NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL
(TEMPORARY FORM)

CONTROL NO: 5542

FILE:

FROM:	DATE OF DOC	DATE REC'D	LTR	TWX	RPT	OTHER
Carolina Power & Light Co. Raleigh, N.C. E.E. Utley	5-19-75	5-20-75	xx			

TO:	ORIG	CC	OTHER	
Mr. Benard C. Rusche	3-signed			SENT AEC PDR ____ SENT LOCAL PDR ____

CLASS	UNCLASS	PROP INFO	INPUT	NO CYS REC'D	DOCKET NO:
	xxx			40	50-261

DESCRIPTION:

Ltr ref the ACRS 6-11-74 ltr ..... trans the following:

ENCLOSURES:

Attachment A
Axial Power Distribution Monitoring System Analysis & Data

PLANT NAME: H.B. Robinson #2

FOR ACTION/INFORMATION 5-20-75 JGB

BUTLER (L) W/ Copies	SCHWENCER (L) W/ Copies	ZIEMANN (L) W/ Copies	REGAN (E) W/ Copies
CLARK (L) W/ Copies	STOLZ (L) W/ Copies	DICKER (E) W/ Copies	✓ LEAR (L) W/ 6 Copies
PARR (L) W/ Copies	VASSALLO (L) W/ Copies	KNIGHTON (E) W/ Copies	SPEIS W/ Copies
KNIEL (L) W/ Copies	PURPLE (L) W/ Copies	YOUNGBLOOD (E) W/ Copies	LICENSING PROJECT MANAGER ____ W/ Copies

INTERNAL DISTRIBUTION

	TECH REVIEW		LIC ASST.	A/T IND
✓ REG FILE	SCHROEDER	✓ DENTON	R. DIGGS (L)	BRAITMAN
✓ NRC PDR	✓ MACCARY	GRIMES	H. GEARIN (L)	SALTZMAN
✓ OGC, ROOM P-506A	KNIGHT	GAMMILL	E. GOULBOURNE (L)	MELTZ
GOSSICK/STAFF	PAWLICKI	KASTNER	P. KREUTZER (E)	
CASE	SHAO	BALLARD	J. LEE (L)	PLANS
GIAMBUSSO	✓ STELLO	SPANGLER	M. MAIGRET (L)	MCDONALD
BOYD	HOUSTON		S. REED (E)	CHAPMAN
MOORE (L)	NOVAK	ENVIRO	M. SERVICE (L)	DUBE (Ltr)
DEYOUNG (L)	ROSS	MULLER	S. SHEPPARD (L)	E. COUPE
SKOVHOLT (L)	IPPOLITO	DICKER	M. SLATER (E)	PETERSON
GOLLER (L) (Ltr)	✓ TEDESCO	KNIGHTON	H. SMITH (L)	HARTFIELD (2)
P. COLLINS	J. COLLINS	YOUNGBLOOD	✓ S. TEETS (L)	KLECKER
DENISE	LAINAS	REGAN	G. WILLIAMS (E)	EISENHUT
✓ REG OPR	BENAROYA	✓ PROJECT LDR Dittman	V. WILSON (L)	WIGGINTON
FILE & REGION (2)	VOLLMER	HARLESS	R. INGRAM (L)	
MPIC				
STEELE				

EXTERNAL DISTRIBUTION MISC ✓ N

✓ 1 – LOCAL PDR Hartsville, S.C.
✓ 1 – TIC (ABERNATHY)
✓ 1 – NSIC (BUCHANAN)
1 – ASLB
1 – Newton Anderson
14 – ACRS H[redacted]G/SENT
to Lic Asst

(1)(2)(10) – NATIONAL LABS ____
1 – W. PENNINGTON, Rm E-201 GT
1 – CONSULTANTS
NEWMARK/BLUME/AGBABIAN

1 – PDR-SAN/LA/NY
1 – BROOKHAVEN NAT LAB
1 – G. ULRIKSON, ORNL
1 – AGMED (RUTH GUSSMAN)
Rm B-127 GT
1 – J. D. RUNKLES, Rm E-201
GT

CP&L

Carolina Power & Light Company

May 19, 1975

File: NG-3514 (R) Serial: NG-75-725

Mr. Benard C. Rusche, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Rusche:

H. B. ROBINSON UNIT NO. 2
LICENSE NO. DPR-23
UPRATING TO 2300 MWT

50-261

In the ACRS letter of June 11, 1974, regarding the uprating of the core thermal power output for the H. B. Robinson Unit No. 2 plant, the committee identified several items for which further discussions or exchanges of information between Carolina Power & Light Company and members of your staff was suggested prior to granting the license amendment allowing operation at the higher power level. Most of the items have been resolved through technical specification changes either granted or proposed, or by information submitted during the past year. Two items remain for which information is submitted as an attachment to this letter, thus allowing your action to proceed on the amendment to the license.

The first item, concerning APDMS operation and operational experience in the Robinson plant, is responded to by a report entitled, "Axial Power Distribution Monitoring System - Analysis and Data", prepared by Carolina Power & Light Company and included as Attachment A. This report provides the history of APDMS operation in the Robinson plant, the methodology of correlating thimble measurements to total core peaking factors, calculations which provide verification of the applicability of the methodology, and in-plant data during Cycle 3 operations to date showing the margins available to peaking factor limits during normal power operations and slow transient situations.

The second item, concerning the Turbine Redundant Overspeed Trip System (TROTS), is responded to by information contained in Attachment B. The information was developed as a response to the concerns raised by Mr. Walter Lapinski during the ACRS full committee meeting of June 7, 1974, as presented on pages 325-329 of the meeting transcript.

