 4, 5, 6, 7, 8 flux levels:



Indicated Power VS. Avg. Tc for NI-5, 6
EFPD ________
CP 6/7 ________
Boron Conc. ________
RC Press ________

4. For each detector in Step 3, linearize the data and find the slope of the line which will be the correction factor for that detector.

5. Using the correction factors from step 4 above, construct charts for operators use showing correction to be applied to indicated power V. Tc:



Make chart similar to this. Since all detectors should be approximately the same, it should be possible to make one chart for all power range detectors and one for intermediate range.

6. The correction factor will be used in Phase II to correct indicated power:

$$P_{Actual} = P_{Ind.} + CF$$

TP 800.04.0

THE TOLEDO EDISON COMPANY

POWER PRODUCTION DEPT.

TEST READINGS

OF

Station ______

Test of ______

Test No. ______

Date ______

Time ______

Sheet No. 1 of 1

Page No. ______

Observers ______

Int. No. / Time	DVM Loop 1 NNI Comp. Flow (Volts)		DVM Loop 2 NNI Comp. Flow (Volts)									

R

Babcock & Wilcox

Attachment 1: Test Results Summary: Natural Circulation in Oconee I Type Plants, "A Description of Measurements and Summary of Results' March 21, 1974, as evaluated by B&W Nuclear Service. Natural circulation steam generator level approximately 50% on the operating range instrumentation.

Attachment 2: Natural Circulation

Graph 1: Flow vs Reactor Power (Decay Heat) @ Natural Circulation Level of 50% on the operating range instrumentation "Conservative analytical results".

Graph 2: Same as Graph 1, except curves represent "Realistic analytical results".

These two graphs represent our Engineering Department's evaluation of charact istics for Davis-Besse Unit I as compared to the Oconee I natural circulation characteristics normalized to Davis-Besse power and flow parameters. Graph 1 represents the conservative characteristics in which all heat transferred frc the Reactor Coolant System to the Secondary System is assumed to occur in the lower portion of the steam generator, in the vicinity of the lower tube sheet Graph 2 represents the more realistic situation for it assumes that all heat transferred from the Reactor Coolant System to the Secondary System occurs in the vicinity of the auxiliary feedwater nozzles where feedwater is introduced to the steam generators. Both graphs are based on a natural circulation leve of 50% on the operating range and as indicated the more realistic characteris tics, Graph 2, reflect more natural circulation flow than the conservative rc sults shown in Graph 1.

In each case the natural circulation flow at Davis-Besse Unit I will always b greater than that at Oconee I, a plant of like design, for the corresponding power conditions.

I hope that this information is sufficient for deletion of the Natural Circu tion Test and for making the necessary corrections to the FSAR. If you have questions, please contact Fred Faist.

Yours truly,

R J Baker Jr

R. J. Baker, Jr.
Site Operations Manager

RJB:FRF:nlf
encl.
cc: G. M. Olds
E. J. Coppola
J. A. Lauer
R. L. Pittman
T. F. Scott
E. L. Logan
E. R. Michaud

E. C. Novak, TECo
J. D. Lenardson, TECo
T. D. Murray, TECo

7/16/75

ATTACHMENT 1

Natural Circulation in Oconee I Type Plants

A Description of Measurements and Summary of Results

March 21, 1974

Prepared BY:

A. Robeson
Plant Performance Service

Reviewed fo Accuracy:

NATURAL CIRCULATION IN OCONEE I TYPE PLANTS

Summary

Adequate natural circulation in the reactor coolant system assumes heat removal from the reactor core upon loss of all reactor coolant pumps. Babcock & Wilcox nuclear steam systems are designed to provide natural circulation, and safety analysis verifies that in the natural circulation mode, more than adequate cooling is provided for the reactor core. As indicated in the Oconee I FSAR, the system is designed to provide natural circulation flow, at 1% decay heat, greater than that required for heat removal by a factor of five. Natural circulation tests performed on Oconee I, using two independent methods, yielded a minimum factor of ten. Although normal reactor coolant flow sensors are not intended to read flow rates in the range produced by natural circulation, a flow rate in agreement with test measurements was indicated in the control room. Thus, analysis and experimental measurements have verified that Oconee I-type plants are capable of adequate natural circulation flow in the reactor coolant system upon loss of all reactor coolant pumps.

