IMPACT OF DATA PRESENTED IN DRAFT
NUREG-0630
ON DONALD C.COOK UNIT 2 LOCA ANALYSIS

A. Base Case

The most limiting break for Donald C. Cook Unit 2 is a double ended cold leg guillotine break with a discharge coefficient of 0.8.

Using the February 1978 evaluation model, the results for this break are:

1. F_Q = 2.02
2. Hot Rod Peak Cladding Temperature (PCT) at

   Burst Node = 1905.5°F,

   Elevation = 6.05 feet.
3. Hot Rod PCT at non-ruptured Node = 2171.2°F,

   Elevation = 7. 5 feet

   Clad Strain During Blowdown At 7.5 feet = 1.15%

   Maximum Clad Strain at 7.5 feet = 9.05%
4. Average Hot Assembly Rod Burst Elevation = 9.0 feet

   Hot Assembly Blockage Calculated = 20.4%

B. Burst Node

The maximum potential impact on the ruptured clad node is expressed in letter NS-TMA-2174 in terms of the change in the peaking factor limit ΔF_Q required to maintain a PCT of 2200°F and in terms of a change in PCT (Δ PCT) at a constant F_Q. This procedure eliminates extrapolating data over a wide range above 2200°F since the increase in metal water reaction at these elevated temperatures may make such extrapolations inaccurate.

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Using NS-TMA-2174:

a. +0.01 ΔF_Q corresponds to +150°F ΔPCT at the burst node,
b. NRC burst model could require ΔF_Q of -0.015,
c. Minimum estimated impact of using NRC strain model is F_Q of -0.030.

Therefore, maximum penalty for hot burst mode is

$$\Delta PCT_1 = (0.015 + 0.030)\ (150^oF/0.01) = 675^oF$$

$$\text{Margin to } 2200^oF = 2200 - \text{Burst Node PCT}$$
$$= 2200 - 1905.5 = 294.5^oF = \Delta PCT_2$$

Therefore, F_Q penalty at burst node (ΔF_{QB}) =

$$(675 - 294.5)^oF \times (-0.01/150^oF) = -0.025$$

C. Non-Burst Node

The maximum temperature calculated for a non-burst location typically occurs above the core midplane during reflood. The potential impact in this area in using the NRC fuel rods models can be estimated by examining two aspects of the analysis. The first aspect is the change in gap conductance resulting from differences in cladding strain. Note that clad strain along the fuel rod stops after rupture and use of a different burst model can change the calculated burst time. Three sets of a LOCA analysis were studied to establish an acceptable sensitivity to apply generically to this evaluation. The maximum PCT increase resulting from a change in strain in the hot rod is 20°F per percent decrease in strain at the maximum clad temperature location. Since the clad strain during the RCS blowdown is unaffected by the new NRC data, the maximum decrease in clad strain that must be considered in the difference between the "maximum clad strain" (MCS) and clad strain at the end of blowdown (BCS) which are listed above in the base case discussion. Therefore,

$$\Delta PCT_3 = (20^oF/1\%)\ (MCS - BCS)$$
$$= (20^oF/1\%)\ (9.05\% - 1.15\%) = 158^oF$$

The second aspect of the analysis that can increase PCT is the calculated flow blockage. Using the methods detailed in NS-TMA-2174, the following change in PCT is calculated.

ΔPCT_4 = (1.25°F/%) (50% - Hot Assembly Blockage)
+ (2.36°F/%) (75% - 50%)
= 1.25 (50 - 20.4) + 59°F
= 96°F

$\Delta PCT_5 = \Delta PCT_4 + \Delta PCT_3 = 158 + 96 = 254°F$

ΔPCT_6 = 2200°F - Actual PCT = 2200 - 2171.2 = 28.8°F

The F_Q reduction required to maintain the 2200°F limit using the above values in conjunction with the results of NS-TMA-2174 is $\Delta F_{QN} = -0.23$.

D. Benefit From Improved Analytical Modelling

The effect on LOCA analysis of using improved analytical techniques which are currently approved for use in LOCA analysis of plants utilizing upper head injection in the blowdown (SATAN Code) calculation has been quantified via an analysis recently submitted to the NRC. Since the review of this analysis is not yet complete, the NRC has established a credit that is acceptable for this interim period. This credit for Donald C. Cook Unit 2, which is a four loop plant is $\Delta F_Q = +0.20$.

