LOFT TECHNICAL REPORT LTR 143-12

FEBRUARY 8, 1978

MASTER

NIS POWER RANGE SETPOINTS FOR PHASE-B OPERATION

J. A. Rose

EGG/LTR--143-12

DE85 015437

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DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

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INTEROFFICE CORRESPONDENCE

date February 2, 1978
to Distribution
from J. A. Rose *J. A. Rose*
subject NIS POWER RANGE SETPOINTS FOR PHASE-B OPERATION-JAR-1-78

Ref: a) J. A. Rose to E. L. Johnson letter; "Determination of NIS Power Range Setpoints for Phase-B Operation", JAR-28-77, dated Dec. 16, 1977
b) LTR 111-88, "Zero-Power Physics Testing Safety Analysis", by R. A. Dimenna/ T. M. Howe, dated Jan 5, 1978

Since reference a) was written it has been shown that two of the factors used in calculation of the average power trip setpoint voltages were in error. The first is that the vendor test data for the P.R. detectors indicates the actual neutron sensitivities are higher than the catalog data specified. The minimum actual sensitivity is used in the attached calculations since this biases the data in a conservative direction.

The second factor changed is the average flux density expected at the P. R. detector locations for a cold, rods out condition. The new value (see attached) is a factor of 1.22 more conservative than the number originally used.

It should be noted that to meet the Technical Specification requirements for Phase-B operation only the average power trip setpoint need be set to a particular value. The required maximum nominal setpoint is calculated on the attached sheets based on the Limiting System Safety Setting (LSSS) specified in the Technical Specification, minimum actual detector sensitivity and the revised average flux density at the detector locations. The nominal value was derived by subtracting the trip setpoint uncertainty (50 MV - per the G.A. Corp. alignment procedure which is the basis for the LOFT Cal. Procedure) and a bistable drift allowance (1% = 100 MV) from the specified LSSS value. The alarm setpoint was chosen by the writer as 2% indicated power below the trip setpoint. This keeps the tolerance bands for the two setpoints from over-lapping therefore precluding a trip-before-alarm condition.

Further, in conversations with T. M. Howe and R. A. Dimenna it was pointed out that flux peaking within the core has already been taken into account in the average power setpoints, therefore, the peak power trip and alarm setpoints should be set for and left at a value considerably above the average power trip setpoint. The indicated values given below were chosen by

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the writer because they are "out of the way" and because they are the probable required setpoints for later testing.

The tolerance on all the setpoints given below is the 50 MV setpoint uncertainty from the calibration procedures.

Average Power Trip (per Technical Specification requirements and attached)

Indicated - $480 + 50$ MV
- $6 + 0.625\%$ Indicated Power (IP)

Actual - $0.35 + 0.036$ MW
- $0.7 + 0.073\%$ Full Power (FP)

Average Power Alarm (Chosen by the writer at 2% indicated power below the trip setpoint)

Indicated - $320 + 50$ MV
- $4 + 0.625\%$ IP

Actual - $0.233 + 0.036$ MW
- $0.466 + 0.073\%$ FP

Peak Power Trip - Chosen by writer as probable trip setpoint for later testing)

Indicated - 8.32 V + 50 MV
- $104 + 0.625\%$ IP

Actual - $6.06 + 0.036$ MW
- $12.13 + 0.073\%$ FP

Peak Power Alarm - (Chosen by writer at 2% indicated power below the trip setpoint)

Indicated - 8.16 V + 50 MV
- $102 + 0.625\%$ IP

Actual - $5.95 + 0.036$ MW
- $11.9 + 0.073\%$ FP

JAR:aer

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CALCULATION WORK SHEET

PAGE 1 OF 4 PAGESSUBJECT NOMINAL AVE. PWR. TRIP SETPOINT FOR PHASE-B DATE FEB. 2, 1978PREPARED BY J. A. ROSE CHECKED T. M. HOWE WORK REQUEST _____

