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

May 21, 1989

Docket No. 50-443

Mr. Edward A. Brown
President & Chief Executive
Officer
New Hampshire Yankee Division
Public Service Company of New
Hampshire
Post Office Box 300
Seabrook, New Hampshire 03874

Dear Mr. Brown:

SUBJECT: SEABROOK LOW POWER PHYSICS TESTS

In accordance with the Commission Order, CLI-88-10 dated December 21, 1989, for any low power testing license that may be issued for Seabrook Unit 1, the license will be conditioned to allow operation at power levels not in excess of five percent and shall permit no more than 0.75 effective full power hours (EFPH) of operation.

In consideration that such a license may be issued, we have reviewed the manner in which your staff intends to perform low power physics tests and remain within the license restriction of 0.75 EFPH and 5% maximum power level. The enclosure presents a summary of our understanding of how the two restrictions are expected to be met. We find the approach to be satisfactory.

Sincerely,

Victor Nerses

Victor Nerses, Project Manager
Project Directorate I-3
Division of Reactor Projects I/II

Enclosure:
As stated

cc w/o enclosure:
See next page

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cc:

Thomas Dignan, Esq.
John A. Ritscher, Esq.
Ropes and Gray
225 Franklin Street
Boston, Massachusetts 02110

Mr. Bruce B. Beckley, Project Manager
Public Service Company of New Hampshire
Post Office Box 330
Manchester, New Hampshire 03105

Dr. Mauray Tye, President
Sun Valley Association
209 Summer Street
Haverhill, Massachusetts 01830

Robert Backus, Esq.
Backus, Meyer and Solomon
116 Lowell Street
Manchester, New Hampshire 03106

Diane Curran, Esq.
Harmon and Weiss
2001 S Street, NW
Suite 430
Washington, D.C. 20009

Philip Ahren, Esq.
Assistant Attorney General
State House, Station #6
Augusta, Maine 04333

Mr. Edward A. Brown, President
and Chief Executive Officer
New Hampshire Yankee Division
Public Service Company of
New Hampshire
Post Office Box 300
Seabrook, New Hampshire 03874

Seacoast Anti-Pollution League
5 Market Street
Portsmouth, New Hampshire 03801

Ms. Diana P. Randall
70 Collins Street
Seabrook, New Hampshire 03874

Mr. T. Feigenbaum
Public Service Company of
New Hamsphire
Post Office Box 330
Seabrook, New Hampshire 03874

E. Tupper Kinder, Esq.
G. Dana Bisbee, Esq.
Assistant Attorney General
Office of Attorney General
208 State House Annex
Concord, New Hampshire 03301

Resident Inspector
US Nuclear Regulatory Commission
Post Office Box 1149
Seabrook, New Hampshire 03874

Mr. A. M. Ebner, Project Manager
United Engineers & Constructors
Post Office Box 8223
Philadelphia, Pennsylvania 19101

Steven Oleskey, Esq.
Office of the Attorney General
One Ashburton Place
P.O. Box 330
Boston, Massachusetts 02108

Carol S. Sneider, Esq.
Office of the Assistant Attorney General
One Ashburton Place
P.O. Box 330
Boston, Massachusetts 02108

D. Pierre G. Cameron, Jr., Esq.
General Counsel
Public Service Company of New
Hampshire
Manchester, New Hampshire 03105

Mr. James M. Peschel
Public Service Company of New Hamsphire
P.O.Box 300
Seabrook, New Hampshire 03874

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
25 Maplewood Ave.
King of Prussia, Pennsylvania 19406

Ashod N. Amirian, Esq.
Town Counsel for Merrimac
376 Main Street
Haverhill, Massachusetts 08130

cc:

Mr. Calvin A. Canney, City Manager
City Hall
126 Daniel Street
Portsmouth, New Hampshire 03801

Board of Selectmen
RFD Dalton Road
Brentwood, New Hampshire 03833

Ms. Suzanne Breiseth,
Board of Selectmen
Town of Hampton Falls
Drinkwater Road
Hampton Falls, New Hampshire 03844

