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DESCRIPTION:
Ltr re our 6-25-73 ltr....furnishing addl info in support of 100% Thermal Power Authorization......W/Attached Figs 1, 2 & 3

ENCLOSURES:

ACKNOWLEDGED

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PLANT NAME: H. B. Robinson Unit 2

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Carolina Power & Light Company

July 6, 1973

File: NG 5213

NG-73-163

Mr. Robert J. Schemel, Chief
Operating Reactors Branch No. 1
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Schemel:

H. B. ROBINSON UNIT NO. 2
LICENSE DPR-23, DOCKET NO. 50-261
ADDITIONAL INFORMATION IN SUPPORT OF
100% THERMAL POWER AUTHORIZATION

Your letter of June 25, 1973 requested certain additional information to be supplied in support of Carolina Power & Light Company's request for 100% thermal power authorization for H. B. Robinson Unit No. 2. Your request identified six areas requiring additional information. Set forth below are our responses to these questions in the order posed.

1. Additional analyses have been performed to evaluate the consequences for a LOCA during Cycle 2 operation for various axial power shapes. Specifically, analysis has been performed for an axial power shape representing the "corner point" on the Fq versus axial offset flyspeck plot (refer to Figure 4.2 of WCAP-8114), ie, at the axial offset value beyond which a power reduction is required by the Technical Specification.

   The power shape analyzed is shown on Figure 1 as a plot of Fq versus core height. As shown on the figure, allowances have been made for the effect of pellet density variations (1.013) and the power spike penalty appropriate to a region with flattened clad sections. Additionally, the measured values for the radial peaking factor, F_{xy}, as a function of axial height have been included in this figure. The peak linear rod power corresponding to this power shape is 13.8 kw/ft.

   As presented in WCAP-8114, the most limiting fuel regions are Region 3 prior to clad flattening (low burnup rods) and Regions 2 and 3 subsequent to flattening. The flattened rods are required to meet a maximum clad temperature limit of 1800°F for LOCA.

   This analysis was performed using fuel average temperatures consistent with those shown in WCAP-8114 and including an allowance of 9.375°F x P where P is the rod power in kw/ft. The blowdown analysis was performed using the SATAN code run at 102% of rated core power. The

5381

fuel rod temperature calculations were made with the LOCTA code using reflooding heat transfer coefficients from the FLECHT correlation (WCAP-7931).

The results of the analysis in terms of peak clad temperature are shown below:

Fuel Region	Rod Power kw/ft	Initial Avg. Fuel Temp.	Peak Clad Temp.
Regions 2 & 3 with flattened clad	13.8	2115°F	1811
Region 3 low burnup rod	13.8	2790°F	2249

As expected, the higher axial location of the core hot spot results in slightly lower reflooding heat transfer. This reduced heat transfer is compensated for by the lower peak power corresponding to this power shape.

For more skewed power shapes, the Technical Specifications require a power reduction when the flux difference limits are exceeded. Such shapes are generally characteristic of end of life conditions where fuel rod temperatures are decreased due to clad creep. For the special case of rods with flattened clad sections, this benefit due to fuel temperature decrease does not occur. It should be noted that the LOCA fuel rod thermal transient claculation is conservative in the treatment of the power spike in that the spike penalty is applied over the entire rod rather than locally at the hot spot.

2. A steady-state DNB analysis has been performed using the power shape described in response to question 2. The resulting DNB ratios, which were obtained in the same manner as in WCAP-8114, are presented below along with those which were obtained with the design nuclear hot channel factor, $F_{\Delta H}^{N}$, of 1.55 and a 1.55 peak-to-average chopped cosine axial distribution. It can be seen from the results that if the accident analyses utilized the power distribution described in response to question 1 rather than the current design distribution, higher DNBR's would be obtained.

	Minimum DNBR	
Steady-State Conditions	Design Power Shape	Power Peaked To Top of Core
Nominal	1.66	2.00
Overpower	1.35	1.63
Core Limits	1.30	1.58

3. Under the conditions requiring surveillance of the axial power distribution assurance that the nuclear hot channel factor F_q^N is not exceeding the limits established shall be developed and maintained in the following manner:

   A. A relationship and the associated uncertainty in this relationship will be developed between the monitor thimble used during surveillance and F_q. This information will be developed based upon at least six most current full in-core power maps. In this form the hot channel factor shall be expressed as:

   $$F_q^N = (\bar{R} + \sigma) \cdot F_z \cdot S_z \cdot Fu$$

   where $\bar{R}$ is a thimble dependent factor derived from the full in-core power maps which relates the F_z measured in a given thimble to F_q^N, σ is the standard deviation associated with the determination of $\bar{R}$, S_z the axial power spike factor and Fu the nuclear uncertainty factor associated with the determination of F_q^N by a full in-core power map.

