NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL
(TEMPORARY FORM)

CONTROL NO: 6930

FILE:

FROM: Carolina Power & Light Raleigh, N C E E Utley	DATE OF DOC 6-20-75	DATE REC'D 6-30-75	LTR XX	TWX	RPT	OTHER
TO: Mr. Rusche	ORIG 3 signed	CC	OTHER	SENT NRC PDR XXX SENT LOCAL PDR XXX		
CLASS UNCLASS XXX PROP INFO	INPUT	NO CYS REC'D 40	DOCKET NO: 50-261			

DESCRIPTION:

Ltr notarized 6-20-75 trans the following:

ACKNOWLEDGED

DO NOT REMOVE

PLANT NAME: H B Robinson # 2

ENCLOSURES:

Proposed Amdt to OL/change to Tech Specs : consists of proposed changes to the requirements for monitoring incore peaking factors to incorporate Constant Axial Offset Control Limits...

40 copies encl rec'd

FOR ACTION/INFORMATION wtm 6-30-75

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	SPIES W/ Copies
KNIEL (L) W/ Copies	PURPLE (L) W/ Copies	YOUNGBLOOD (E) W/ Copies	LPM 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	ENVIRO	S. REED (E)	CHAPMAN
✓ MOORE (L)	✓ NOVAK (3)	MULLER	M. SERVICE (L)	✓ DUBE (Ltr)
DEYOUNG (L)	✓ ROSS	DICKER	S. SHEPPARD (L)	✓ E. HUGHES
SKOVHOLT (L)	✓ IPPOLITO	KNIGHTON	M. SLATER (E)	PETERSON
GOLLER (L) (Ltr)	✓ TEDESCO	YOUNGBLOOD	H. SMITH (L)	HARTFIELD (2)
P. COLLINS	LONG	REGAN	✓ S. TEETS (L) LTR	KLECKER
DENISE	LAINAS	PROJECT LDR	G. WILLIAMS (E)	EISENHUT
✓ REG OPR (2)	BENAROYA	✓ DITTMAN	V. WILSON (L)	WIGGINTON
FILE & REGION (2)	VOLLMER	HARLESS	R. INGRAM (L)	✓ VARGA
MIPC			M. DUNCAN	

EXTERNAL DISTRIBUTION

✓ 1 – LOCAL PDR Hartville, S C
✓ 1 – TIC (ABERNATHY)
✓ 1 – NSIC (BUCHANAN)
✓ 1 – ASLB
1 – Newton Anderson
✓ 14 – ACRS ~~HOLDING~~/SENT

(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

CP&L
Carolina Power & Light Company

Regulatory Docket File

June 20, 1975

RECEIVED
6-30
U. S. NUCLEAR REGULATORY COMMISSION
Mail Section
am

FILE: NG-3514 (R)

SERIAL: NG-75-816

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

Dear Mr. Rusche:

H. B. ROBINSON UNIT NO. 2
LICENSE NO. DPR-23
REQUEST FOR LICENSE AMENDMENT - REVISION OF TECHNICAL SPECIFICATIONS

In accordance with the Code of Federal Regulations, Title 10, Parts 50.59 and 50.90, Carolina Power & Light Company submits a proposed revision to the Technical Specifications for its H. B. Robinson Unit No. 2 Plant. The revision, attached to this letter, proposes changes to the requirements for monitoring incore peaking factors to incorporate Constant Axial Offset Control (CAOC) limits.

This revision is required as a result of further studies by our vendor, Westinghouse, of the possible effects of adverse xenon distributions and resultant axial distributions on margins to DNB limits during anticipated transients such as an uncontrolled rod withdrawal. Constant Axial Offset Control limits xenon redistribution during power changes, thus maintaining DNB limits. In addition, control of adverse power shapes during normal operation provides assurance that peaking factor limits associated with the loss of coolant accident (LOCA) will not be violated, thus resulting in peak clad temperatures in excess of the 2200°F limits. The value of total peaking factor for the Robinson Plant which maintains peak clad temperature limits is 2.30. All of these requirements have been factored into the revisions, with Attachment A, which are similar to Technical Specifications proposed by other utilities employing Westinghouse reactors.

Normally, assurance of the peaking factor limit of 2.30 would have required supplemental monitoring in addition to CAOC, such as the APDMS system now employed at the Robinson Plant. It is proposed, however, that this supplemental means of monitoring is not required in the case of H. B. Robinson Plant for the remainder of Cycle 3 operations based on analytical studies supplemented by observed plant data. Justification for this approach is presented in Attachment B and reflected in the Technical Specifications of Attachment A.