Mr. Guy Chichester, Chairman
Rye Nuclear Intervention
Committee
c/o Rye Town Hall
10 Central Road
Rye, New Hampshire 03870

Chairman, Board of Selectmen
RFD 2
South Hampton, New Hampshire 03827

R. Scott Hill - Whilton
Lagoulis, Clark, Hill-Whilton
& McGuire
79 State Street
Newburyport, Ma. 01950

Ms. R. Cashman, Chairman
Board of Selectmen
Town of Amesbury
Town Hall
Amesbury, Massachusetts 01913

Honorable Peter J. Matthews
Mayor, City of Newburyport
City Hall
Newburyport, Massachusetts 01950

Mr. Donald E. Chick, Town Manager
Town of Exeter
10 Front Street
Exeter, New Hampshire 03823

Mr. John C. Duffett
President and Chief Executive Officer
Public Service Company of New Hampshire
1000 Elm St., P.O.Box 330
Manchester, New Hampshire 03105

Mr. Alfred V. Sargent,
Chairman
Board of Selectmen
Town of Salisbury, MA 01950

Senator Gordon J. Humphrey
ATTN: Tom Burack
531 Hart Senate Office Building
U.S. Senate
Washington, D.C. 20510

Mr. Owen B. Durgin, Chairman
Durham Board of Selectmen
Town of Durham
Durham, New Hampshire 03824

Jane Spector
Federal Energy Regulatory
Commission
825 North Capital Street, N.E.
Room 8105
Washington D. C. 20426

Mr. R. Sweeney
Three Metro Center
Suite 610
Bethesda, Maryland 20814

Mr. Richard Strome, Director
New Hampshire Office of Emergency
Management
State Office Park South
107 Pleasant Street
Concord, New Hampshire 03301

Adjudicatory File (2)
Atomic Safety and Licensing Board
Panel Docket
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Congressman Nicholas Mavroules
70 Washington Street
Salem, Massachusetts 01970

Mr. G. Thomas
Public Service Company of
New Hampshire
Post Office Box 330
Seabrook, New Hampshire 03874

Enclosure

Seabrook 5%/0.75 EFPH Operation

GENERAL INFORMATION

0.75 effective full power hours (EFPH) operation for Seabrook is equivalent to 0.75 x 3411MW_t x 1 hour = 2558 MW_t-hr. At 5% power (or 170.6 MW_t), Seabrook could operate continuously for 15 hours. The tests to be conducted are primarily low power physics tests and a natural circulation test. The majority of the low power physics tests are conducted in the zero power test range (approximately .01% power). Low power flux mapping will be conducted at approximately 1% power and the natural circulation test will be conducted at approximately 3% power.

The process that will be used to determine core exposure during the low power test program will be identical to that used to determine core exposure during normal plant operation. However, instead of using a secondary calorimetric to calibrate (normalize) the power range nuclear instruments the core ΔT power will be used to calibrate (normalize) the intermediate range (IR) nuclear instruments. This calibration will be based on the full power core temperature rise (core ΔT). One of the first evolutions to be performed in the low power test program will be to increase reactor power to 3% (based on core ΔT) and record the IR detector currents. From the data obtained by this evolution, the normalization constants for each intermediate range detector (amps/% power) will be determined.

A process computer program has been written to record the IR detector currents and the time between program executions. The program then utilizes this data along with the IR detector normalization constants to calculate core exposure. The EFPH will be the sum of the test power levels times the test time and this sum will be maintained below 2558 Mw_t-hr.

SPECIFIC INFORMATION

Reactor power will be measured using the core temperature rise normalized to the full power core temperature rise (commonly referred to as ΔT power). The IR detector outputs will then be normalized to the measured core ΔT power. It will be necessary to calibrate (normalize) the IR detectors to trace core exposure because most of the low power testing is conducted in the zero power test range where core ΔT is 0°F but the IR detectors are producing a current equivalent to approximately .01% power.