5542

We trust this information is suitable for your review and use.

Yours very truly,

E. E. Utley
Vice-President
Bulk Power Supply

DBW:bn
Attachments

cc: Messrs. N. B. Bessac
T. E. Bowman
P. W. Howe
R. E. Jones
J. B. McGirt
D. B. Waters

ATTACHMENT A

H. B. ROBINSON UNIT NO. 2
DOCKET NO. 50-261

AXIAL POWER DISTRIBUTION MONITORING SYSTEM

Analysis & Data

Thomas A. Wells
Carolina Power & Light
May, 1975

CONTENTS

INTRODUCTION

Power distribution measurements at the H. B. Robinson Plant are performed on a monthly basis, and the results are compared with peaking factor requirements to determine continued acceptability of the core performance under steady state operation at rated power. Continuous power distribution control during normal operations consists of flux detection by two-section, long ion chambers outside the reactor pressure vessel which provide a measure of power generated in the top and bottom halves of the core. The detector response due to varying axial power shapes is correlated to incore measurements during startup of each cycle, and periodically during the cycle, ensuring a representative picture of power distribution changes in the core. Flux difference, related to difference in power generation in the top and bottom halves of the core, are fed into the overpower and overtemperature setpoint equations. Changes in setpoints as a function of flux difference are programmed into the reactor control and protective system based on computer calculations of acceptable peaking factor limits as a function of flux difference. This correlation of peaking factor and flux difference is known to Westinghouse plant owners as the fly-speck correlation, and defines an acceptable envelope of peaking factors.

During discussions between the AEC staff and CP&L in April 1973 covering fuel densification effects for Cycle 2 of Robinson, the staff indicated that additional incore monitoring would be required before the plant could be operated in excess of 94.8% of rated power. This requirement was imposed because peaking factor and LOCA analyses, including conservative penalty factors due to densification, indicated this power level was the maximum allowable power level using only the excore monitoring system described above. This would ensure that a limiting value of total peaking factor $F_Q^T = 2.60$ would not be exceeded in the core during normal operation. The limiting value of F_Q^T for full rated power operation, again based on LOCA analyses, was calculated to be 2.41 which would require additional monitoring capability according to AEC ground rules. CP&L, in an effort to achieve the maximum possible power output from Robinson, proceeded to purchase and install a prototype system for axial flux profile monitoring labeled Axial Power Distribution Monitoring System, or APDMS. This system was installed in June 1973 and, after several months of

checkout and debugging, the system was employed for justification of full power operation after approval by the AEC. It was used continuously for the remainder of Cycle 2 which ended on May 6, 1974. Prior to operation with APDMS, the power level was restricted to a value of 94.8% rated power.

Initial operation during Cycle 3, which commenced on June 24, 1974, did not require the use of APDMS for power distribution monitoring. This was due to the removal of two regions of low density, low prepressurized fuel which had the potential for collapse of fuel clad sections and refinements in the fuel densification models which led to a lower peaking factor penalty. The limiting value of F_Q^T based on IAC LOCA analyses, was 2.65. However, the results of Appendix K ECCS analyses showed that a peaking factor limit of 2.32 at an uprated power level of 2300 MWt was required, and thus CP&L chose to employ APDMS for Cycle 3 operations beginning October 3 to show compliance with the new limit. To provide assurance of meeting peaking factor limits over a wide range of power level and rod position, an upper limit of 50% rated power was chosen for excore monitoring.

Recent results of a loss of coolant accident analysis based on the ECCS peaking factor of 2.32 indicate that a peak clad temperature could theoretically exceed the 2200°F limit. For this reason, a peaking factor limit of 2.30 is employed and additional restrictions have been placed on operation above 99% power. The Constant Axial Offset Control procedures are used to insure that an F_Q^T of 2.32 is not violated. APDMS will be used to provide additional surveillance to ensure the F_Q^T limit of 2.30 is not violated above 99% power. Below 99% of rated power, the nuclear analysis of credible power shapes consistent with ECCS criteria has shown that the limit of 2.3/P is not exceeded.

The intent of this report is to document APDMS operability and ability to observe actual core conditions during a transient. APDMS allows comparison of observed core F_Q^T to the limiting F_Q^T during all core activities and can serve to indicate the direction and magnitude of change of F_Q^T with respect to its limiting value.

Methodology

APDMS operation consists of periodic measurements of the axial power shape employing two incore detectors and comparing the measured value of the peak axial power in the monitored core location to a limiting value based on the F_Q^T limit of 2.30. The measured value of F(Z) is multiplied by an axially varying penalty factor S(Z), which accounts for the variation in allowable kw/ft as a function of axial location of the power peak. This variation of kw/ft defines our envelope of peak local power density calculated under normal operating conditions. This envelope results from considerations of the axial power shape dependence of DNB limits and effects of reduced heat transfer near the top of the core during the reflood phase of a loss-of-coolant accident. Figure 1 provides the relationship between the penalty factor and axial location. The APDMS measurement must show that, at all times during power operations,

$$[F(Z)_j S(Z)] \max \leq \frac{2.085}{\bar{R}_j (1+\sigma_j) P} \qquad (1)$$

The value of 2.085 is the limiting value of the measured F_Q^N derived from the F_Q^T limit of 2.30.