6930

336 Fayetteville Street • P. O. Box 1551 • Raleigh, N. C. 27602

The proposed Technical Specifications also reflect modifications to the requirements for power ramp rate restrictions following core movements or reduced power operations, consistent with vendor recommendations, and a modification to the quadrant power tilt specification. In light of the number of submittals of proposed specifications in this area, this submittal should be considered as completely superseding previous submittals for Sections 3.10 and 4.11.

In the use of CAOC, an alarm on the ±5% target band has been required by the Commission on other plants. This specification has not been incorporated in the attached revision because the necessary modifications to the plant equipment have not yet been performed. Carolina Power & Light Company expects to complete the necessary modifications by Janaury 1, 1976 and will file a revision to the Technical Specifications incorporating the alarm at that time.

As required by Commission regulations, this submittal is signed under oath by a duly authorized officer of the Company.

Yours very truly,

E. E. Utley
Vice President
Bulk Power Supply

DBW:cpw

Attachment

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

Sworn to and subscribed before me this 20th day of June 1975.

Margaret M. Cox
Notary Public

My Commission Expires July 4, 1975

ATTACHMENT A

TECHNICAL SPECIFICATION MODIFICATIONS

3.10.2 Power Distribution Limits

3.10.2.1 Power distribution limits are expressed as hot channel factors. Limiting values except during low power physics tests are:

$$F_{\Delta H}^{N} = 1.55 \{1 + 0.2(1-P)\}$$

$$F_{Q}^{N}(z) = \frac{2.233 \cdot K(z)}{P} \text{ for } P > 0.5$$

$$= 4.466 \cdot K(z) \text{ for } P \leq 0.5$$

Where:

a. P is the fraction of rated power at which the core is operating ($P \leq 1.0$).

b. K(z) is defined in Figure 3.10-3 and reflects the variation of limiting KW/ft as a function of core height above the core midplane.

If measured peaking factors exceed these values, the maximum allowable reactor power level and the nuclear overpower trip setpoint shall be reduced in direct proportion to the amount which F_Q^N or $F_{\Delta H}^N$ exceeds the limiting values, whichever is more restrictive. If the $F_{\Delta H}^N$ or F_Q^N cannot be reduced below the limiting values with 24 hours, the overpower ΔT and overtemperature ΔT trip setpoint shall be similarly reduced.

3.10.2.2 During full power operation, the measured value of axial offset must be between -17% and +12%. During part power operation, deviations from full power axial offset limits are allowed by Specification 2.3.1.2 (d) and (e). Exceeding the adjusted limits results in overpower and overtemperature setpoint reductions.

3.10.2.3 Following initial loading and each subsequent reloading, a power distribution map, using the Movable Detector System, shall be made to confirm that power distribution limits will be met, in the full power configuration, before the plant is operated above 75% of rated power.

3.10.2.4 The reference equilibrium indicated axial flux difference for each excore channel as a function of power level (called the target flux difference) shall be measured at least once per equivalent full power quarter. The target differences must be updated at least each equivalent full power month using a measured value or by interpolation using the most recent measured value and a value of 0 percent for the end of cycle life.

3.10.2.5 Except during physics tests, control rod exercises, excore detector calibration and except as modified by 3.10.2.6 through 3.10.2.8, the indicated axial flux difference for at least two excore channels shall be maintained within ± 5% about their target flux differences (defines the target band on axial flux difference).

3.10.2.6 Except during physics tests, control rod exercises, or excore calibration, at a power level greater than 90% of rated power, if the indicated axial flux difference of N-1 out of N operable excore channels deviates from its target band, either the deviation shall be eliminated or the reactor power shall be reduced to a level no greater than 90% of rated power.

3.10.2.7 Except during physics tests, control rod exercises, turbine valve tests, or excore calibration, at a power level less than or equal to 90% of rated power:

a. The indicated axial flux difference for N-1 out of N operable excore channels may deviate simultaneously from their ±5% target band for a maximum of one hour (cumulative) in any 24-hour period; however, if the flux difference is outside its target band, then the flux difference shall not exceed the envelope bounded by -11% and +11% about a flux difference of zero at 90% power and increasing by -1% and +1% for each 2% of rated power below 90% power. If the cumulative time for N-1 out of N operable excore channels exceeds one hour, then the reactor power shall be immediately reduced to no greater than 50% power and the high neutron flux setpoint reduced to no greater than 55% of rated values.

b. A power increase to a level greater than 90% of rated power is contingent upon the indicated axial flux difference of at least two excore channels being within their target bands.