   B. Separate relationships shall be used to relate the measured F_z in a given thimble acquired during surveillance to the F_q^N limits applicable to region 2 and 3 fuel and the region 4 fuel.

   C. Until which time automatic computations of $F_z(z) \cdot S(z)$ can be made rapidly, a conservative constant S_z value shall be applied to F_z. For region 2 & 3 fuel a value of 1.25 shall be used and for region 4 fuel a value of 1.15.

   D. Fu shall take on the value of 1.04 to account for uncertainties in determining F_q^N from a full in-core power map. The total uncertainty factor in determining F_q^N during periods of surveillance will effectively be $(1 + \sigma/\bar{R})$ x Fu where $\sigma/\bar{R}$ is the standard deviation expressed as a fractional uncertainty.

   E. A minimum of two thimbles shall be traced simultaneously at any one point in time during surveillance. For each thimble, values of F_q will be determined applicable to region 2 & 3 and region 4 fuel. (4 values) The resulting values of F_q^N shall not exceed (2.34/P) for region 2 & 3 fuel and (2.49/P) for region 4 fuel, where P is the fraction of rated power.

   F. In the event a limit is exceeded by one of the four values, an immediate re-trace and F_q^N determination shall be allowed to discriminate against possible equipment problems. Otherwise exceeding the above define limits shall require a 1% reduction in operating power level for each percent F_q exceeds the stated limits, and a verification at the reduced power level to assure F_q^N is within limits.

Criteria for selecting representative assemblies as monitoring positions during the conduct of surveillance are set forth as follows:

A. The assemblies selected and the associated numerical relations which permit determination of F_q in the core shall be sufficient to determine F_q with a high degree of accuracy as determined through previous full in-core power maps.

B. Continued accuracy of this surveillance method and the representativeness of the selected thimbles shall be verified for each bi-weekly full in-core power map taken. If the uncertainty associated with the representative thimbles and its relationship to F_q exceeds twice the standard deviation previously established, a re-analysis of the relationships will be made incorporating the results of the most current full in-core map. These new relationships and uncertainties derived may result in the selection of alternate monitoring thimbles.

C. The two thimbles used in any one determination of F_q shall not be located in adjacent quadrants of the core.

4. The methodology for determining hot channel factors F_q^N from monitoring F_z in selected assemblies has been applied to the first seven full in-core power maps acquired during Cycle 2 operations of the H. B. Robinson Unit. The specific operational conditions under which these maps were obtained are summarized in Table 1 below.

TABLE 1 - ROBINSON UNIT NO. 2 INCORE POWER MAPS

Map ID	Control Bank Position	Power % Rated	Peak F_q^N/Fu Reg 2 & 3	Peak F_q^N/Fu Reg 4	Axial Offset
102	200	70	2.138	2.024	+5.8
103	211	70	2.475	2.277	+15.9
104	152	70	2.50	2.369	-18.3
105	200	75	2.063	1.990	+2.2
106	200	90	2.013	1.909	-0.4
107	200	94	2.038	1.909	-2.0
108	200	100	2.038	2.001	-5.2

Values of $\bar{R}$, the factor relating a specific thimble $F_z \cdot S_z$ to the region F_q^N and the associated standard deviation for each $\bar{R}$ were determined and are illustrated in Figures 2 and 3. The values of $\bar{R}$ presented shall serve as the initial values for the conduct of the surveillance program subject to the continued accuracy conditions set forth in 3 above. Likewise the standard deviations contained in Figure 3 serve as the initial bases for thimble selection and the associated uncertainty to be used during surveillance.

Frequency of surveillance shall be governed by the following conditions:

1. Surveillance of the axial power distribution shall be required for all operations above 75% of rated power.

2. Surveillance of the axial peaking factor shall be performed every eight hours using at least two thimbles for each determination.

3. Movement of the control bank of rods more than a total of five steps in any one direction will initiate an increase in surveillance frequency. Surveillance shall be initiated immediately upon exceeding the five-step limit and conducted every one-half hour thereafter for a two-hour period and once at 3, 5, 8, and 12 hours following the rod motion.

4. During periods of operations where divergent xenon oscillations are being experienced surveillance will be conducted at the maxima, minima and nil values of axial offset as determined by ex-core detectors.