The uncertainties associated with the measurement of core ΔT are about the same magnitude as the measurement itself. To offset this, a full power core ΔT of 57.0°F is used to determine the IR detector normalization constants. A full power core ΔT of 57.0°F is conservative with respect to the expected full power value of 59.4°F. The process of normalizing the IR detector output to match core ΔT power also normalizes out any uncertainties associated with the IR detector outputs. Thus, the IR detector outputs simply inherit the error associated with the core ΔT measurements which has already been accounted for.

All instruments necessary to monitor core exposure are calibrated with the exception of the IR detector output normalization. IR detector normalization will be performed during normal plant startup regardless of any core exposure limitations.

There is no specific plan or schedule for expending the .75 EFPH. The only plan that exists is the low power test sequence which, if goes as planned and without any unforeseen test or equipment difficulties, should be completed within the allotted exposure limit. The tests are expected to be completed in about ten days.

A special computer program has been written for the main plant computer to calculate and track core exposure. An administrative procedure will be written to ensure that the exposure limit will not be exceeded and to document core exposure. The administrative procedure that tracks and documents core exposure will contain a section on manual tracking of core exposure if the plant computer is unavailable.

REACTOR ENGINEERING DEPARTMENT CALCULATION COVER SHEET

RECALC - 89 - 0004

SHEET 1 OF 5

CALCULATION TITLE:

IR Detector Conversion Constants for Core Exposure Tracking During the Low Power Test Program

PREPARED BY: Paul V. Grady DATE 6/14/89

REVIEWED BY: [signature] DATE 6/14/89

APPROVED BY: Paul V. Grady DATE 6/14/89

1.0 Title

IR Detector Conversion Constants for Core Exposure Tracking During The Low Power Test Program.

2.0 Purpose

The purpose of this calculation is to determine the IR detector conversion constants necessary to track core exposure during the low power test program.

3.0 References

1. Functional Description for the Program Used to Calculate Accumulated Core Exposure during the Low Power Physics Testing Program (Attached as figure 2)

4.0 Assumptions

None

5.0 Summary of Results

The conversion constants for both IR Detector Channels is

1680 EFPM / amp - minute

6.0 Body of Calculation

6.1 Convert ΔT power indication from a full power ΔT of 51°F to a full power ΔT of 57°F

$$\text{Corrected } \Delta T \text{ power} = \text{Uncorrected } \Delta T \text{ power} \times \frac{51°F}{57°F}$$

Note. Computer points A0312, A0317, A0322, and A0327 read out in units of % power.

	IR Detector Current	Uncorrected ΔT Power	Corrected ΔT Power
Loop 1	6×10^{-6}	.13	.12
	9×10^{-6}	.71	.64
	1×10^{-5}	.95	.85
Loop 2	6×10^{-6}	.31	.28
	9×10^{-6}	.80	.72
	1×10^{-5}	1.02	.91
Loop 3	6×10^{-6}	1.40	1.25
	9×10^{-6}	2.01	1.80
	1×10^{-5}	2.21	1.98
Loop 4	6×10^{-6}	.72	.64
	9×10^{-6}	1.15	1.03
	1×10^{-5}	1.43	1.28

6.2 Determine the slope (ie amps/% Power) for the observed IR Detector currents and Corrected ΔT Power indications. This information is presented graphically on figure 1.

Slope calculations were performed using the linear regression function on a HP 11C calculator.

	amps / % power
Loop 1	5.53×10^{-6}
Loop 2	6.43×10^{-6}
Loop 3	5.47×10^{-6}
Loop 4	6.38×10^{-3}

Although the magnitude of the loop ΔT powers varied the slope of the ΔT power versus IR detector current exhibited linear behavior. The variations in the magnitudes of the loop ΔT powers can be attributed to variations in steam generator loads

6.3 Determination of average slope and current equivalent to 100% power.

Average Slope 5.95×10^{-6} Amps / % power

Current Equivalent to 100% power

$$= 5.95 \times 10^{-6} \text{ amps}/\% \times 100\% = 5.95 \times 10^{-4} \text{ am}$$

Note: Preliminary value of IR current provided in the PCS was 1×10^{-4} amps. Per discussion with W personnel the above observed value is consistent with other W plant of similar design. The above value will be reevaluated during power ascension.