3.10.2.8 At a power level no greater than 50% of rated power:

a. The indicated axial flux difference may deviate from its target band and will be bounded by an envelope as defined in Specification 2.3.1.2 (d) and (e) .

b. A power increase to a level greater than 50% of rated power is contingent upon the indicated axial flux difference of at least two excore channels not being outside their target bands for more than one hour (cumulative) out of the preceding 24-hour period.

3.10.2.9 For the purpose of determining penalties associated with deviations from the ± 5% target band, time for use in applying 3.10.2.7a and 3.10.2.8b above shall be accumulated in the following manner:

a. For deviations at or below 50% power, time shall be accumulated such that a one-minute actual deviation equals 1/2 minute accumulative penalty in applying items 3.10.2.7a and 3.10.2.8b above.

b. For deviations above 50% power, time shall be accumulated on a 1 for 1 basis in applying items 3.10.2.7a and 3.10.2.8b above.

3.10.3 Quadrant Power Tilt Limits

3.10.3.1 Except for physics tests and during power increases below 50% of full power, whenever the indicated quadrant power tilt ratio exceeds 1.02, the tilt condition shall be eliminated within two hours or the following actions shall be taken:

a. Restrict core power level and reset the power range high flux setpoint to be less two percent of rated values for every percent of indicated power tilt ratio exceeding 1.0, and

b. If the tilt condition is not eliminated after 24 hours, the power range high flux setpoint shall be reset to 55% of allowed power. Subsequent reactor operation would be permitted up to 50% power for the purpose of measurement and testing to identify the cause of the tilt condition.

3.10.3.2 Except for low power physics tests, if the indicated quadrant tilt exceeds 1.09 and there is simultaneous indication of a misaligned rod:

a. The core power level shall be reduced by 2% of rated values for every 1% of indicated power tilt exceeding 1.0, and

b. If the tilt condition is not eliminated within two hours, the reactor shall be brought to a hot shutdown condition.

3.10.3.3 If the indicated quadrant tilt exceeds 1.09 and there is not simultaneous indication of rod misalignment, the reactor shall immediately be brought to a hot shutdown condition.

3.10.4 Rod Drop Time

3.10.4.1 The drop time of each control rod shall be no greater than 1.8 seconds at full flow and operating temperature from the beginning of rod motion to dashpot entry.

3.10.5 Part Length Control Rod Banks

3.10.5.1 The eight (8) part length control rods shall be configured under administrative control into one of the following part length rod configurations.

a. Four part length rods occupying core positions K-6, K-10, F-6, and F-10 shall constitute a part length control rod bank, hereafter designated bank P-1.

b. Four part length rods occupying core positions P-8, H-2, H-14, and B-8 shall constitute a part length control bank, hereafter designated part length bank P-2.

c. Combined Banks P-1 and P-2, hereafter designated bank P-3.

3.10.5.2 The part length control rods will not be inserted. They will remain in the fully withdrawn position except for physics tests and for axial offset calibration which will be performed at 75% of permitted power or less.

3.10.6 Inoperable Full Length and Part Length Control Rods

3.10.6.1 A full length or part length control rod shall be deemed inoperable if (a) the rod is misaligned by more than 15 inches with its bank, (b) if the rod cannot be moved by its drive mechanism, or (c) if its rod drop time is not met in the case of a full length rod.

3.10.6.2 No more than one inoperable control rod shall be permitted during power operation. This requirement does not apply to part length rods when they are fully withdrawn from the core.

3.10.6.3 If a full length control rod cannot be moved by its mechanism, boron concentration shall be changed to compensate for the withdrawn worth of the inoperable rod such that shutdown margin equal to or greater than shown on Figure 3.10-2 results.

3.10.7 Power Ramp Rate Limits

3.10.7.1 During the return to power following a shutdown where fuel assemblies have been handled (e.g. refueling, inspection), the rate of reactor power increase shall be limited to 3% of full power in an hour between 20% and 100% of full power. This ramp rate requirement applies during the initial startup and may apply during subsequent power increases depending on the maximum power level achieved and length of operation at that power level. Specifically, this requirement can be removed for reactor power levels below a power level P (20% $< P \leq$ 100%) provided that the plant has operated at or above power level P for at least 72 cumulative hours out of any 7-day operating period following the shutdown.

3.10.7.2 The rate of reactor power increases above the highest power level sustained for at least 72 cumulative hours during the preceding 30 cumulative days of reactor power operation shall be limited to 3% of full power in an hour. Alternatively, reactor power increase can be accomplished by a single step increase less than or equal to 10% of full power followed by a maximum ramp rate of 3% of full power in an hour beginning 3 hours after the step increase.