Method of Measurement

The basis for measurement of natural circulation is determination of the reactor core transit time for a temperature transient, the "induced temperature transient circulation time (ITTCT). Decay heat from the reactor core provides the flow, and, prior to the measurement, the reactor is operated at power for a time which will insure that at least a 1% full power decay heat level will be present during the first hour following reactor shutdown. The once-through steam generators (OTSG) are operating at a level of approximately 50%, and the reactor is brought to hot shutdown condition with one reactor coolant pump (RCP) operating in each loop. The main feedwater pumps are stopped and the level in the OTSG's maintained at 50% by the emergency feedwater pump through the auxiliary nozzles.

The remaining two RCP's are tripped, and the core outlet temperature allowed to level off, indicating a stabilized natural circulation flow. The time required is about one-half hour. When natural circulation is established, a temperature drop of about 10 degrees is produced in the core inlet temperature from a rapid reduction in header pressure by opening the steam bypass valves. A measurement of the time between the break point in temperature at the cold leg and that at the hot leg, determines the circulation time.

The volume and weight of water between the two temperature measuring points and the observed transit time are the parameters necessary to determine the natural circulation flow (NCF):

$$NCF = \left(\frac{M}{ITTCT}\right) \qquad (1)$$

where: M = Mass of the reactor coolant between cold and hot leg RTD's at the time the ITTCT is measured in lbm.

ITTCT = Induced Temperature Transient Circulation Time in hours.

An alternate value for the natural circulation flow is obtained by using a calculated value of the decay heat source in the reactor at the time of introduction of the temperature breakpoint. Using a calculated decay heat curve and the recent power history of the plant, a value for the decay heat generated by the core for any time after shutdown can be obtained.

The calculated value of Q, the decay heat generated by the core (Btu/hr), permit the natural circulation flow (NCF) to be calculated by:

$$NCF = \frac{Q}{C \times (T_h - T_c)} \qquad (2)$$

where: Q = Calculated value of decay heat at time of ITTCT measurement.
C = Specific heat of reactor coolant in Btu/lb°F
T_h = Temperature of hot leg at time breakpoint occurs at hot leg.
T_c = Temperature of cold leg at time breakpoint occurs at cold leg.

Experimental Data

The initial experiment to measure natural circulation flow with decay heat was conducted at Oconee I on November 4, 1973. The results showed that there was adequate natural circulation, but due to problems with data retrieval, no accurat value for ITTCT could be established. A second experiment, on May 2, 1974, yield the r[illegible]own below.

Natural circulation measurement using Equation (1):

M = Mass of reactor coolant between cold and hot leg RTD's
= 254,541 lbm

ITTCT = 1 min. (Graph 1)

$$NCF = \left(\frac{254,541}{1}\right) \times 60 \text{ min/hr} = 15.3 \times 10^6 \text{ lbm/hr @ 1.05\% Decay Heat}$$

The pressure transient which produced the temperature drop is shown in Graph 2.

The sharp temperature decrease (breakpoint), used as a timing indicator to measure ITTCT, produces an increase in natural circulation flow which is included in the above value of NCF. A rough correction can be made by using the results of a similar experiment performed at zero power, beginning of life (May 1, 1973) when the decay heat was essentially zero. Graph 3 shows the result of a measureme yielding an ITTCT = 4.0 min. The flow rate corresponding is then:

$$NCF \text{ (No Decay Heat)} = \left(\frac{256,947^{*}}{4.0}\right) \times 60 = 3.85 \times 10^6 \text{ lbm/hr}$$

* Pressure and temperature conditions were not identical in the two experiments.