E. Maximum Overall F_Q

Base Case (February '78 Model)	= 2.02
ΔF_Q penalty = max($\Delta F_{QB}, \Delta F_{QN}$)	= -0.23
ΔF_Q benefit	= +0.20
	1.99

Maximum Overall F_Q = 1.99

ATTACHMENT B

TO

AEP:NRC:00322B

DONALD C. COOK NUCLEAR PLANT UNIT NO. 2

DOCKET NO. 50-316

LICENSE NO. DPR-74

Change No. 1 (Change No. 2 of AEP:NRC:00297)

Revisions to Limiting Condition of Operation (LCO) 3.2.2, Figure 3.2-2 and Basis Item 3/4 2.1 - Unit No. 2

This change involves lowering the maximum allowable F_Q (Z) limits. The maximum value is being reduced from 2.32 to 1.99. Until the 1.99 limit was established via the evaluation discussed in Attachment A of this letter, an administrative limit of 2.11 was employed in compliance with the NRC order which followed the discovery of a 'logic inconsistency' in the metal-water reaction calculation of the Westinghouse ECCS Evaluation Models. The 2.11 administrative limit was established after a new Westinghouse ECCS analysis (using the October 1975 Model with the metal-water correction) was performed. These analyses results were transmitted to the NRC on April 28, 1978. A reanalysis of Donald C. Cook 2 using the February 1978 Model resulted in a maximum F_Q of 2.02. This base analysis was used to establish the new 1.99 limit. This change assures the continued protection of the public health and safety.

Change No. 2 (Change No. 4 of AEP:NRC:00297)

Revisions to LCO 3.2.1 and Figure 3.2-1 - Unit No. 2

This change involves keeping the upper power limit for the taking of action at 84% Rated Thermal Power. The change requested in AEP:NRC:00297 was to raise the limit to 90% RTP. This technical basis for the change is the same as that of Change No. 1 above. This change assures the continued protection of the public health and safety.

Change No. 3 (Change No. 5 of AEP:NRC:00297)

Revisions to LCO 3.2.6 and 4.2.6 - Unit No. 2

This change involves keeping the APDMS turn-on point at 94% Rated Thermal Power. The change requested in AEP:NRC:00297 was to raise the turn-on point to 100% RTP. This change is based on the revisions to LCO 3.2.1 and Figure 3.2-1 as discussed in Change No. 2 since the APDMS turn-on point is defined as 10% above the upper limit of LCO 3.2.1. This change assures the continued protection of the public health and safety.

HEAT FLUX HOT CHANNEL FACTOR-$F_Q(Z)$

LIMITING CONDITION FOR OPERATION

3.2.2 $F_Q(Z)$ shall be limited by the following relationships:

$$F_Q(Z) \leq \frac{[1.99]}{P} [K(Z)] \text{ for } P > 0.5$$

$$F_Q(Z) \leq [(3.98)] \; [K(Z)] \text{ for } P \leq 0.5$$

$$\text{where } P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

and K(Z) is the function obtained from Figure 3.2-2 for a given core height location.

APPLICABILITY: MODE 1

ACTION:

With $F_Q(Z)$ exceeding its limit:

a. Comply with either of the following ACTIONS:

1. Reduce THERMAL POWER at least 1% for each 1% $F_Q(Z)$ exceeds the limit within 15 minutes and similiarly reduce the Power Range Neutron Flux-High Trip Setpoints within the next 4 hours; POWER OPERA .ON may proceed for up to a total of 72 hours; subsequent POWER OPERATION may proceed provided the Overpower ΔT Trip Setpoints have been reduced at least 1% for each 1% $F_Q(Z)$ exceeds the limit. The Overpower ΔT Trip Setpoint reduction shall be performed with the reactor in at least HOT STANDBY.

2. Reduce THERMAL POWER as necessary to meet the limits of Specification 3.2.6 using the APDMS with the latest incore map and updated $\bar{R}$.

b. Identify and correct the cause of the out of limit condiiton prior to increasing THERMAL POWER above the reduced limit required by a, above; THERMAL POWER may then be increased provided $F_Q(Z)$ is demonstrated through incore mapping to be within its limit.