3.10.8 Required Shutdown Margins

3.10.8.1 When the reactor is in the hot shutdown condition, the shutdown margin shall be at least that shown in Figure 3.10-2.

3.10.8.2 When the reactor is in the cold shutdown condition, the shutdown margin shall be at least 1% $\Delta k/k$.

3.10.8.3 When the reactor is in the refueling operation mode, the shutdown margin shall be at least 10% $\Delta k/k$.

Basis:

The reactivity control concept is that reactivity changes accompanying changes in reactor power are compensated by control rod motion. Reactivity changes associated with xenon, samarium, fuel depletion, and large changes in reactor coolant temperature (operating temperature to cold shutdown) are compensated by changes in the soluble boron concentration. During power operation, the shutdown groups are fully withdrawn and control of reactor power is by the control groups. A reactor trip occurring during power operation will put the reactor into the hot shutdown condition.

The control rod insertion limits provide for achieving hot shutdown by reactor trip at any time assuming the highest worth control rod remains fully withdrawn with sufficient margins to meet the assumptions used in the accident analysis. In addition, they provide a limit on the maximum inserted rod worth in the unlikely event of hypothetical rod ejection and provide for acceptable nuclear peaking factors. The solid lines shown in Figure 3.10-1 meet the shutdown requirement for the first 50% of Cycle 3. The end-of-cycle life limit is represented by the dotted lines. The end-of-cycle life limit may be determined on the basis of plant startup and operating data to provide a more realistic limit which will allow for more flexibility in plant operation and still assure compliance with the shutdown requirement. The maximum shutdown margin requirement occurs at end of core life and is based on the value used in analysis of the hypothetical steam break accident. Early in core life, less shutdown margin is required, and Figure 3.10-2 shows the shutdown margin equivalent to 1.77% reactivity [3] at end of life with respect to an uncontrolled cooldown. All other accident analyses are based on 1% reactivity shutdown margin. The specified control rod insertion limits have been revised for Cycle 3 in order to meet the design basis criteria on (1) potential ejected control rod worth and peaking factor [4], (2) radial power peaking factors, $F_{\Delta H}$, and (3) required shutdown margin.

The various control rod banks (shutdown banks, control banks, and part length rods) are each to be moved as a bank, that is, with all rods in the bank within one step (5/8 inch) of the bank position. Position indication is provided by two methods: a digital count of actuation pulses which shows the demand position of the banks and a linear position indicator (LVDT) which indicates the actual rod position[2]. The 15-inch permissible misalignment provides an enforceable limit below which design distribution is not exceeded. In the event that an LVDT is not in service, the effects of a malpositioned control rod are observable on nuclear and process information displayed in the control room and by core thermocouples and in-core movable detectors. The determination of the hot channel factors will be performed by means of the movable in-core detectors.

The two hours in 3.10.1.5 are acceptable because complete rod misalignment (part-length or full-length control rod 12 feet out of

alignment with its bank) does not result in exceeding core safety limits in steady state operation at rated power and is short with respect to probability of an independent accident. If the condition cannot be readily corrected, the specified reduction in power to 70% will ensure that design margins to core limits will be maintained under both steady state and anticipated transient conditions.

The intent of the test to measure control rod worth and shutdown margin (Specification 3.10.1.6) is to measure the worth of all rods less the worth of the worst case for an assumed stuck rod; that is, the most reactive rod. The measurement would be anticipated as part of the initial startup program and infrequently over the life of the plant, to be associated primarily with determinations of special interest such as end of life cooldown, or startup of fuel cycles which deviate from normal equilibrium conditions in terms of fuel loading patterns and anticipated control bank worths. These measurements will augment the normal fuel cycle design calculations and place the knowledge of shutdown capability on a firm experimental as well as analytical basis.

Operation with abnormal rod configuration during low power and zero power testing is permitted because of the brief period of the test and because special precautions are taken during the test.

Two criteria have been chosen as a design basis for fuel performance related to fission gas release, pellet temperature, and cladding mechanical properties. First, the peak value of linear power density must not exceed 21.1 kW/ft. Second, the minimum DNBR in the core must not be less than 1.30 in normal operation or in short term transients.

In addition to the above, the initial steady state conditions for the peak linear power for a loss-of-coolant accident must not exceed the values assumed in the accident evaluation. This limit is required in order for the maximum clad temperature to remain below that established by the ECCS Acceptance Criteria. To aid in specifying the limits on power distribution the following hot channel factors are defined.