Current Technical Specifications require that $\bar{R}$ be calculated using the average of six flux maps taken within a successive span of not more than one effective full power month. The flux maps are taken over a range of operating conditions which the core might actually experience during normal operation. A predetermined insertion limit of 120 steps has been established for APDMS operation, and one map in each set of six is taken at this limit. Table 1 lists a typical set of maps used in the $\bar{R}$ analysis. For each measured thimble of the various flux maps, the ratio of the core maximum F_Q, including the variable kw/ft penalty factor, to the penalized thimble F(Z)S(Z) is determined. This ratio is then averaged over the six maps and is used as a multiplier on the appropriate measured thimble F(Z)S(Z) for each of the six maps. The product of the average ratio and the thimble F(Z)S(Z) defines a new F_Q that is used as an indication of the accuracy of the $\bar{R}$ calculation. Quantitatively, these operations are as follows:

For Thimble j and map i : $R_{ji} = (F_Q^N)_i / F(Z)_{ji} S(Z)$

Averaging over n maps : $\bar{R}_j = \frac{1}{n} \sum_n [(F_Q^N)_i / F(Z)_{ji} S(Z)]$

F_Q^N value for map i obtained from F_Z for thimble j : $(F_Q^N)^*_{ji} = (\bar{R}j)\ F(Z)_{ji} S(Z)$

Deviation of $(F_Q^N)^*_{ji}$ from $(F_Q^N)_i$:

$$\Delta(\%)_{ji} = \frac{(F_Q^N)^*_{ji} - (F_Q^N)_i}{(F_Q^N)_i} \times 100$$

Standard Deviation of R : $\sigma j = \left[\frac{1}{n-1} \sum_n [\Delta(\%)_{ji}]^2\right]^{1/2}$

The flux map information is obtained using the INCORE computer code, which has been modified to incorporate the axially varying penalty factor S(Z) and produce values of R for each thimble.

The accuracy and applicability of this method is discussed in the following sections of this report, and it will be shown that the reactor operator can confidently assess his margin to LOCA limitations under normal operating conditions using APDMS as a measurement device.

Calculational Verification of APDMS Methodology

In an attempt to better understand the nature of the R factor under various conditions, the XTG nodal simulator code was utilized to calculate R factors for each assembly. The local peaking factors used in XTG were taken from the PDQ decks that are also used by INCORE.

FLUX MAP COMPARISONS

Flux map 167 was taken at H. B. Robinson after power had been reduced from 100% to 70% and control rods inserted from 210 steps to 120 steps. This map was taken approximately 46 hours after the maneuver began. The XTG code was used to simulate this transient and to provide R factors for each assembly at hourly intervals. Figure 2 compares the XTG calculated R values after 46 hours with the flux map measured R values. The agreement between calculated and measured results is good considering the complex Cycle 3 core configuration with varying amounts of burnable poison in different assemblies.

Figure 3 shows another more interesting comparison between calculated and measured results. A flux map (#166) was taken prior to the start of the deep rod insertion which allowed a comparison to be made between the calculated and measured values of the change in R from the beginning of the transient to the end of the 46-hour time period. The change in R is expressed as a ratio of Map 166/Map 167 R values. The agreement between these calculated and measured results is shown to be excellent.

VARIATION IN R WITH TIME

One of the prime reasons for initiating an analytical investigation of R was the uncertainty in the application of an $\overline{R}$ factor for determining F_Q^N under transient conditions when, in fact, $\overline{R}$ was experimentally determined under steady state conditions.

Table 2 shows the calculated variation in R during a maneuver from 100% to 70% power with D bank insertion from 212 to 120 steps. The final conditions of 70% power and 120 steps were reached 30 hours after the maneuver began. Calculations were made for 16 hours past this point, or a total of 46 hours of real time was simulated. R values are shown at one hour intervals from assemblies H-09, H-10, and F-09. Assembly H-09 was chosen because it is adjacent to a D control rod. Assemblies H-10 and F-09 were chosen because they are typical of locations used for H. B. Robinson's APDMS. As seen in Table 2, the change in R during the transient is extremely small for assemblies H-10 and F-09. The maximum absolute change in R is only .045 for H-10 and .019 for F-09 over the range 0 to 46 hours. Being adjacent to D bank, assembly H-09 shows a larger absolute change of .093. The standard deviation of R is .03, .01, and .01 for H-09, H-10, and F-09, respectively.

The preceding results were based on a relatively slow maneuver in power and rods. A more severe test of the behavior of R was simulated and is shown in Table 3 where the same final conditions, 70% power and 120 steps, were reached in only three hours. The conclusions drawn from the previous case are identical to those drawn from Table 2 results. Assemblies H-10 and F-09 show only a small variation in R. Assembly H-09, being adjacent to a control rod, shows a larger variation between maximum and minimum values of R. The standard deviation of R is .023, .01 and .004 for H-09, H-10, and F-09, respectively, for this "fast" transient case. Therefore, the rate at which power and rods are moved has little or no effect on the variation of R during the transient.

The variation in R with burnup, holding power and control rods constant has been investigated. Figure 4 shows the calculated R for every assembly at 100, 4,000, 8,000 and 12,000 MWD/MTU during Cycle 3. R increases from 100 to 4,000 MWD/MTU and decreases thereafter. This trend is probably not true of every cycle since the presence or absence of burnable poison is expected to significantly influence this trend. It is noted that the R values at 12,000 MWD/MTU drop considerably from the 8,000 MWD/MTU values. Therefore, cycle length affects the variation in R. A normal reload cycle, such as Cycle 4, which a design exposure of 9,500 MWD/MTU and no burnable poison should show a smaller variation in R than shown in Figure 4.

It can also be concluded that in Cycle 3 of H. B. Robinson the variation in R with exposure is greater than the variation in R during a transient. The comparison between Table 2 or 3 with Figure 4 is the basis for this statement.