I) MIN. DETECTOR SENSITIVITY (PER VENDOR TEST DATA)

$$S_D = 4.48 \times 10^{-14} \text{ A/NV}$$

II) MAX. AVE. FLUX DENSITY AT DETECTOR LOCATIONS
(PER DISCUSSIONS WITH T. M. HOWE FOR RODS
FULL OUT, COLD)

$$\Phi_{ma} = 1.2138 \times 10^9 \text{ NV}$$

(@ 50 MW)

$$= 1.0924 \times 10^9 \text{ NV}$$

(@ 0.45 MW
(PER PHASE-B
TECH. SPEC'S))

III) ACTUAL CURRENT INPUT TO DRAWER WILL BE:

$$I_A = (S_D) (\Phi_{ma})$$

$$= 5.4378 \times 10^{-5} \text{ AMP}$$

(@ 50 MW)

$$= 4.894 \times 10^{-7} \text{ AMP}$$

(@ 0.45 MW)

IV) CURRENT INPUT TO DRAWER BASED ON "INDICATED"
POWER IS:

$$I_I = 6.34 \times 10^{-6} \text{ AMP}$$

(@ 50 MW (=100%
POWER FROM
SO 89.01

$$= 5.706 \times 10^{-8} \text{ AMP}$$

(@ 0.45 MW)

CALCULATION WORK SHEET

PAGE 2 OF 4 PAGESSUBJECT NOMINAL AVE. PWR TRIP SETPOINT FOR PHASE-B DATE _____

PREPARED BY _____ CHECKED _____ WORK REQUEST _____

V) RATIO OF "ACTUAL" TO "INDICATED" INPUTS IS:

$$\frac{I_A}{I_I} = \frac{4.894 \times 10^{-7}}{5.706 \times 10^{-8}} = \underline{8.577} = \frac{V_A}{V_I}$$

VI) VOLTAGE OUT OF DRAWER BASED ON "INDICATED" POWER IS:

$$V_I = 8 \text{ VDC}$$

$$(\text{a}) 50 \text{ mW} = 100\% \text{ PWR}$$

$$= 72.0 \text{ mV}$$

$$(\text{a}) 0.45 \text{ mW} = 0.90\%$$

VII) THEREFORE, THE MAXIMUM ALLOWABLE SETPOINT IS THE VOLTAGE OUT OF THE DRAWER THAT THE AVERAGE POWER SETPOINT MUST NOT EXCEED. THAT IS:

$$V_{AM} = (I_A/I_I)(V_I)$$

(= LOSS FROM TECH.
SPEC. TABLE 2.3-1)

$$= (8.577)(72.0)$$

$$= 617.54 \text{ mV}$$

$$(\text{a}) 0.45 \text{ mW} = 0.90\%$$

NOTE: THIS CORRESPONDS TO A DRAINAGE AVERAGE
POWER METER READING OF 7.72%

VIII) THE NOMINAL VOLTAGE OUT OF THE DRAWER AT WHICH THE AVERAGE POWER SETPOINT MUST BE SET IS BELOW THE MAXIMUM ALLOWABLE SETPOINT BY THE SUM OF THE FOLLOWING: (PER VENDOR ALIGNMENT PROCEDURE)

$$\text{a) SET POINT ALLOWANCE} = A_{SP} = 50 \text{ mV}$$

$$\text{b) BISTABLE DRIFT ALLOWANCE} = A_{BD} = 100 \text{ mV}$$

CALCULATION WORK SHEET

PAGE 3 OF 4 PAGESSUBJECT NOMINAL AVE. PWR TRIP SETPOINT FOR PHASE A DATE _____

PREPARED BY _____ CHECKED _____ WORK REQUEST _____

IX) TOTAL ALLOWANCE IS:

$$A_T = A_{SP} + A_{RD} = 150 \text{ mV}$$

BUT

$$\frac{LSSS \text{ (mW)}}{V_{Am} \text{ (mV)}} = \frac{A_T \text{ (mW)}}{A_T \text{ (mV)}}$$

$$\frac{0.45 \text{ mW}}{618 \text{ mV}} = \frac{A_T \text{ (mW)}}{150 \text{ mV}}$$