F_Q, Heat Flux Hot Channel Factor, is defined as the maximum local heat flux on the surface of a fuel rod divided by the average fuel rod heat flux, allowing for manufacturing tolerances on fuel pellets and rods.

F_Q^N, Nuclear Heat Flux Hot Channel Factor, is defined as the maximum local fuel rod linear power density divided by the average fuel rod linear power density, assuming nominal fuel pellet and rod dimensions.

F_Q^E, Engineering Heat Flux Hot Channel Factor, is defined as the allowance on heat flux required for manufacturing tolerances. The engineering factor allows for local variations in enrichment, pellet density and diameter, surface area of the fuel rod and eccentricity of the gap between pellet and clad. Combined statistically the net effect is a factor of 1.03 to be applied to fuel rod surface heat flux.

$F_{\Delta H}^{N}$, Nuclear Enthalpy Rise Hot Channel Factor, is defined as the ratio of the integral of linear power along the rod with the highest integrated power to the average rod power.

It should be noted that $F_{\Delta H}^{N}$ is based on an integral and is used as such in the DNB calculations. Local heat fluxes are obtained by using hot channel and adjacent channel explicit power shapes which take into account variations in horizontal (x-y) power shapes through the core. Thus, the horizontal power shape at the point of maximum heat flux is not necessarily directly related to $F_{\Delta H}^{N}$.

It has been determined by extensive analysis of possible operating power shapes that the design limits on peak local power density and on minimum DNBR at full power are met, provided:

$$F_Q^N \leq 2.233 \cdot K(z) \text{ and } F_{\Delta H}^N \leq 1.55$$

K(z) is the normalized peaking factor axial dependence used in the LOCA analysis and is shown in Figure 3.10-3. For normal operation, it is not necessary to measure these quantities. Instead, it has been determined that, provided certain conditions are observed, the above hot channel factor limits will be met; these conditions are as follows:

1. Control rods in a single bank move together with no individual rod insertion differing by more than 15 inches from the bank demand position.

2. Control rod banks are sequenced with overlapping banks as shown in Figure 3.10-1.

3. The control bank insertion limits are not violated.

4. Part length control rods are not inserted.

5. Axial power distribution control procedures, which are given in terms of flux difference control, are observed. Flux difference refers to the difference in signals between the top and bottom halves of two-section excore neutron detectors. The flux difference is a measure of the axial offset which is defined on the difference in power between the top and bottom halves of the core.

For operation at a fraction P of full power the design limits are met, provided,

$$F_Q^N \leq \frac{2.233 \cdot K(z)}{P}$$ in the flux difference range -17 percent to +12 percent

and $F_{\Delta H}^N \leq 1.55 \{1 + 0.2 (1-P)\}$

where P is the fraction of full power at which the reactor is operating: $0 \leq P \leq 1.0$.

The permitted relaxation in $F^N_{\Delta H}$ with reduced power allows radial power shape changes with rod insertion to the insertion limits. It has been determined that provided the above conditions 1 through 4 are observed, these hot channel factors limits are met.

The procedures for axial power distribution control referred to above include operator control of flux difference to minimize the effects of xenon redistribution on the axial power distribution during load-follow maneuvers. Basically, control of flux difference is required to limit the difference between the current value of Flux Difference (ΔI) and a reference value which corresponds to the full power equilibrium value of Axial Offset (Axial Offset = ΔI/fractional power). The reference value of flux difference varies with power level and burnup but expressed as axial offset, it varies primarily with burnup.

The target (or reference) value of flux difference is determined as follows: At any time that equilibrium xenon conditions have been established, the indicated flux differnece is noted with part length rods withdrawn from the core and with control Bank D more than 190 steps withdrawn. This value, divided by the fraction of full power at which the core was operating is the full power value of the target flux difference. Values for all other core power levels are obtained by multiplying the full power value by the fractional power. Since the indicated equilibrium value was noted, no allowances for excore detector error are necessary and indicated deviation of $\pm$ 5 percent ΔI is permitted from the indicated reference value. During periods where extensive load following is required, it may be impossible to establish the required core conditions for measuring the target flux difference every month. For this reason, the specification provides two methods for updating the target flux difference.

Strict control of the flux difference (and rod position) is not as necessary during part power operation. This is because xenon distribution control at part power is not as significant as the control at full power and allowance has been made in predicting the heat flux peaking factors for less strict control at part power.