5. Justification for the above frequency of surveillance is based upon the anticipated behavior of the axial power shape following the introduction of a perturbation in the core. Under the frequency set forth above, the core is monitored on an eight hour bases during steady-state conditions, and the effect of perturbations are monitored immediately and at progressive expanding intervals thereafter during the decay of the transient. The information acquired at this frequency may establish a quantitative bases for more accurate following of such transients. At which time these information become available, the above prescribed frequencies may be revised subject to the approval of the AEC.

5. The power spike penalty for Region 4 fuel has been calculated considering the influence of possible clad flattening in adjacent Region 2 assemblies. The results indicate the Region 4 power spike factor must be increased by 1% over what it would have been considering gaps only in Region 4. This gives good agreement with the 1.15 S(Z) previously proposed in our June 20, 1973, letter.

6. A sampling of xenon oscillations initiated by various reactor power transients shows that the per cent change in F_q per unit change in axial offset is generally of the order of 1.0 with a maximum value of 1.6. For conservatism it is recommended that a value of 1.75 be used.

These information supplied are based upon a conservative and operationally sound approach. Carolina Power & Light believes the information supplied herein fully supports authorization of Robinson Unit to operate at 100% thermal power rating.

Very truly yours,

N. B. Bessac
Manager
Nuclear Generation

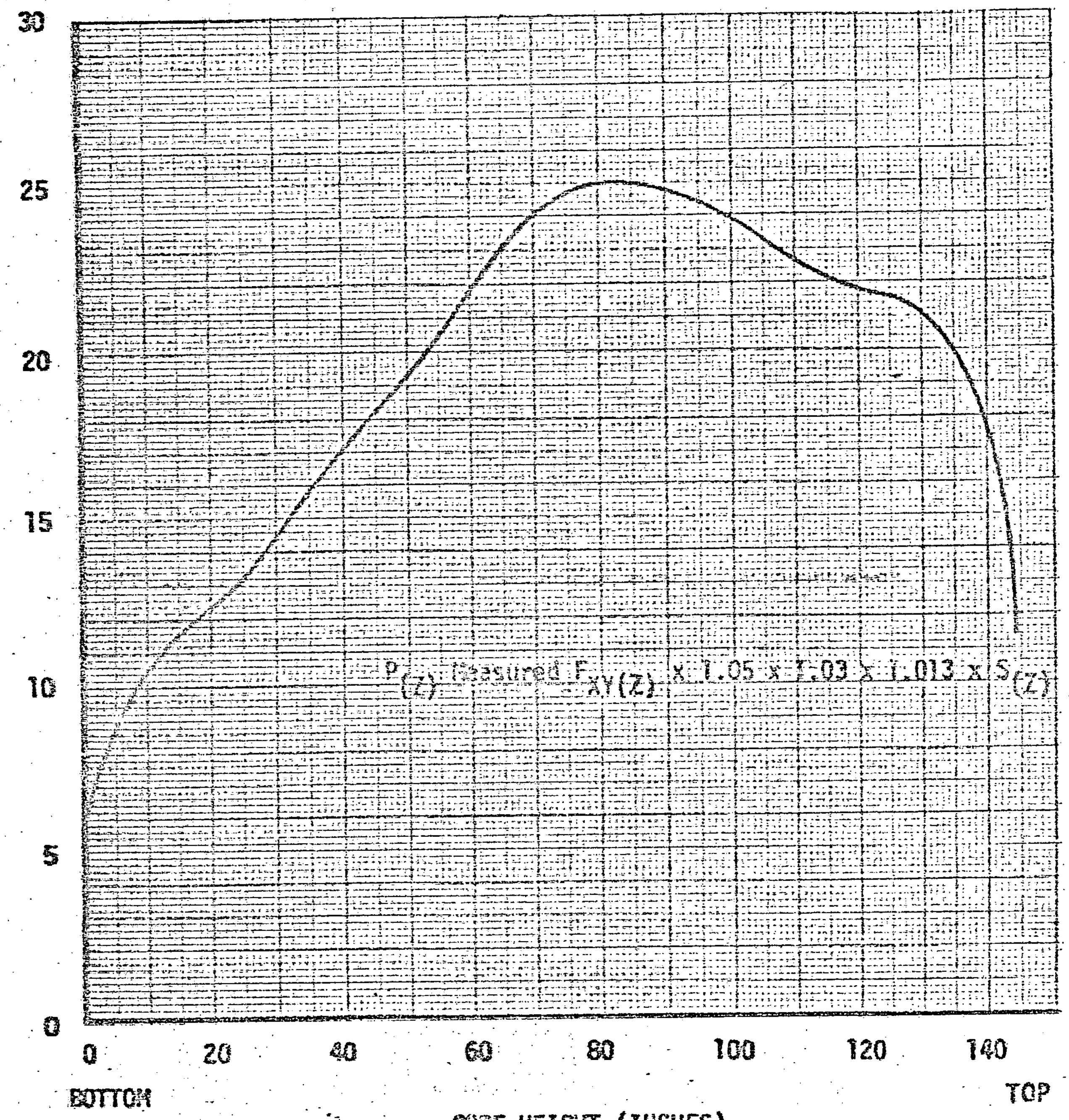
RAW:mvp

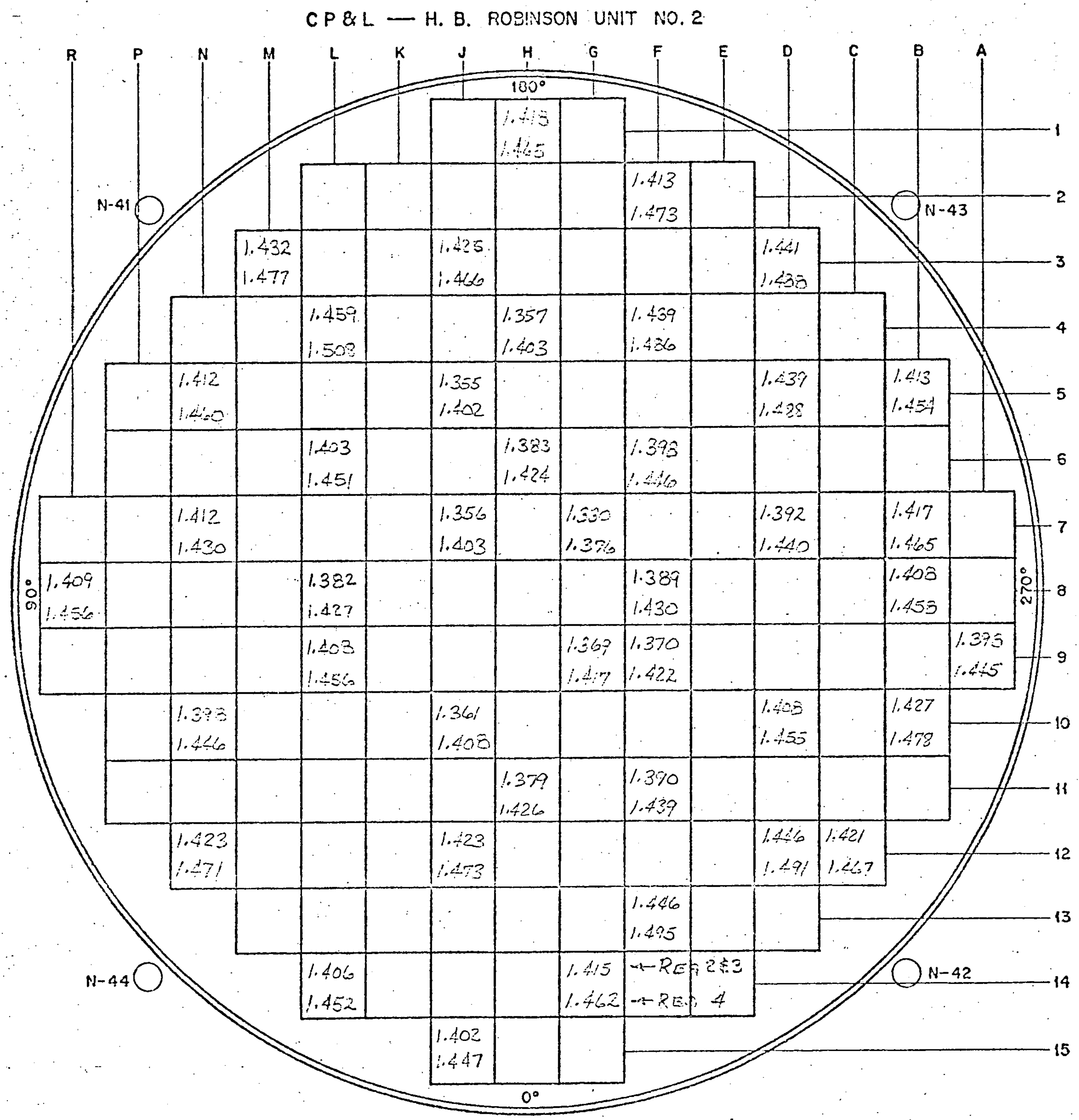
cc: Mr. C. D. Barham
Mr. N. B. Bessac
Mr. B. J. Furr
Mr. D. V. Menscer
Mr. D. B. Waters
Mr. E. E. Utley