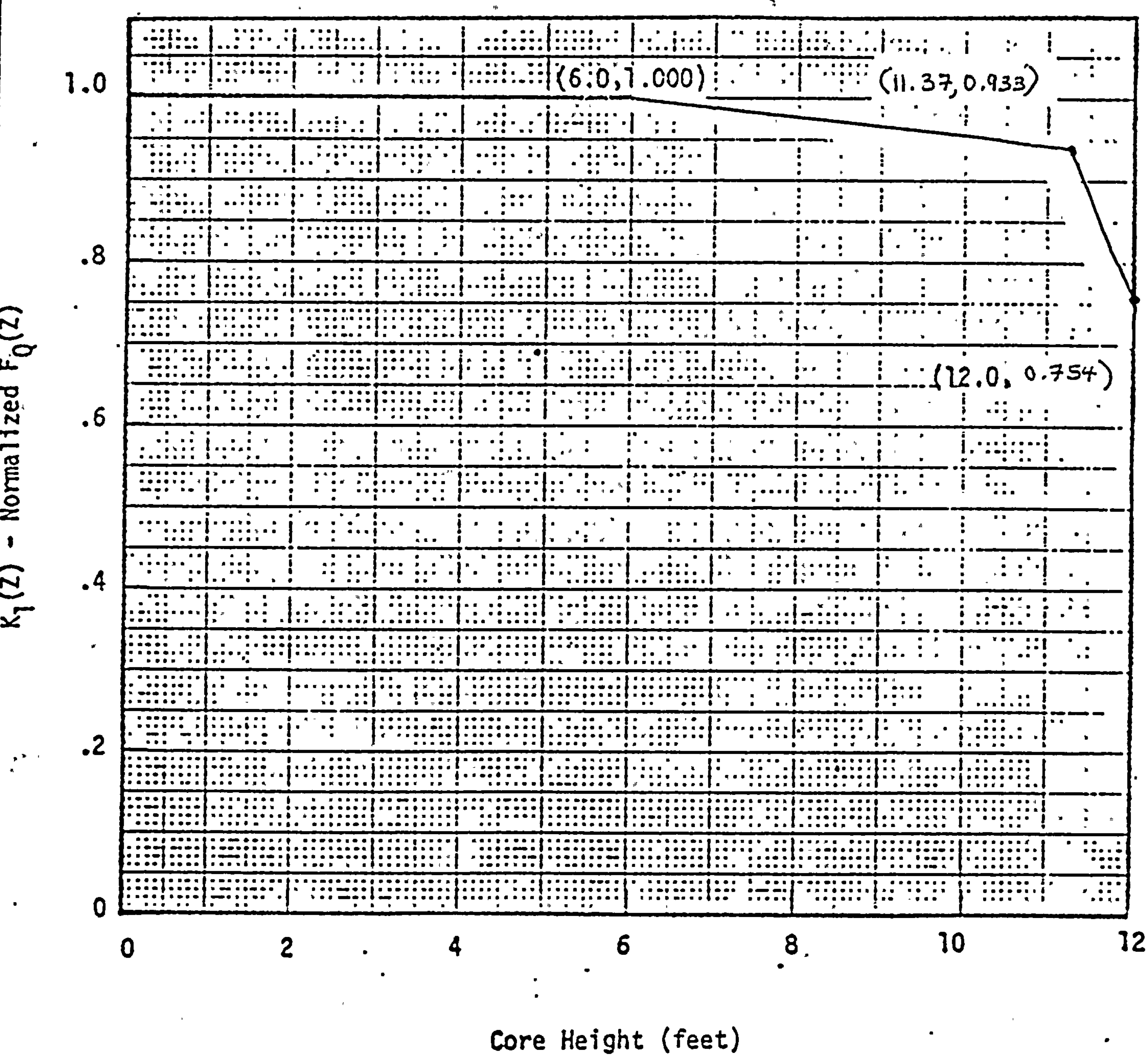
FIGURE 3.2-2 K(Z) — NORMALIZED $F_Q(Z)$ AS A FUNCTION OF CORE HEIGHT

HEAT FLUX HOT CHANNEL FACTOR

NORMALIZED OPERATING ENVELOPE

FOUR-LOOP OPERATION

Basis: $F_Q(Z)$ x P ECCS limit of 1.99



BASES

The specifications of this section provide assurance of fuel integrity during Condition I (Normal Operation) and II (Incidents of Moderate Frequency) events by: (a) maintaining the calculated DNBR in the core at or above design during normal operation and in short term transients, and (b) limiting the fission gas release, fuel pellet temperature and cladding mechanical properties to within assumed design criteria. In addition, limiting the peak linear power density during Condition I events provides assurance that the initial conditions assumed for the LOCA analyses are met and the ECCS acceptance criteria limit of 2200°F is not exceeded.