STANDARD DEVIATION OF MEASURED VALUES OF R

The standard deviation of the measured R values in Maps 165 through 181 is shown in Table 4. Map 165 was obtained on September 12, 1974, while Map 181 was obtained on March 10, 1975. These data exhibit the following characteristics:

a) 12 out of 44 assemblies have $\sigma<.02$
b) 28 out of 44 assemblies have $\sigma<.03$
c) All assemblies with $\sigma>.03$ are either adjacent to D control rods or located on the periphery of the core.

It is also interesting to note the comparison between measured and calculated values of σ for assemblies F-09 and H-10. The calculated values of R, obtained from XTG, cover the same exposure range as covered by Maps 165 through 181.

TABLE 4
STANDARD DEVIATION OF R

Assembly	Calculated	Measured
F-09	.0356	.0138
H-10	.0328	.0203

CONCLUSIONS

This study has shown that the $\overline{R}$ method of determining F_Q^N is justified from a theoretical viewpoint. The almost invariant nature of R during transient operation for assemblies located away from a control rod or the core periphery is the key to this unique method of peaking factor surveillance.

Operating Data

Comparison of APDMS data with INCORE data taken at approximately the same time has been performed for Maps 181 and 182 and is presented in Table 5. Map 181 was taken during the deep rod transient used for APDMS calibration and presents a significant deviation from the normal power distribution usually monitored by APDMS. Map 182 was taken ten hours later with approximately normal core conditions. The data presented indicates that more conservatism is shown towards calculation of F_Q^T by APDMS during a transient than under steady state power conditions. The $\bar{R}$ values used in Table 5 were those being used by APDMS at the time of the transient.

Typical F(Z)S(Z) values as determined by APDMS versus the limiting value of F(Z)S(Z) are presented on a daily basis in Figures 5 and 6. Figure 5 is illustrative of initial APDMS operations during Cycle 3 and Figure 6 is from data taken during a recent month. F(Z), F(Z)S(Z), and the F(Z)S(Z) limit are listed for Channel 1 as well as a pseudo plot of F(Z)S(Z) versus the limit for both channels. In Figure 6 note that the location of the peak F(Z)S(Z) has moved upwards in the core for Channel 1. This is the result of a lower F(Z) in the core and the effect of high penalty factors at the top of the core.

Figure 7 is used to demonstrate the change in F(Z)S(Z) versus its limit for both channels during a weekend turbine stop valve test. This valve test, initiated at full power, resulted in a minimum power level of 67 percent and maximum D-Bank insertion of 153 steps. As noted on the pseudo plot, the monitored F_Q^T during the transient was very conservative with respect to its limit.

F(Z)S(Z) versus the limit as a function of time is presented in Figure 8 for a recent five-month period. As expected, with increasing burnup of the fuel, the observed values of F(Z)S(Z) are decreasing.

TABLE 1 - H. B. ROBINSON #2 - M/D MAPS

Map No.	Date	(Steps Withdrawn) D	Power	Peak F_Q^N	Axial Offset
169	10/31/74	211	100%	1.70	-3.0
174	11/27/74	211	100%	1.66	-3.04
176	12/30/74	213	100%	1.63	-2.76
177	1/17/75	210	100%	1.61	-3.15
179	2/13/75	212	100%	1.61	-3.38
181	3/10/75	120	69%	1.72	-12.80

Table 2

Time (Hours)	R H-09	R H-10	R F-09	Time (Hours)	R H-09	R H-10	R F-09
0	1.393	1.399	1.380	25	1.324	1.363	1.367
1	1.387	1.393	1.380	26	1.321	1.362	1.366
2	1.380	1.389	1.380	27	1.314	1.359	1.364
3	1.376	1.388	1.379	28	1.309	1.357	1.363
4	1.375	1.387	1.379	29	1.304	1.355	1.362
5	1.372	1.386	1.379	30	1.302	1.354	1.361
6	1.371	1.385	1.378	31	1.301	1.354	1.361
7	1.366	1.383	1.378	32	1.301	1.354	1.361
8	1.363	1.381	1.377	33	1.301	1.355	1.362
9	1.360	1.380	1.376	34	1.302	1.357	1.364
10	1.359	1.379	1.375	35	1.301	1.356	1.363
11	1.359	1.378	1.375	36	1.300	1.357	1.364
12	1.357	1.377	1.374	37	1.300	1.357	1.364
13	1.354	1.376	1.374	38	1.300	1.357	1.364
14	1.350	1.374	1.373	39	1.301	1.358	1.365
15	1.348	1.373	1.372	40	1.301	1.358	1.365
16	1.348	1.373	1.372	41	1.301	1.358	1.365
17	1.349	1.374	1.373	42	1.301	1.358	1.366
18	1.348	1.373	1.372	43	1.301	1.359	1.366
19	1.347	1.373	1.372	44	1.302	1.359	1.366
20	1.345	1.372	1.372	45	1.302	1.359	1.366
21	1.343	1.372	1.371	46	1.303	1.360	1.367
22	1.337	1.369	1.370				
23	1.332	1.367	1.369				
24	1.327	1.365	1.368				

MANEUVER FROM 100% POWER, 212 STEPS TO 70% POWER, 120 STEPS IN 30 HOURS

Table 3

Time (Hours)	R		
	H-09	H-10	F-09
0	1.392	1.396	1.380
.25	1.382	1.391	1.380
.50	1.376	1.388	1.380
.75	1.373	1.388	1.381
1.00	1.364	1.383	1.379
1.25	1.359	1.381	1.378
1.50	1.353	1.378	1.376
1.75	1.348	1.376	1.375
2.00	1.345	1.374	1.375
2.25	1.338	1.371	1.373
2.50	1.334	1.369	1.372
2.75	1.327	1.366	1.370
3.00	1.321	1.363	1.368

