Attachment I to IPN-88-015
Proposed Technical Specifications Related To
Movable Incore Neutron Detector Guide Thimbles

New York Power Authority
Indian Point 3 Nuclear Power Plant
Docket No. 50-286
DPR-64

## LIST OF FIGURES

# LIST OF FIGURES

3.10.2.2 Following initial core loading, subsequent reloading and at regular effective full power monthly intervals thereafter, power distribution maps, using the movable detector system, shall be made to confirm that the hot channel factor limits of this specification are satisfied. For the purpose of this comparison,

3.10.2.2.1 The measurement of total peaking factor $F_Q^{Meas}$, shall be increased by three percent to account for manufacturing tolerances and further increased by five percent to account for measurement error when 38 or more thimbles are utilized in the generation of the full core flux map. When less than 38 thimbles are utilized, the measurement error factor increases linearly from five to seven percent at 29 thimbles operable. Figure 3.10-6 provides the measurement error factor as a function of available thimbles.

3.10.2.2.2 The measurement of enthalpy rise hot channel factor, $F_{\Delta}^{N}H$, shall be increased by four percent to account for measurement error when 38 or more thimbles are utilized in the generation of the full core flux map. When less than 38 thimbles are utilized, the measurement error factor increases linearly from four to five percent at 29 thimbles operable. Figure 3.10-6 provides the measurement error factor as a function of available thimbles. If either measured hot channel factor exceeds its limit specified under Item 3.10.2.1, the reactor power and high neutron flux trip setpoint shall be reduced so as not to exceed a fraction of rated power equal to the $F_Q$ or $F_{\Delta}^{N}H$ limit to measured value, whichever is less. If subsequent in-core mapping cannot, within a 24-hour period, demonstrate that the hot channel factors are met, the reactor shall be brought to a hot shutdown condition with return to power authorized only for the purpose of physics testing.

3.10.2.3 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 flux differences must be updated each effective full power month by linear interpolation using the most recent measured value and a value of 0 percent at the end of the cycle life.

3.10.2.4 Except during physics tests, during excore calibration procedures and except as modified by Items 3.10.2.5 through 3.10.2.7 below, the indicated axial flux difference of all but one operable excore channel shall be maintained within a ± 5% band about the target flux difference. The indicated axial flux difference will be maintained less than + 10.0% at full power with the allowed axial flux difference increasing by 0.65% for each 1% reduction in power to a maximum of +16.5%.

3.10.2.5 At a power level greater than 90% of rated power,

3.10.2.5.1 If the indicated axial flux difference of more than one operable excore channel deviates from its target band, either such deviation shall be immediately eliminated or the reactor power shall be reduced to a level no greater than 90 percent of rated power.

3.10.2.6 At a power level no greater than 90 percent of rated power,

3.10.2.6.1 The indicated axial flux difference may deviate from its ± 5% target band for a maximum of one hour (cumulative) in any 24 hour period provided the flux difference does not exceed an envelope bounded by -11 percent and +11 percent at 90% power and increasing by -1 percent and +1 percent for each 2 percent of rated power below 90% power. A two hour deviation is permissible during tests performed as part of the augmented startup program.[(1)]

3.10.2.6.2 If Item 3.10.2.6.1 is violated by more than one operable excore channel, then the reactor power shall be reduced to no greater than 50% power and the high neutron flux setpoint reduced to no greater than 55 percent of rated values.

3.10.2.6.3 A power increase to a level greater than 90 percent of rated power is contingent upon the indicated axial flux difference of all but one operable excore channel being within their target band.

3.10.2.7 At a power level no greater than 50 percent of rated power,

3.10.2.7.1 The indicated axial flux difference may deviate from its target band.

3.10.2.7.2 A power increase to a level greater than 50 percent of rated power is contingent upon the indicated axial flux difference of all but one operable excore channel not being outside their target bands for more than two hours (cumulative) out of the preceding 24-hour period. One-half the time the indicated axial flux difference is out of its target band up to 50% of rated power is to be counted as contributing to the one-hour cumulative (two-hour cumulative during augmented startup tests) [1] maximum the flux difference may deviate from its target band of a power level ≤ 90% of rated power.