$$\therefore A_T \text{ (mW)} \approx 0.1 \text{ mW}$$

X) THEREFORE, THE NOMINAL TRIP SETPOINT IS:

$$S_N = LSSS - A_T$$

$$= 0.45 \text{ mW} - 0.1 \text{ mW}$$

$$= 0.35 \text{ mW}$$

OR (IN TERMS OF mV)

$$\frac{S_N \text{ (mV)}}{S_N \text{ (mW)}} = \frac{V_{Am} \text{ (mV)}}{LSSS \text{ (mW)}}$$

$$S_N \text{ (mV)} = \frac{617.54}{0.45} (0.35)$$

$$= 480.3 \text{ mV}$$

(at 0.35 mW)

NOTE: THIS CORRESPONDS TO A DMMER AVERAGE
POWER METER READING OF 6%

SUMMARY OF CONTROL PARAMETERS TO COMPLY WITH TECH. SPECS. REQUIREMENTS

	LIMITING CONDITIONS	PARAMETERS USED IN DERIVATION OF NOMINAL VALUES				MEASURED PARAMETERS	
	AVERAGE REACTOR CORE POWER	CALC'D FLUX VALUES (FLUX AT DET'S Vs AVG CORE POWER)		DETECTOR SENSITIVITY (VENDOR DATA)	AMPLIFIER PLUS AVERAGER (V _{OUT} /I _{IN})	BISTABLE TRIP POINT (TRIP AT V _{IN})	BUFFER AMP/ METER (IND AT TRIP PT.)
		COLD	HOT				
WORST CASE TRIP	≤ 1.0 MW	(SEE LTR 111-88 FOR UNCERTAINTIES USED IN DERIVATION OF LS ³ VALUES)				N/A	N/A
LIMITING SAFETY SYSTEM SETTING (LS ³)	≤ 0.45 MW (0.9% FP) (SPEC)	1.2138x10 ⁹ NV (BASIS)	N/A	≥4.48x10 ⁻¹⁴ V/A (SPEC)	≥1.26x10 ⁸ V/A (6.34x10 ⁻⁶ A INPUT EQUALS 8.0 OUTPUT) (SPEC)	<617.5 MV (SPEC)	7.72% INDICATED POWER (BASIS)
NOMINAL VALUES	0.35 MW (0.7% FP)	1.2138x10 ⁹ NV	2.5248x10 ⁹ NV (INFO. ONLY)	4.48 ^{+0.27} _{-0.0} x10 ⁻¹⁴ A/NV	6.34±0.02x10 ⁻⁶ A (AMP INPUT EQUALS 8.0± 1 V OUTPUT)	480± 50 MV (INCLUDES 100 MV DRIFT ALLOWANCE)	6± 1.5% INDICATED POWER

**LOFT TECHNICAL REPORT
LOFT PROGRAM**

FORM EG&G-229
(Rev. 12-78)

TITLE NIS POWER RANGE SETPOINTS FOR PHASE-B OPERATION		REPORT NO. LTR 143-12
AUTHOR J. A. Rose <i>JAR</i>		GWA NO.
PERFORMING ORGANIZATION LOFT TECHNICAL SUPPORT DIVISION		DATE February 8, 1978 <i>[Signature]</i>
LOFT APPROVAL <i>[Signatures]</i> P+CSB Mar PSB Mar		

SUMMARY

The following are the nominal values at which the bistable inputs should be set to guarantee compliance with Phase-B Technical Specification Requirements.

Average Power Trip (per Technical Specification requirements and attached)

Indicated - 480 ± 50 MV
- $6 \pm 0.625\%$ Indicated Power (IP)

Actual - 0.35 ± 0.036 MW
- $0.7 \pm 0.073\%$ Full Power (FP)

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Peak Power Alarm - (Chosen by writer at 2% indicated power below the trip setpoint)

Indicated - 8.16 V ± 50 MV
- $102 \pm 0.625\%$ IP

Actual - 5.95 ± 0.036 MW
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LSW *2/9*