MANEUVER FROM 100% POWER, 212 STEPS TO 70% POWER, 120 STEPS IN 3 HOURS

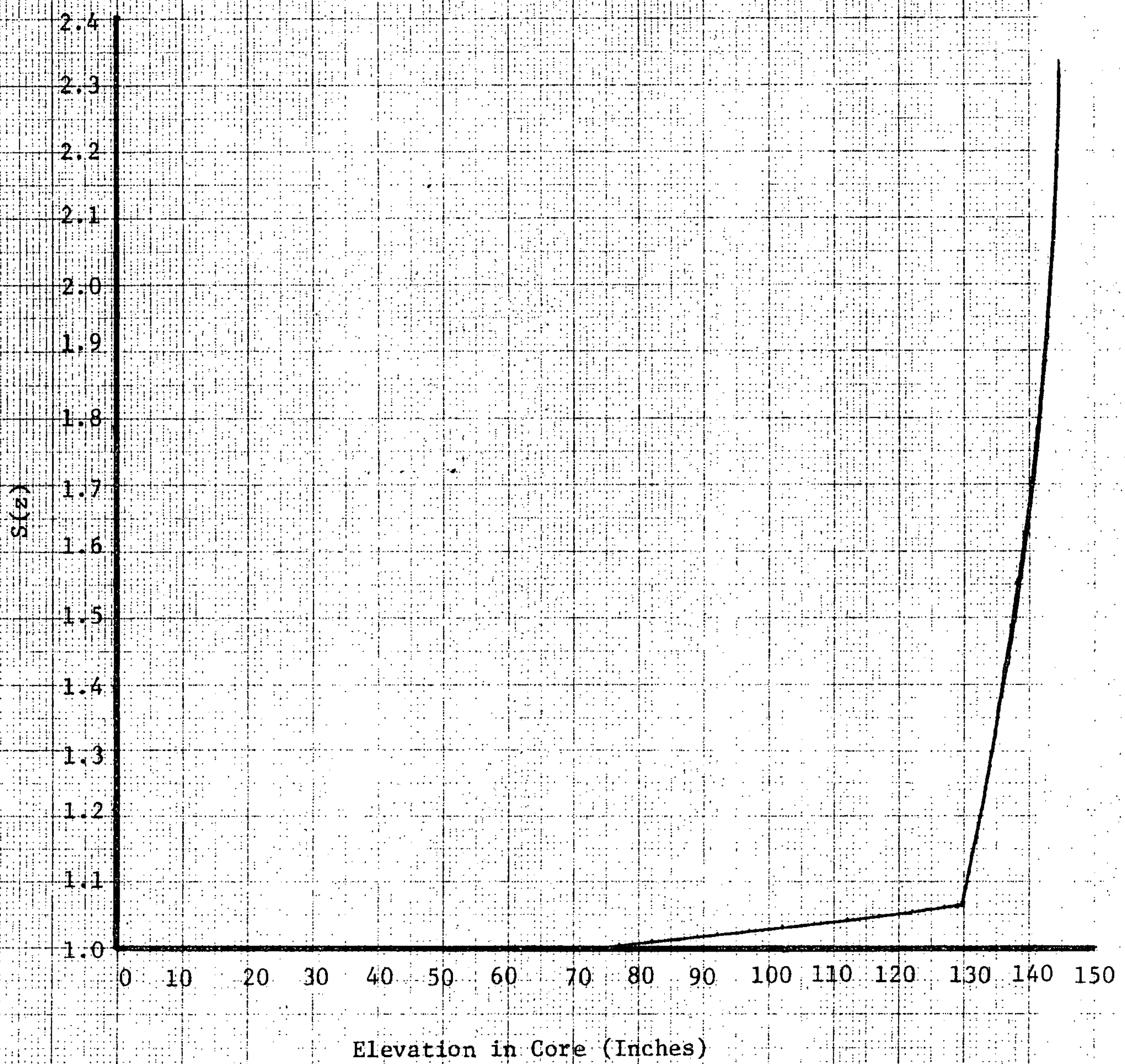
TABLE 5

Map No.	Thimble ID	F(Z)S(Z) Map	F(Z)S(Z) APDMS	$\bar{R}$	σ	Peak Map F_Q^T	APDMS F_Q^T
181	H-06	1.2916	1.402	1.383	.777	1.723	1.939
181	F-09	1.2662	1.358	1.384	.418		1.879
182	H-06	1.3267	1.366	1.383	.777	1.764	1.889
182	F-09	1.3175	1.360	1.384	.418		1.881

CONDITIONS:	Map 181	APDMS	Map 182	APDMS
Time	0107	0251	1052	1040
Date	3/10/75	3/10/75	3/10/75	3/10/75
B-Bank	120	120	211	211
Axial Offset	-12.8	-8.2	+7.85	+6.6
Power	69%	70%	100%	99%

Figure 1

INVERSE OF THE NORMALIZED
PEAKING FACTOR AXIAL DEPENDENCE



		1.375 1.397	1.310 1.321		1.326 1.389		1.453 1.505
	1.365 1.391	1.391 1.412	1.370 1.399	1.346 1.359	1.398 1.453	1.446 1.483	1.444 1.506
1.376 1.401	1.375 1.414	1.408 1.449	1.417 1.457	1.434 1.479	1.437 1.513	1.455 1.517	
1.321 1.335	1.367 1.402	1.417 1.458		1.446 1.527	1.452 1.524	1.473 1.534	
1.131 1.128	1.337 1.360	1.442 1.480	1.441 1.527	1.480 1.540	1.475 1.541	<——— Incore <——— XTG	
1.340 1.386	1.401 1.452	1.421 1.512		1.470 1.541			
	1.428 1.482	1.450 1.516	1.457 1.533				
1.439 1.504	1.453 1.505						