3.10.2.8 Alarms are provided to indicate non-conformance with the flux difference requirements of 3.10.2.5.1 and the flux difference-time requirements of 3.10.2.6.1. If the alarms are temporarily out of service, conformance with the applicable limit shall be demonstrated by logging the flux difference at hourly intervals for the first 24 hours and half-hourly thereafter.

3.10.2.9 If the core is operating above 75% power with one excore nuclear channel out of service, then core quadrant power balance shall be determined once a day using movable incore detectors (at least two thimbles per quadrant).

3.10.3 <u>Quadrant Power Tilt Limits</u>

3.10.3.1 When ever the indicated quadrant power tilt ratio exceeds 1.02, except for physics tests, within two hours the tilt condition shall be eliminated or the following actions shall be taken:

a) Restrict core power level and reset the power range high flux setpoint three percent of rated value 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 nuclear instrumentation setpoint shall be rest to 55% of allowed power. Subsequent reactor operation is permitted up to 50% for the purpose of measurement, testing and corrective action.

3.10.3.2 Except for physics tests, if the indicated quadrant power tilt ration exceeds 1.09 and there is simultaneous indication of a misaligned control rod, restrict core power level 3% of rated value for every percent of indicated power tilt ratio exceeding 1.0 and realign the rod within two hours. If the rod is not realigned within two hours or if there is no simultaneous indication of a misaligned rod, the reactor shall be brought to the hot shutdown condition within 4 hours If the reactor is shut down, subsequent testing up to 50% of rated power shall be permitted to determine the cause of the tilt.

3.10.3.3 The rod position indicators shall be monitored and logged once each shift to verify rod position within each bank assignment.

3.10.3.4 The tilt deviation alarm shall be set to annunciate whenever the excore tilt ratio exceeds 1.02. If one or both of the quadrant power tilt monitors is inoperable, individual upper and lower excore detector calibrated outputs shall be logged once per shift and after a load change greater than 10 percent of rated power.

3.10.4 Rod Insertion Limits

3.10.4.1 The shutdown rods shall be fully withdrawn when the reactor is critical or approaching criticality (i.e., the reactor is no longer subcritical by an amount equal to or greater than the shutdown margin in Figure 3.10-1).

3.10.4.2 When the reactor is critical, the control banks shall be limited in physical insertion to the insertion limits shown in Figure 3.10-4 or Figure 3.10-5.

3.10.4.3 Control bank insertion shall be further restricted if:

a. The measured control rod worth of all rods, less the worth of the most reactive rod (worst case stuck rod), is less than the reactivity required to provide the design value of available shutdown,

b. A rod is inoperable (Specification 3.10.7).

3.10.4.4 Control rod insertion limits do not apply during physics tests or during periodic exercise of individual rods. However, the shutdown margin indicated in Figure 3.10-1 must be maintained except for the low power physics test to measure control rod worth and shutdown margin. For this test, the reactor may be critical with all but one control rod inserted.

3.10.5 Rod Misalignment Limitations

3.10.5.1 If a control rod is misaligned from its bank demand position by more than 12 steps (indicated position), then realign the rod or determine the core peaking factors within 2 hours and apply Specification 3.10.2.

3.10.5.2 If the requirements of Specification 3.10.3 are determined not to apply and the core peaking factors have not been determined within two hours and the rod remains misaligned, the high reactor flux setpoint shall be reduced to 85% of its rated value.

3.10.5.3 If the misaligned control rod is not realigned within 8 hours the rod shall be declared inoperable.

3.10.6 Inoperable Rod Position Indicator Channels

3.10.6.1 If a rod position indicator channel is out of service then:

a. For operation between 50 percent and 100 percent of rating, the position of the control rod shall be checked indirectly by core instrumentation (excore detectors and/or movable incore detectors) every shift, or subsequent to rod motion exceeding 24 steps, whichever occurs first.

b. During operation below 50 percent of rating, no special monitoring is required.

3.10.6.2 Not more than one rod position indicator channel per group nor two rod position indicator channels per bank shall be permitted to be inoperable at any time.

3.10.6.3 If a control rod having a rod position indicator channel out of service, is found to be misaligned from 3.10.6.1a above, then Specification 3.10.5 will be applied.