FIGURE 1-4 -

F_Q VS CORE HEIGHT

H. B. ROBINSON UNIT 2 - CYCLE 2



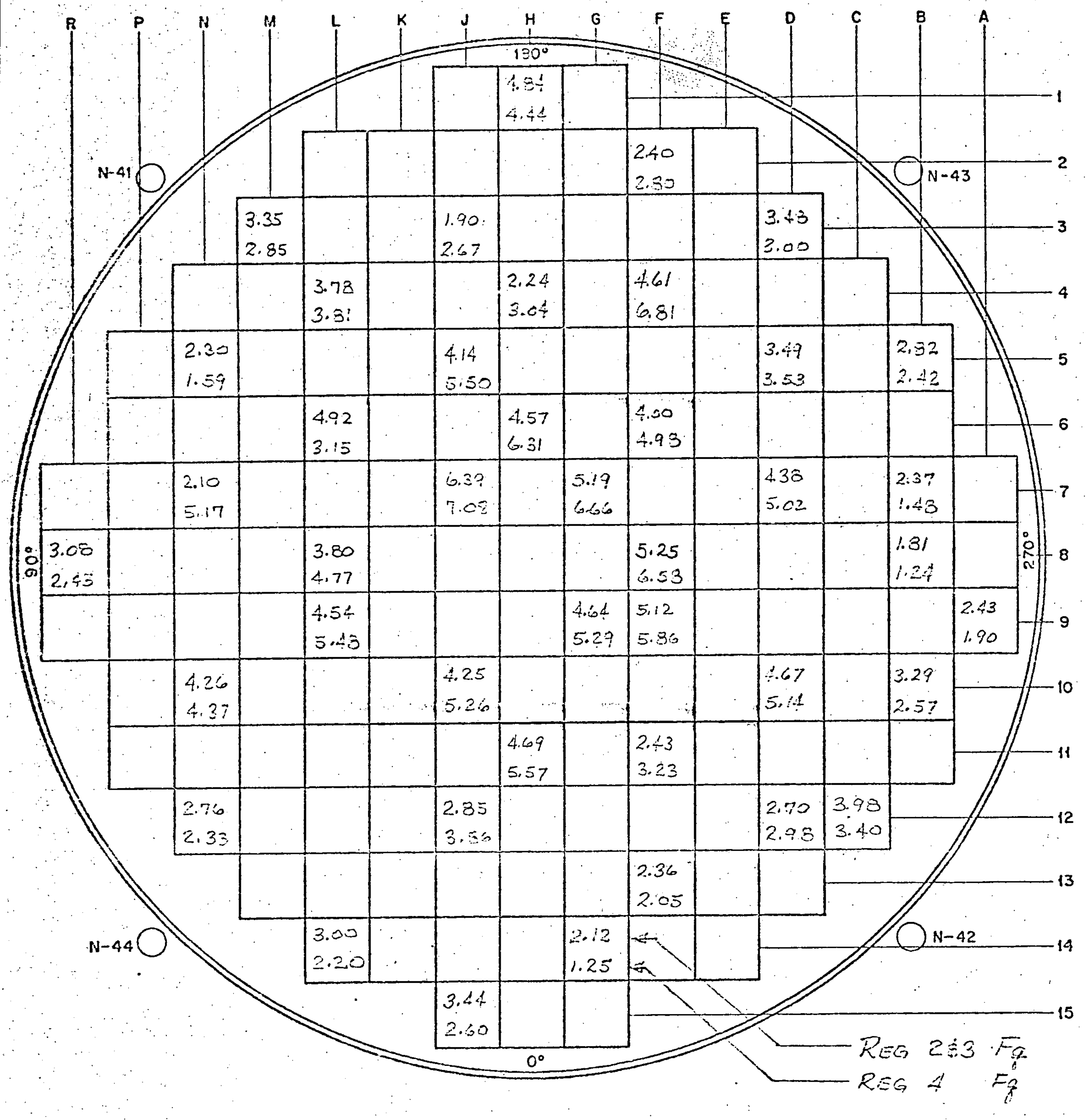


EQUIVALENCE FACTOR ($\bar{R}$) [$F_q = \bar{R} \times F_z \times S_z$]

FOR VARIOUS MONITORING ASSEMBLIES

FIGURE 2

CP&L — H. B. ROBINSON UNIT NO. 2



UNCERTAINTY IN PREDICTING Fq

FROM VARIOUS MONITORED ASSEMBLIES

STANDARD DEVIATION IN PERCENT

FROM SEVEN FLUX MAPS

FIGURE 3