COMPARISON OF CALCULATED AND MEASURED R VALUES

MAP #167 ** 70% POWER ** D @ 120 STEPS

Figure 2

		.976 .974	.942 .948		.950 .952	1.013	1.031 1.026
	.968 .974	.972 .993	.978 .974	.955 .960	.991 .978	1.021 1.018	1.039 1.026
.976 .982	.992 .979	1.008 .988	1.007 1.014	1.017 1.004	1.029 1.029	1.035 1.026	
.930 .949	.977 .972	1.017 1.022		1.044 1.031	1.050 1.036	1.051 1.037	
.794 .804	.954 .945	1.016 1.027	1.044 1.034	1.053 1.048	1.058 1.053	<—— XTG <—— Incore	
.949 .950	.991 .992	1.029 1.007		1.058 1.051			
	1.022 1.008	1.036 1.016	1.051 1.046				
1.032 1.027	1.036 1.039						

COMPARISON OF CALCULATED AND MEASURED CHANGE IN R

FROM 100% POWER, 212 STEPS TO 70% POWER, 120 STEPS

Figure 3

	H	G	F	E	D	C	B	A
8	1.380 1.432 1.377 1.318	1.380 1.429 1.369 1.303	1.378 1.433 1.377 1.301	1.371 1.390 1.351 1.287	1.373 1.416 1.359 1.279	1.405 1.466 1.410 1.321	1.415 1.472 1.417 1.334	1.409 1.462 1.404 1.334
9	1.380 1.430 1.370 1.303	1.380 1.440 1.380 1.304	1.380 1.420 1.364 1.299	1.381 1.429 1.376 1.303	1.391 1.418 1.372 1.303	1.410 1.470 1.414 1.325	1.410 1.449 1.393 1.318	1.409 1.457 1.404 1.329
10	1.379 1.438 1.380 1.303	1.381 1.423 1.366 1.300	1.382 1.438 1.380 1.307	1.387 1.429 1.373 1.306	1.396 1.457 1.397 1.321	1.411 1.475 1.415 1.328	1.407 1.467 1.404 1.333	
11	1.377 1.415 1.360 1.291	1.382 1.435 1.379 1.305	1.387 1.430 1.373 1.307	1.391 1.457 1.395 1.323	1.400 1.467 1.409 1.330	1.403 1.452 1.393 1.325	1.405 1.463 1.405 1.337	
12	1.374 1.422 1.360 1.280	1.391 1.422 1.373 1.304	1.395 1.458 1.396 1.321	1.399 1.468 1.408 1.330	1.398 1.468 1.407 1.335	1.400 1.462 1.405 1.338	100 MWD/MTU 4000 MWD/MTU 8000 MWD/MTU 12000 MWD/MTU	
13	1.405 1.466 1.411 1.323	1.409 1.470 1.413 1.325	1.410 1.475 1.413 1.328	1.402 1.452 1.392 1.325	1.400 1.462 1.405 1.338			
14	1.413 1.470 1.415 1.333	1.408 1.448 1.392 1.318	1.406 1.466 1.403 1.333	1.405 1.462 1.404 1.337				
15	1.408 1.460 1.402 1.332	1.408 1.456 1.402 1.329						

CALCULATED VARIATION OF R WITH EXPOSURE

H. B. ROBINSON CYCLE 3

Figure 4

```
APDM4
                            FZSZ            FZSZ (+)  VS  LIMIT (#)
        CHANNEL 1         LOCATION          CHANNEL 1             CHANNEL 2           TIME
DATE  FZ    FZSZ  LIMIT!345678901234! 1 2 3 4 5 6 7 8 9 0! 1 2 3 4 5 6 7 8 9 0!0452 5
10/24 1.267 1.273 1.496!     2      !     +   #          !     +   #          !   +
10/25 1.270 1.276 1.492!     2      !     +   #          !     +   #          !    +
10/26 1.268 1.273 1.491!     2      !     +   #          !     +   #          !    +
10/27 1.257 1.273 1.494!       2    !     +   #          !     +   #          !    +
10/28 1.260 1.266 1.492!     2      !     +   #          !     +   #          !    +
10/29 1.265 1.269 1.493!     2      !     +   #          !     +   #          !    +
10/30 1.277 1.279 1.500!     2      !     +   #          !     +   #          !    +
10/31 1.264 1.270 1.495!     2      !     +   #          !     +   #          !    +
11/ 1 1.258 1.272 1.506!       21   !     +   #          !     +   #          !    +
11/ 2 1.258 1.260 1.505!     2      !    +    #          !    +    #          !    +
11/ 3 1.256 1.268 1.506!       2    !     +   #          !     +   #          !    +
11/ 4 1.256 1.261 1.500!     2      !    +    #          !    +    #          !    +
11/ 5 1.268 1.279 1.514!      21    !     +   #          !     +   #          !    +
11/ 6 1.254 1.260 1.506!     2      !    +    #          !    +    #          !    +
11/ 7 1.253 1.259 1.507!     2      !    +    #          !    +    #          !    +
11/ 8 1.253 1.258 1.504!     2      !    +    #          !    +    #          !    +
11/ 9 1.253 1.258 1.512!     2      !    +    #          !    +    #          !    +
11/10 1.243 1.268 1.505!       2    !     +   #          !    +    #          !    +
11/11 1.250 1.256 1.507!     2      !    +    #          !    +    #          !    +
11/12 1.270 1.276 1.504!     2      !     +   #          !    +    #          !    +
11/13 1.260 1.267 1.506!     2      !     +   #          !    +    #          !    +
11/14 1.254 1.259 1.502!     2      !    +    #          !    +    #          !    +
11/15 1.235 1.241 1.504!     2      !    +    #          !     +   #          !   +
11/16 1.240 1.273 1.512!      21    !     +   #          !      +  #          !    +
11/18 1.238 1.242 1.505!     2      !    +    #          !     +   #          !    +
11/19 1.249 1.253 1.514!     2      !    +    #          !      +  #          !    +
11/20 1.274 1.281 1.505!     12     !     +   #          !      +  #          !    +
11/21 1.245 1.249 1.511!     2      !    +    #          !     +   #          !   +
11/22 1.241 1.247 1.505!     2      !    +    #          !     +   #          !   +
11/23 1.241 1.245 1.501!     2      !    +    #          !     +   #          !    +
11/24 1.242 1.249 1.503!     2 1    !    +    #          !      +  #          !   +
11/25 1.245 1.250 1.502!     2      !    +    #          !      +  #          !   +
```