6.4 Determination of EFPM Tracking Program conversion constants.

The initial value of 10,000 was determined as follows

$$\frac{100\%}{10^{-4} \text{ amps}} \times \frac{1 \text{ EFPM}}{(100\%)(1 \text{ min})} = 10{,}000 \frac{\text{EFPM}}{\text{amp-m}}$$

Using the full power current determined in Section 6.3 the new conversion constants are as follows

$$\frac{100\%}{5.95 \times 10^{-4}\ \text{amps}} \times \frac{1\ \text{EFPM}}{(100\%)(1\ \text{min})} = 1680\ \frac{\text{EFPM}}{\text{amp-min}}$$

6.5 Based on a full power current of 5.95×10^{-4} amps the following information is calculated to aid in plant operations during low power testing

Zero Power Test Range Low 1×10^{-8} amps = .0017 % power
Zero Power Test Range Hi 1×10^{-7} amps = .0168 % power

Reactor Power	IR Detector Output
1%	5.95×10^{-6} amps
2%	1.19×10^{-5} amps
3%	1.79×10^{-5} amps
4%	2.38×10^{-5} amps
5%	2.97×10^{-5} amps

FIGURE 1 RECALC-89-0004

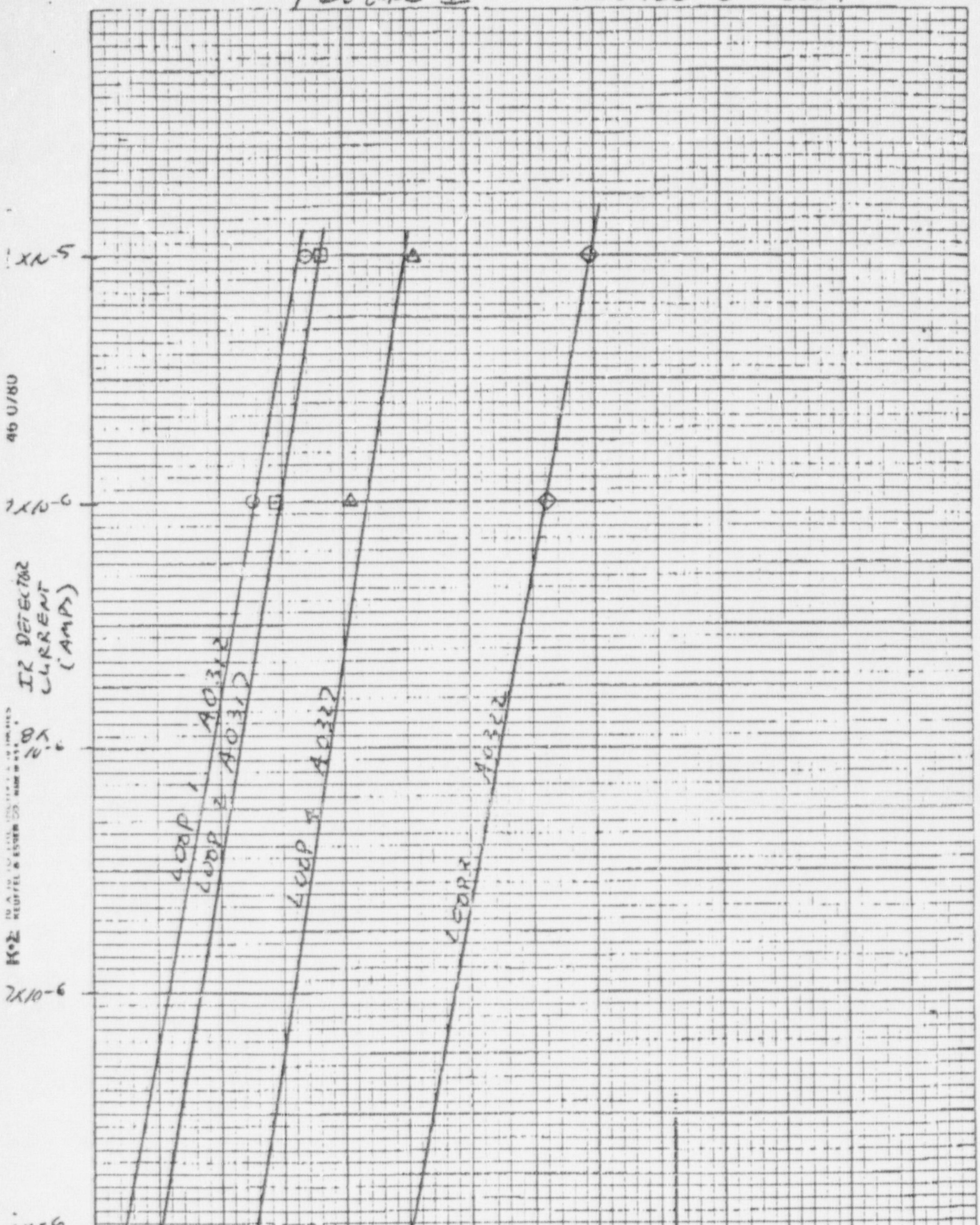

FIGURE 2
RECALC-89-0004

Functional Description for the Program Used to Calculate Accumulated Core Exposure During Low Power Physics Testing

Submitted by: [signature] 12/30/88

Approved by: [signature] 1/3/89

1.0 INTRODUCTION

When the low power license for Seabrook is issued, it is expected to contain an accumulated core exposure limitation of 45 effective full power minutes (EFPM). To verify compliance with any EFPM limitations and to simplify the core exposure tracking, an MPCS computer program will be used. This functional description specifies the requirements and basis for the calculations that will be used by the program to track accumulated core exposure.

2.0 DEFINITION OF TERMS

EFPM, Effective Full Power Minute
LPPT, Low Power Physics Testing
MCB, Main Control Board
MPCS, Main Plant Computer System
RE, Reactor Engineering

3.0 ASSUMPTIONS

3.1 The power level existing at the time of program execution has existed since the last program execution.

3.2 The response of intermediate range instrumentation versus power level is linear.

4.0 DESCRIPTION

A program for tracking core burnup currently exists on the MPCS; however, it lacks the capability to accurately track core exposure at low power levels. A separate program is required to track core exposure (in EFPM) during low power physics testing. The new program will operate as follows:

4.1 The program will be activated by the periodic scheduler on a 5 minute basis. Since the program is temporary in nature, it will be a stand alone program and will not be incorporated in the existing RE 5 minute task (RE5MIN).

4.2 Due to the temporary need for the program, no DA1 disc storage will be used. All tracking will be done with 6 calculated points which are described below:

- Calculated Point 1: This point is the cumulative amp-minutes calculated using intermediate range channel 35 indication. This C point will be updated every program execution.
- Calculated Point 2: This point is the cumulative amp-minutes calculated using intermediate range channel 36 indication. This C point will be updated every program execution.

- Calculated Point 3: This point is the channel conversion constant used to convert intermediate range channel 35 amp-minutes into an EFPM value. This C point will be updated by RE, as required, using the Analog Management Function at the MCB. This point will not be RELIAB checked since use of a substitute value causes an unreliable flag to be set.

- Calculated Point 4: This point is the channel conversion constant used to convert intermediate range channel 36 amp-minutes into an EFPM value. This C point will be updated by RE, as required, using the Analog Management Function at the MCB. This point will not be RELIAB checked since use of a substitute value causes an unreliable flag to be set.

- Calculated Point 5: This point is the current core exposure as of the last program execution. This C point will be updated every program execution.

- Calculated Point 6: This point is the scan number corresponding to the previous program execution. This C point will be updated every program execution.

4.3 Every time the program is executed, it will perform the following items:

4.3.1 Obtain the analog values for intermediate range channels 35 and 36, and convert to units of amps. If one value is unreliable, the alternate value will be substituted for the unreliable value. If both values are unreliable, a value of zero amps will be assigned to both channels.

4.3.2 The difference in scan number since last program execution will be calculated and converted to minutes.

4.3.3 The Step 4.3.1 values will be multiplied by the Step 4.3.2 delta time to obtain the change in amp-minutes for each intermediate range channel.