Strict control of the flux difference is not possible during certain physics tests, control rod exercises, or during the required periodic excore calibration which require larger flux differences than permitted. Therefore, the specifications on power distribution are not applicable during physics tests, control rod exercises, turbine valve tests, or excore calibrations; this is acceptable due to the extremely low probability of a significant accident occurring during these operations. Excore calibration and turbine valve tests include that period of time necessary to return to equilibrium operating conditions. In some instances of rapid plant power reduction automatic rod motion will cause the flux difference to deviate from the target band when the reduced power level is reached. This does not necessarily affect the xenon distribution sufficiently to change the envelope of peaking factors which can be reached on a subsequent return to full power within the target band, however, to simplify the specification, a limitation of one hour in any

period of 24 hours is placed on operation outside the band. This ensures that the resulting xenon distributions are not significantly different from those resulting from operation within the target band. The instantaneous consequence of being outside the band, provided rod insertion limits are observed, is not worse than a 10 percent increment in peaking factor for flux difference in the range +14 percent to -14 percent (+11 percent to -11 percent indicated) increasing by +1 percent for each 2 percent decrease in rated power. Therefore, while the deviation exists the power level is limited to 90 percent or lower depending on the indicated flux difference. In all cases the (±5) percent target band is the Limiting Condition for Operation. Only when the target band is violated do the limits under specification 3.10.2.7 apply.

If, for any reason, flux difference is not controlled with the ± 5 percent band for as long a period as one hour, then xenon distributions may be significantly changed and operation at 50 percent is required to protect against potentially more severe consequences of some accidents.

As discussed above, the essence of the limits is to maintain the xenon distribution in the core as close to the equilibrium full power condition as possible. This is accomplished by using the chemical volume control system to position the full length control rods to produce the required indication flux difference.

An upper bound envelope of 2.30 times the normalized peaking factor axial dependence has been determined from extensive analysis considering all operating maneuvers consistent with the technical specifications on power distribution control as given in Section 3.10.2. The specifications on power distribution control insure that xenon distributions are not developed which, at a later time could cause greater local power peaking even though the flux difference is then within limits. The results of a loss of coolant accident analysis based this upper bound envelope indicate that a peak clad temperature could theoretically exceed the $2200^{\circ}F$ limits. The nuclear analyses of credible power shapes consistent with the power distribution control procedures have shown that the F_q^T limit of 2.30/P is not exceeded.

For transient events the core is protected from exceeding 21.1 KW/ft locally, and from going below a minimum DNBR of 1.30, by automatic protection on power, flux difference, pressure and temperature.

Measurements of the hot channel factors are required as part of startup physics tests and whenever abnormal power distribution conditions require a reduction of core power to a level based on measured hot channel factors.

In the specified limit of F_q^N there is a 5% allowance for uncertainties[1] which means that normal operation of the core within the defined conditions and procedures is expected to result in a measured $F_q^N \leq 2.233/1.05$; for example, at rated power even on a worst case basis. When a measurement is taken, experimental error must be allowed for and 5% is the appropriate allowance for a full core representative map taken with the movable incore detector flux mapping system.

In the specified limit of $F_{\Delta H}^N$ there is an 8% allowance for design prediction uncertainties which means that normal operation of the core is expected to result in $F_{\Delta H}^N \leq 1.55/1.08$ at rated power. The uncertainty to be associated with a measurement of $F_{\Delta H}^N$ by the movable incore system on the other hand is 4% which means that the normal operation of the core shall result in a measured $F_{\Delta H}^N \leq 1.55/1.04$ at rated power. The logic behind the larger design uncertainty in this case is that (a) abnormal perturbation in the radial power shape (e.g., rod misalignment) affect $F_{\Delta H}^N$ in most cases without necessarily affecting F_q^N through movement of part length rods and can limit it to the desired value (b) while the operator has some control over F_q^N through F_z^N by motion of control rods, he has no direct control over $F_{\Delta H}^N$, and (c) an error in the predictions for radial power shape which may be detected during startup physics tests can be compensated for in F_q^N by tighter axial control, but compensation for $F_{\Delta H}^N$ is less readily available.

Quadrant power tilts are based upon the following considerations. The radial power distribution within the core must satisfy the design values assumed for calculation of power capability. Radial power distributions, measured as part of the startup physics testing, are periodically measured at a monthly or greater frequency. These measurements are taken to assure that the radial power distribution with any quarter core radial power asymmetry conditions are consistent with the assumptions used in power capability analyses. It is not intended that extended reactor operation would continue with a power tilt condition which exceeds the radial power asymmetry considered in the power capability analysis.