The definitions of certain hot channel and peaking factors as used in these specifications are as follows:

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

$F^N_{\Delta H}$ 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.

$F_{xy}(Z)$ Radial Peaking Factor, is defined as the ratio of peak power density to average power density in the horizontal plane at core elevation Z.

3/4.2.1 AXIAL FLUX DIFFERENCE (AFD)

The limits on AXIAL FLUX DIFFERENCE assure that the $F_Q(Z)$ upper bound envelope of 1.99 times the normalized axial peaking factor is not exceeded during either normal operation or in the event of xenon redistribution following power changes.

Target flux difference is determined at equilibrium xenon conditions. The full length rods may be positioned within the core in accordance with their respective insertion limits and should be inserted near their normal position for steady state operation at high power levels. The value of the target flux difference obtained under these conditions divided by the fraction of RATED THERMAL POWER is the target flux difference at RATED THERMAL POWER for the associated core burnup conditions. Target flux differences for other THERMAL POWER levels are obtained by multiplying the RATED THERMAL POWER value by the appropriate fractional THERMAL POWER level. The periodic updating of the target flux difference value is necessary to reflect core burnup considerations.

Although it is intended that the plant will be operated with the AXIAL FLUX DIFFERENCE within the ±5% target band about the target flux difference, during rapid plant THERMAL POWER reductions, control rod motion will cause the AFD to deviate outside of the target band at reduced THERMAL POWER levels. This deviation will not affect the xenon redistribution sufficiently to change the envelope of peaking factors which may be reached on a subsequent return to RATED THERMAL POWER (with the AFD within the target band) provided the time duration of the deviation is limited. Accordingly, a 1 hour penalty deviation limit cumulative during the previous 24 hours is provided for operation outside of the target band but within the limits of Figure 3.2-1 while at THERMAL POWER levels between 50% and 94% of RATED THERMAL POWER R. For THERMAL POWER levels between 15% and 50% of RATED THERMAL POWER, deviations of the AFD outside of the target band are less significant. The penalty of 2 hours actual time reflects this reduced significance.

Provisions for monitoring the AFD on an automatic basis are derived from the plant process computer through the AFD Monitor Alarm. The computer determines the one minute average of each of the OPERABLE excore detector outputs and provides an alarm message immediately if the AFD for at least 2 of 4 or 2 of 3 OPERABLE excore channels are outside the target band and the THERMAL POWER is greater than 94% of RATED THERMAL POWER. During operation at THERMAL POWER levels between 50% and 94% and between 15% and 50% RATED THERMAL POWER, the computer outputs an alarm message when the penalty deviation accumulates beyond the limits of 1 hour and 2 hours, respectively.

Figure B 3/4 2-1 shows a typical monthly target band.

CHANGE NO. 2

AXIAL FLUX DIFFERENCE (AFD)

LIMITING CONDITION FOR OPERATION

3.2.1 The indicated AXIAL FLUX DIFFERENCE (AFD) shall be maintained within a +5% target band (flux difference units) about the target flux difference.

APPLICABILITY: MODE 1 ABOVE 50% RATED THERMAL POWER*

ACTION:

a. With the indicated AXIAL FLUX DIFFERENCE outside of the +5% target band about the target flux difference and with THERMAL POWER:

   1. Above 84% of RATED THERMAL POWER, within 15 minutes:

      a) Either restore the indicated AFD to within the target band limits, or

      b) Reduce THERMAL POWER to less than 84% of RATED THERMAL POWER.

   2. Between 50% and 84% of RATED THERMAL POWER:

      a) POWER OPERATION may continue provided:

         1) The indicated AFD has not been outside of the +5% target band for more than 1 hour penalty deviation cumulative during the previous 24 hours, and

         2) The indicated AFD is within the limits shown on Figure 3.2-1. Otherwise, reduce THERMAL POWER to less than 50% of RATED THERMAL POWER within 30 minutes and reduce the Power Range Neutron Flux-High Trip Setpoints to $\leq$ 55% of RATED THERMAL POWER within the next 4 hours.

      b) Surveillance testing of the Power Range Neutron Flux Channels may be performed pursuant to Specification 4.3.1.1.1 provided the indicated AFD is maintained within the limits of Figure 3.2-1. A total of 16 hours operation may be accumulated with the AFD outside of the target band during this testing without penalty deviation.