4.3.4 The change in amp-minutes from Step 4.3.3 will be added to the applicable calculated points to obtain new values of cumulative amp-minutes for each intermediate range channel. Calculated points 1 and 2 will be updated with the new values.

4.3.5 The cumulative amp-minutes from Step 4.3.4 will be multiplied by the applicable channel conversion constant (calculated points 3 and 4 input into the program and not RELIAB checked) to obtain an EFPM value for each intermediate range channel.

4.3.6 The current core burnup in EFPM will be obtained by averaging the two EFPM values of Step 4.3.5. The result will be used to update calculated point 5.

4.3.7 Calculated point 6 will be udpated with the scan number of the current program execution.

5.0 DETAILS OF CALCULATIONS

5.1 Conversion of MPCS intermediate range analog values to amps.

The analog values for intermediate range channels 35 and 36 are in units of MCAMPS. To obtain the required units of amps, the MCAMPS must be multiplied by 10^{-6}.

5.2 Calculating the time since last program execution and converting to minutes.

$$\text{Delta Time (Minutes)} = \left[\left(\text{Current scan number}\right) - \left(\text{Scan number of previous program execution}\right) \right] \times \left[\left(\frac{5 \text{ seconds}}{\text{scan}}\right) \times \left(\frac{1 \text{ minute}}{60 \text{ seconds}}\right) \right]$$

Note that if the delta scan time is less than zero (indicating a new day has started), a value of 17,280 will be added to the current scan time in order to obtain the delta scan time.

5.3 Converting amp-minutes to EFPM using channel conversion constants.

The value of cumulative amp-minutes for intermediate range channel 35 and 36 is converted to EFPM using channel conversion constants. The initial value of the channel conversion constant is determined as explained below; however, the values should be updated when a more accurate value has been obtained from LPPT data.

Revision 2 of the Precautions, Limitations and Setpoints for Nuclear Steam Supply Systems states that the initial setting for intermediate range channels is such that the full power current for 100% is 10^{-4} amps. Therefore the initial value for the channel conversion constants is:

$$\left[\frac{100\%}{10^{-4} \text{ amps}}\right] \left[\frac{1 \text{ EFPM}}{(100\%)\ (1 \text{ min})}\right] = 10^{+4} \text{ EFPM/amp-minute}$$

During LPPT, overlap data consisting of intermediate range currents and core delta temperatures (in units of % power) will become available. This data should be evaluated for possible channel conversion constant update as described below:

5.3.1 Verify the data represents stable conditions (constant power level and constant RCS temperatures).

5.3.2 Average the % power values to obtain a core average % power.

5.3.3 Correct the core average % power by multiplying by (51°F/57°F) where:

1) 51°F is the conservative value initially used by delta temperature instrumentation to convert delta temperature to % power.

2) 57°F is an estimate of actual full power delta temperature. (Note that an alternate value specified by the RE Department Supervisor can also be used).

5.3.4 Calculate new channel conversion constants as follows:

$$\text{Calculated Point 3} = \left[\frac{\%\text{ power (from Step 5.3.3)}}{\text{IR 35 indication (amps)}}\right] \times \left[\frac{1\text{ EFPM}}{(100\%)\ (1\text{ min})}\right]$$

$$\text{Calculated Point 4} = \left[\frac{\%\text{ power (from Step 5.3.3)}}{\text{IR 36 indication (amps)}}\right] \times \left[\frac{1\text{ EFPM}}{(100\%)\ (1\text{ min})}\right]$$

5.3.5 If directed by the RE Department Supervisor, update calculated points 3 and 4 with the Step 5.3.4 values using the Analog Management Function at the MCB.

5.4 Calculation of current core exposure.

Calculated point 5 for current core exposure in EFPM will be the average of the EFPM calculated by both intermediate range channels as shown below:

$$\text{Calculated Point 5 (EFPM)} = \frac{\left[\text{Calculated Point 1}\right]\left[\text{Calculated Point 3}\right] + \left[\text{Calculated Point 2}\right]\left[\text{Calculated Point 4}\right]}{2}$$