During normal plant startup, quadrant power tilt ratio may exceed 1.02 due to instrumentation instabilities as a result of rodded configurations and low excore detector signal levels below 50% of full power. Sustained power operation below 50% of full power would require a renormalization of the calculational methods for determining power tilt to compensate for change in signal levels once equilibrium conditions are met.

The two-hour time interval in this specification is considered ample to identify a dropped or misaligned rod and complete realignment procedures to eliminate the tilt. In the event that the tilt conditions cannot be eliminated within the two-hour time allowance, additional time would be needed to investigate the cause of the tilt condition. The measurements would include a full core physics map utilizing the movable detector system. For a tilt condition ≤ 1.09 an additional 22 hours time interval is authorized to accomplish these measurements. However, to assure that the peak core power is maintained below limiting values, a reduction of reactor power of two percent for each one percent of indicated tilt is required. Physics measurements have indicated that the core radial power peaking would not exceed a two-to-one relationship with the indicated tilt from the excore nuclear detector system for the worst rod misalignment.

In the event the tilt condition of 1.09 cannot be eliminated after 24 hours, the reactor power level will be reduced to the range required for low power physics testing. To avoid reset of a large number of protection setpoints, the power range nuclear instrumentation would be reset to cause an automatic reactor trip at 55% of allowed power. A reactor trip at this power has been selected to prevent, with margin, exceeding core safety limits even with a nine percent tilt condition. If a tilt ratio greater than 1.09 occurs which is not due to a misaligned rod, the reactor power shall be brought to a hot shutdown condition for investigation.

However, if the tilt condition can be identified as due to rod misalignment, operation can continue at a reduced power (2% for each one percent the tilt ratio exceeds 1.0) for the two-hour period necessary to correct the rod misalignment.

The specified rod drop time is consistent with safety analyses that have been performed. (1)

Part length rod insertion has been limited to eliminate adverse power shapes (Section 3.10.5.2).

An inoperable rod imposes additional demands on the operator. The permissible number of inoperable control rods is limited to one in order to limit the magnitude of the operating burden, but such a failure would not prevent dropping of the operable rods upon reactor trip.

Normal reactor operation causes significant pellet cracking and fragmentation. Consequently, handling of irradiated fuel assemblies can result in relocation of these fragments against the cladding. Calculations show that high cladding stresses can occur if the reactor power increase is rapid during the subsequent startup.

The 72-hour period allows for stress relaxation of the clad before the ramp rate requirement is removed, thereby, reducing the potential harmful effects of possible pellet or fragment relocation.

The 3% limit is imposed to minimize the effects of adverse cladding stresses resulting from part power operation for extended periods of time. The time period of 30 days is based upon the successful power ramp demonstrations performed on Zircaloy clad fuel in operating reactors, resulting in no cladding failures.

References

(1) FSAR, Section 14 and WCAP-8243
(2) FSAR, Section 7.3
(3) WCAP-8243, Section 4.4.2
(4) WCAP-8243, Section 4.4.3