*See Special Test Exception 3.10.2

ACTION: (Continued)

c) Surveillance testing of the APDMS may be performed pursuant to Specification 4.3.3.7.1 provided the indicated AFD is maintained within the limits of Figure 3.2-1. A total of 6 hours of operation may be accumulated with the AFD outside of the target band during this testing without penalty deviation.

b. THERMAL POWER shall not be increased above 84% of RATED THERMAL POWER unless the indicated AFD is within the ±5% target band and ACTION 2.a) 1), above has been satisfied.

c. THERMAL POWER shall not be increased above 50% of RATED THERMAL POWER unless the indicated AFD has not been outside of the ±5% target band for more than 1 hour penalty deviation cumulative during the previous 24 hours.

SURVEILLANCE REQUIREMENTS

4.2.1.1 The indicated AXIAL FLUX DIFFERENCE shall be determined to be within its limits during POWER OPERATION above 15% of RATED THERMAL POWER by:

a. Monitoring the indicated AFD for each OPERABLE excore channel:

1. At least once per 7 days when the AFD Monitor Alarm is OPERABLE, and

2. At least once per hour for the first 24 hours after restoring the AFD Monitor Alarm to OPERABLE status.

b. Monitoring and logging the indicated AXIAL FLUX DIFFERENCE for each OPERABLE excore channel at least once per hour for the first 24 hours and at least once per 30 minutes thereafter, when the AXIAL FLUX DIFFERENCE Monitor Alarm is inoperable. The logged values of the indicated AXIAL FLUX DIFFERENCE shall be assumed to exist during the interval preceding each logging.