FIGURE 5

```
APDM5
                             FZSZ                  FZSZ (+)   VS   LIMIT (#)
          CHANNEL 1        LOCATION              CHANNEL 1                CHANNEL 2        TIME
DATE    FZ    FZSZ  LIMIT!345678901234! 1 2 3 4 5 6 7 8 9 0! 1 2 3 4 5 6 7 8 9 0!04826
3/ 7  1.205  1.205  1.500!   1 2      !   +     #          !   +     #          !   +
3/ 9  1.548  1.546  2.174!   2        !          +         ! #       +          !#  +
3/10  1.218  1.250  1.500!        2   !    +    #          !    +    #          !   +
3/11  1.168  1.209  1.503!        21  !   +     #          !   +     #          !   +
3/12  1.196  1.196  1.505!   2        !   +     #          !   +     #          !  +
3/13  1.195  1.195  1.492!   2        !   +     #          !   +     #          !   +
3/14  1.304  1.304  1.499!   2        !     +   #          !     +   #          !   +
3/15  1.219  1.219  1.490!   2        !    +    #          !   +     #          !   +
3/16  1.170  1.200  1.498!         2  !   +     #          !   +     #          !   +
3/17  1.148  1.193  1.493!        21  !   +     #          !   +     #          !   +
3/18  1.188  1.191  1.491!        2  1!   +     #          !  +      #          !   +
3/19  1.157  1.188  1.492!   2       1!   +     #          !  +      #          !   +
3/20  1.147  1.149  1.491!1  2        !  +      #          !   +     #          !   +
3/21  1.164  1.192  1.491!   2       1!   +     #          !  +      #          !   +
3/22  1.158  1.173  1.491!   2       1!   +     #          !  +      #          !   +
3/23  1.134  1.208  1.492!         2 1!   +     #          !   +     #          !   +
3/24  1.151  1.190  1.489!         2 1!   +     #          !   +     #          !   +
3/25  1.185  1.165  1.494!   2       1!   +     #          !   +     #          !   +
3/26  1.162  1.179  1.491!   2       1!   +     #          !   +     #          !   +
3/27  1.188  1.182  1.488!   2       1!   +     #          !  +      #          !   +
3/28  1.150  1.178  1.488!         2 1!   +     #          !  +      #          !   +
3/29  1.139  1.201  1.489!         2 1!   +     #          !   +     #          !   +
3/30  1.158  1.189  1.496!         2  !   +     #          !   +     #          !   +
3/31  1.154  1.209  1.498!           2!   +     #          !   +     #          !   +
4/ 1  1.157  1.198  1.495!         2 1!   +     #          !  +      #          !   +
4/ 2  1.151  1.194  1.506!         2  !   +     #          !   +     #          !   +
4/ 3  1.135  1.275  1.495!           2!     +   #          !    +    #          !   +
4/ 4  1.139  1.213  1.490!         2 1!    +    #          !   +     #          !   +
4/ 5  1.158  1.183  1.525!        2   !   +     #          !   +      #         !   +
4/ 6  1.170  1.175  1.488!   2        !   +     #          !   +     #          !   +
4/ 7  1.168  1.188  1.493!   2        !   +     #          !   +     #          !   +
```