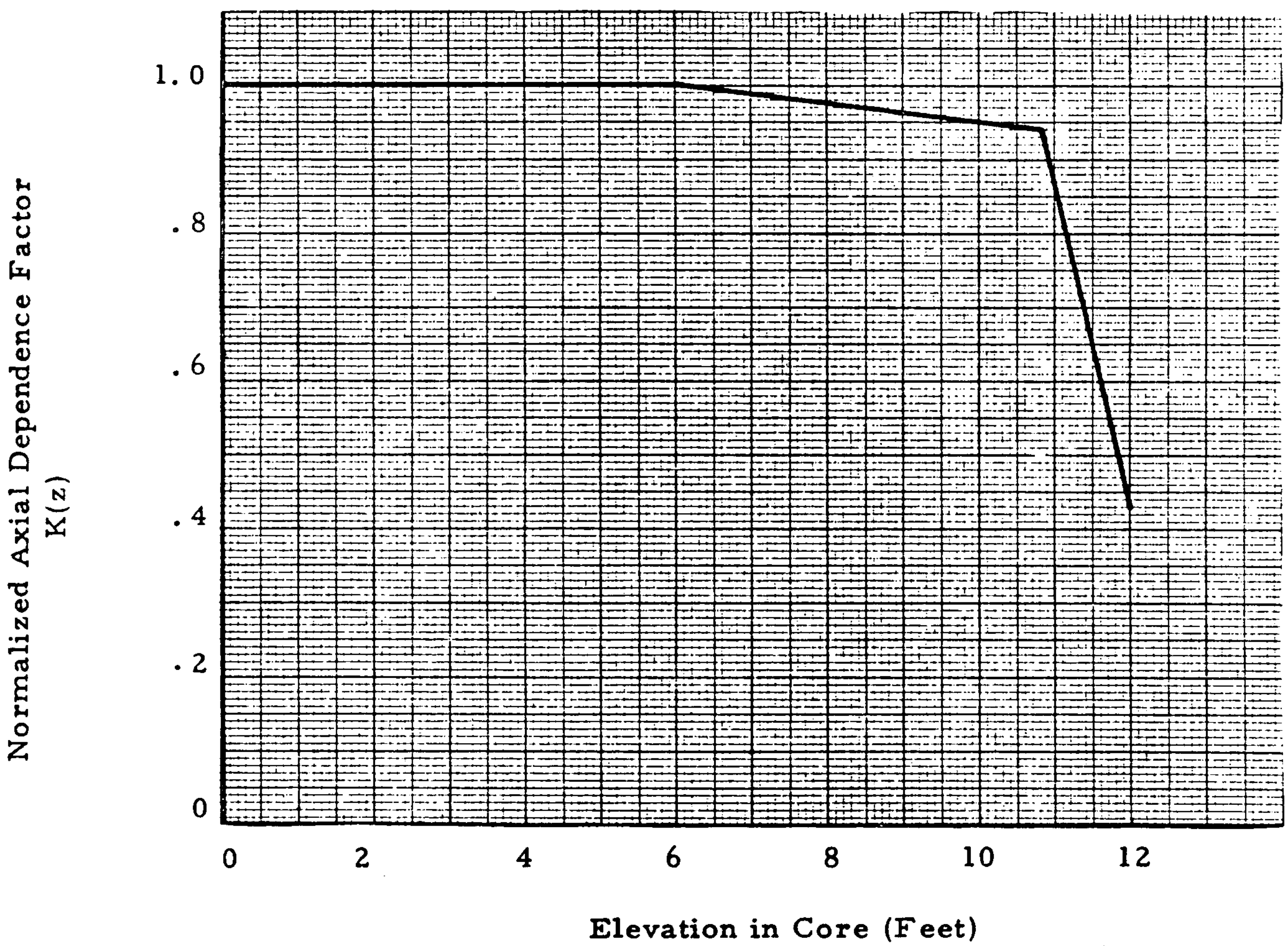

Figure 3.10-3 Normalized Axial Dependence Factor for F_Q versus Elevation

4.11 REACTOR CORE

Applicability:

Applies to surveillance of the reactor core.

Objective:

To insure the integrity of the fuel cladding.

Specifications:

4.11.1 Following initial loading and at regular monthly intervals thereafter, power distribution maps using the movable detector system, shall be made to confirm that the hot channel factor limits of Specification 3.10.2 are satisfied. For the purpose of this confirmation:

a. The measurement of total peaking factor, F_Q^{Meas}, shall be increased by five percent to account for measurement error.

b. The measurement of enthalpy rise hot channel factor, $F_{\Delta H}^N$, shall be increased by four percent to account for measurement error.

4.11.2 Each power distribution map will be based on flux traverses obtained from 36 or more of the 46 monitoring channels.

Attachment B

Justification for Use of Constant Axial Offset Control to Assure $F_Q^T \leq 2.30$

A substantial amount of plant operating data has been acquired during Cycle 3 operation using the Axial Power Distribution Monitoring System (APDMS). These data cover a wide range of operational conditions, including normal base load operation and off-normal operations such as turbine valve testing and excore calibrations. These data, which are shown in the attached figure, establish the fact that the value of F_Q^T measured by APDMS is well below the limiting value of 2.30 within the target band of $\pm 5\%$ consistent with Constant Axial Offset Control (CAOC). A typical target band for the H. B. Robinson Unit No. 2 Plant at this point in Cycle lifetime is shown on the figure.

Analytical justifications to support the above operational data are provided by WCAP-8385.[1] Considering that the Robinson Plant is over 60% through Cycle 3 operations, core power distributions are typical of those assumed in the studies leading to the development of Figure 4.2 of the WCAP, with no part-length central rods present. These studies combined with the above data establish that a peaking factor well below the Robinson limit of 2.30 can be maintained using Constant Axial Offset Control procedures and justify its use in this manner during the remainder of Cycle 3 operations.

---

(1) T. Morita et. al., "Topical Report - Power Distributions Central and Load Following Procedures", WCAP-8385, September, 1974 (Westinghouse Proprietary Class II).

NO. 341-10½ DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH
EUGENE DIETZGEN CO.
MADE IN U. S. A.