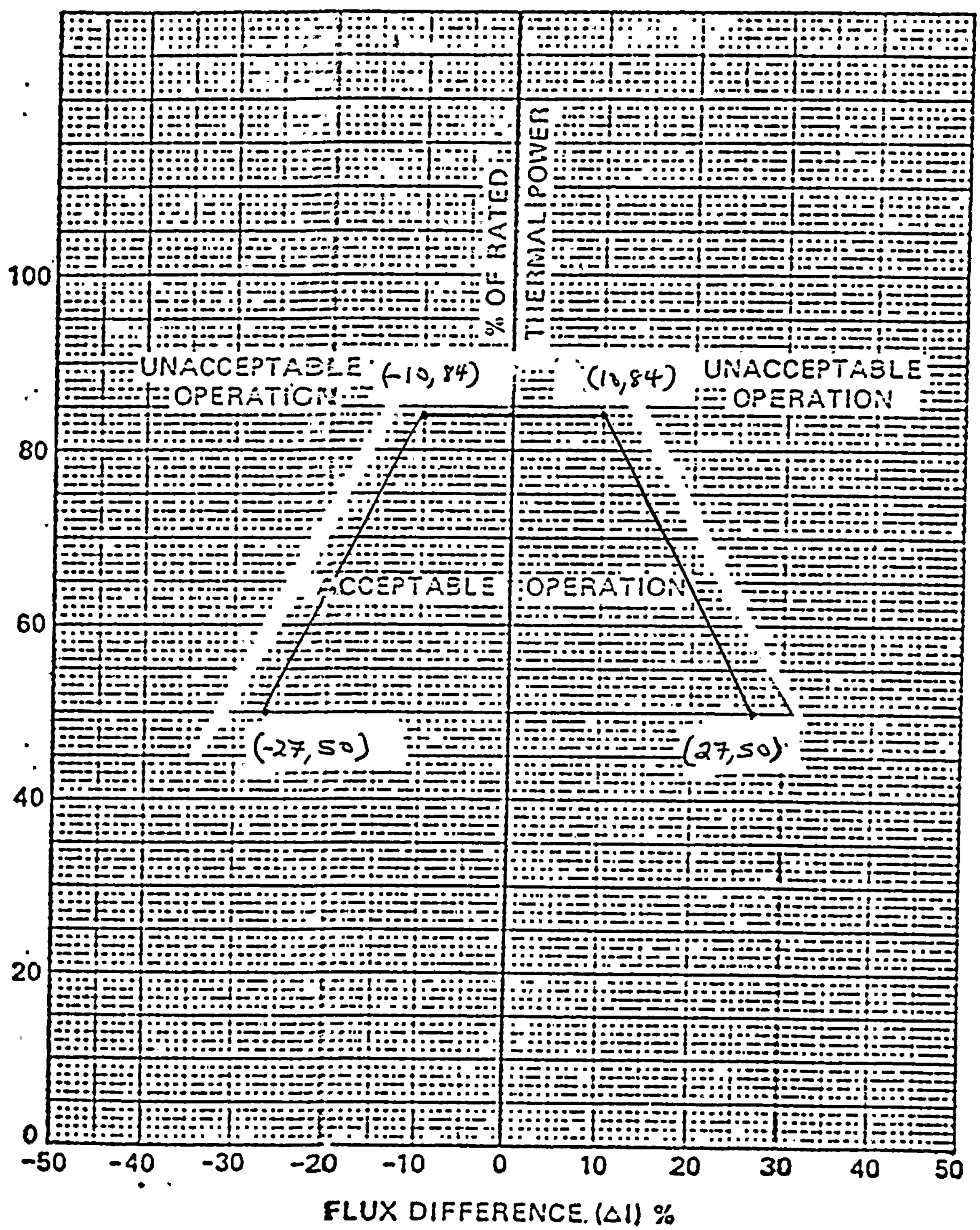


FIGURE 3.2-1 AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF RATED THERMAL POWER

LIMITING CONDITION FOR OPERATION

3.2.6 The axial power distribution shall be limited by the following relationship:

$$[F_j(Z)]_S = \frac{[1.99][K(Z)]}{(\overline{R}_j)(P_L)(1.03)(1 + \sigma_j)(1.07)}$$

Where:

a. $F_j(Z)$ is the normalized axial power distribution from thimble j at core elevation Z.

b. P_L is the fraction of RATED THERMAL POWER.

c. K(Z) is the function obtained from Figure 3.2-2 for a given core height location.

d. $\overline{R}_j$, for thimble j, is determined from at least n=6 in-core flux maps covering the full configuration of permissible rod patterns above 94% of RATED THERMAL POWER in accordance with:

$$\overline{R}_j = \frac{1}{n} \sum_{i=1}^{n} R_{ij}$$

Where:

$$R_{ij} = \frac{F_{Qi}^{Meas}}{[F_{ij}(Z)]_{Max}}$$

and $[F_{ij}(Z)]_{Max}$ is the maximum value of the normalized axial distribution at elevation Z from thimble j in map i which had a measured peaking factor without uncertainties or densification allowance of F_Q^{Meas}.

LIMITING CONDITION FOR OPERATION (Continued)

σ_j is the standard deviation associated with thimble j, expressed as a fraction or percentage of $\overline{R}_j$, and is derived from n flux maps from the relationship below, or 0.02, (2%) whichever is greater.

$$\sigma_j = \frac{\left[\frac{1}{n-1}\sum_{i=1}^{n}(\overline{R}_j - R_{ij})^2\right]^{1/2}}{\overline{R}_j}$$

The factor 1.07 is comprised of 1.02 and 1.05 to account for the axial power distribution instrumentation accuracy and the measurement uncertainty associated with F_Q using the movable detector system respectively.

The factor 1.03 is the engineering uncertainty factor.

APPLICABILITY: MODE 1 above 94% OF RATED THERMAL POWER#.

ACTION:

a. With a $F_j(Z)$ factor exceeding $[F_j(Z)]_S$ by $\leq$ 4 percent, reduce THERMAL POWER one percent for every percent by which the $F_j(Z)$ factor exceeds its limit within 15 minutes and within the next two hours either reduce the $F_j(Z)$ factor to within its limit or reduce THERMAL POWER to 94% or less of RATED THERMAL POWER.

b. With a $F_j(Z)$ factor exceeding $[F_j(Z)]_S$ by > 4 percent, reduce THERMAL POWER to 94% or less of RATED THERMAL POWER within 15 minutes.

The APDMS may be out of service when surveillance for determining power distribution maps is being performed.

[illegible]