FIGURE 6

APDMO

```
                                  FZSZ                  FZSZ (+)  VS  LIMIT (#)
          CHANNEL 1             LOCATION                CHANNEL 1            CHANNEL 2      TIME
DATE    FZ   FZSZ LIMIT!345678901234! 1 2 3 4 5 6 7 8 9 0! 1 2 3 4 5 6 7 8 9 0!04826
10/26 1.267 1.273 1.490!     2      !     +   #          !     +  #           !+
10/26 1.270 1.275 1.492!     2      !     +   #          !     +   #          ! +
10/26 1.271 1.276 1.490!     2      !     +   #          !     +  #           !  +
10/26 1.268 1.273 1.491!     2      !     +   #          !     +   #          !   +
10/26 1.271 1.275 1.497!     2      !     +   #          !     +   #          !
10/27 1.352 1.357 1.634!     2      !      +     #       !       +   #        !+
10/27 1.406 1.409 1.736!     2      !       +     #      !       +     #      !+
10/27 1.469 1.465 1.845!   1 2      !        +       #   !        +      #    !+
10/27 1.444 1.439 1.865!   1 2      !        +       #   !        +       #   !+
10/27 1.406 1.411 1.870!     2      !       +        #   !       +        #   !+
10/27 1.400 1.404 1.878!     2      !       +        #   !       +        #   !+
10/27 1.376 1.381 1.903!     2      !       +         #  !       +        #   !+
10/27 1.379 1.384 1.956!     2      !       +          # !       +         #  !+
10/27 1.416 1.421 2.059!     2      !       +            #        +          #!+
10/27 1.440 1.444 2.134!     2      !        +           !#       +           !#
10/27 1.417 1.422 2.165!     2      !        +           ! #      +           !#
10/27 1.404 1.409 2.171!     2      !       +            ! #      +           !#
10/27 1.382 1.388 2.164!     2      !       +            ! #     +            !#
10/27 1.357 1.362 2.162!     2      !      +             ! #     +            !#
10/27 1.358 1.363 2.220!     2      !      +             !  #    +            !+#
10/27 1.346 1.353 2.166!     2      !      +             ! #     +            !+#
10/27 1.323 1.329 2.197!     2      !      +             ! #    +             !+#
10/27 1.319 1.323 2.139!     2      !      +             !#     +             !#
10/27 1.273 1.287 2.071!       2    !     +              #     +              #!+
10/27 1.293 1.299 2.014!     2      !     +             #!      +           # !+
10/27 1.280 1.285 1.866!     2      !     +          #   !     +          #   !+
10/27 1.289 1.293 1.807!     2      !     +         #    !      +       #     !+
10/27 1.287 1.292 1.754!     2      !     +        #     !      +      #      !+
10/27 1.302 1.308 1.730!     2      !     +       #      !      +      #      !+
10/27 1.310 1.315 1.735!     2      !     +       #      !      +      #      !+
10/27 1.281 1.285 1.670!     2      !     +      #       !     +      #       !+
10/27 1.293 1.297 1.568!     2      !     +     #        !      +   #         !+
10/27 1.266 1.271 1.492!     2      !     +   #          !     +   #          !+
10/27 1.285 1.289 1.498!     2      !     +   #          !     +   #          ! +
10/27 1.279 1.284 1.496!     2      !     +   #          !     +   #          ! +
10/27 1.291 1.297 1.495!     2      !     +   #          !      +  #          ! +
10/27 1.281 1.285 1.497!     2      !     +   #          !     +   #          ! +
10/27 1.280 1.284 1.495!     2      !     +   #          !     +   #          ! +
```

FIGURE 7

APDM7

```
                                  FZSZ                      FZSZ (+)  VS  LIMIT (#)
              CHANNEL 1         LOCATION              CHANNEL 1               CHANNEL 2         TIME
DATE   FZ   FZSZ  LIMIT!345678901234! 1 2 3 4 5 6 7 8 9 0! 1 2 3 4 5 6 7 8 9 0!04826
10/27  0.0  1.273 1.494!        2   !    +   #           !    +   #           !   + 
11/ 7  0.0  1.260 1.500!      2     !   +    #           !   +    #           ! +   
11/17  0.0  1.275 1.511!        2   !    +   #           !     +  #           !+    
11/27  0.0  1.247 1.505!      2     !   +    #           !      + #           !   + 
12/ 7  0.0  1.243 1.512!      2     !   +    #           !   +    #           !   + 
12/17  0.0  1.230 1.509!      2     !   +    #           !   +    #           !  +  
12/27  0.0  1.212 1.511!      2     !   +    #           !   +    #           !   + 
 1/ 6  0.0  1.226 1.495!12          !   +    #           !   +    #           !  +  
 1/17  0.0  1.208 1.493!      2 1   !  +     #           !   +    #           !  +  
 1/26  0.0  1.212 1.494!        12  !   +    #           !   +    #           !  +  
 2/ 7  0.0  1.192 1.491!      2     !  +     #           !  +     #           !  +  
 2/17  0.0  1.198 1.497!    1 2     !  +     #           !  +     #           !   + 
 2/27  0.0  1.189 1.497!    1 2     !  +     #           !  +     #           !  +  
 3/ 7  0.0  1.189 1.498!    2       !  +     #           !  +     #           !  +  
 3/17  0.0  1.193 1.493!    2    1  !  +     #           !  +     #           !    +
 3/27  0.0  1.181 1.495!    2       !  +     #           ! +      #           !  +  
 4/ 7  0.0  1.164 1.495!    2       !  +     #           !  +     #           !   + 
```

FIGURE 8

ATTACHMENT B

Turbine Redundant Overspeed Trip System

In response to the concerns of Mr. Walter Lapinski, ACRS staff consultant at the H. B. Robinson Unit No. 2 full committee meeting on June 7, 1974, the following information is provided. The responses have been prepared by our reactor vendor, Westinghouse, based on our joint interpretation of Mr. Lapinski's statements and questions.

Question 1 - Transcript Page 325, Lines 16 through 19

The blanket statement concerning loss of power which will trip the unit should be interpreted to mean loss of DC power at the battery will trip the unit.

Question 2 - Transcript Page 327, Lines 6 through 17

Concerning the fail-safe design of the Turbine Redundant Overspeed Trip System (TROTS), fail-safe on loss of power was carried through to the solenoid valves, which are normally deenergized for operational reliability. Deenergization avoids the concern of spurious trips of the valves. It should be noted that this is the same design philosophy employed in the Engineered Safeguards Features where components do not operate on a continuous basis, but are energized by the protective system to provide safety function.

The TROTS employed on the H. B. Robinson is identical in design to the system employed on Point Beach Units 1 and 2, Indian Point Units 2 and 3, and Three Mile Island Unit 2. It is a dual channel system. A single channel system, with the same design philosophy of actuation, is employed on Prairie Island Units 1 and 2, Kewaunee and Rancho Seco Unit 1. Thus the system design and its philosophy should be familiar to the staff in its review of these plants as well as the review of the Robinson plant performed in the past.