3.10.7 Inoperable Rod Limitations

3.10.7.1 An inoperable rod is a rod which does not trip or which is declared inoperable under Specification 3.10.5 or fails to meet the requirements of 3.10.8.

3.10.7.2 Not more than one inoperable control rod shall be allowed any time the reactor is critical except during physics tests requiring intentional rod misalignment. Otherwise, the plant shall be brought to the hot shutdown condition.

3.10.7.3 If any rod has been declared inoperable, then the potential ejected rod worth, associated transient power distribution peaking factors and the accident listed in Table 3.10-1 shall be analyzed within 5 days, or the reactor brought to the hot shutdown condition using normal operating procedures. The analysis shall include due allowance for non-uniform fuel depletion in the neighborhood of the inoperable rod. If the analysis results in a more limiting hypothetical transient than the cases reported in the safety analysis, the plant power level shall be reduced to an analytically determined part power level which is consistent with the safety analysis.

3.10.8 **Rod Drop Time**

At operating temperature and full flow, the drop time to each control rod shall be no greater than 2.4 seconds from loss of stationary gripper coil voltage to dashpot entry.

3.10.9 **Rod Position Monitor**

If the rod position deviation monitor is inoperable, individual rod positions shall be logged once per shift and after a load change greater than 10 percent of rated power.

3.10.10 **Reactivity Balance**

The overall core reactivity balance shall be compared to predicted values to demonstrate agreement within $\pm$ 1% $\Delta k/k$ at least once per 31 Effective Fuel Power Days (EFPD). This comparison shall, at least consider reactor coolant system boron concentration, control rod position, reactor coolant system average temperature, fuel burnup based on gross thermal energy generation, xenon concentration, and samarium concentration. The predicated reactivity values shall be adjusted (normalized) to correspond to the actual core condition prior to exceeding a fuel burnup of 60 EFPD after each fuel loading.

3.10.11 **Notification**

Any event requiring plant shutdown on trip setpoint reduction because of Specification 3.10 shall be reported to the Nuclear Regulatory Commission within 30 days.

**Basis**

Design criteria have been chosen for normal operations, operational transients and those events analyzed in FSAR Section 14.1 which are consistent with the fuel integrity analysis. These relate to fission gas release, pellet temperature and cladding mechanical properties. Also, the minimum DNBR in the core must not be less than the applicable design limit DNBR in normal operation or in short term transients.

In addition to the above conditions, the peak linear power density must not exceed the limiting Kw/ft values which result from the large break loss of coolant accident analysis based on the ECCS acceptance criteria limit of 2200°F. This is required to meet the initial conditions assumed for loss of coolant accident analyses. To aid in specifying the limits on power distribution, the following hot channel factors are defined.

$F_Q(Z)$, Height Dependent 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.

$F^E_Q$ 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.

$F^N_{\Delta}H$ Nuclear Enthalphy 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 $F^N_{\Delta}H$ 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 throughout the core. Thus the horizontal power shape at the point of maximum heat flux is not necessarily directly related to $F^N_{\Delta}H$.

An upper bound envelope of 2.20 times the normalized peaking factor axial dependence of Figure 3.10-2 has been determined consistent with Appendix K criteria and is satisfied for OFA transition mixed cores (3) by all operating maneuvers consistent with the technical specifications on power distribution control as given in Section 3.10. The results of the loss of coolant accident analysis based on this upper bound normalized envelope of Figure 3.10-2 demonstrates a peak clad temperature not greater than 2049°F, which below peak clad temperature limit of 2200°F. (2)

When an $F_Q$ measurement is taken, both experimental error and manufacturing tolerance must be allowed for. As depected in Figure 3.10-6, five to seven percent is the appropriate allowance for a full core map taken with the movable incore detector flux mapping system depending on the number of thimbles utilized during the generation of the full core flux map and three percent is the appropriate allowance for manufacturing tolerance.

In the specified limit $F^N_{\Delta}H$ there is an eight percent allowance for uncertainties which means that normal operation of the core is expected to result in $F^N_{\Delta}H$ 1.55/1.08. The logic behind the larger uncertainty in this case is that (a) normal (e.g. rod misalignment) affect $F^N_{\Delta}H$, in most cases without necessarily affecting $F_Q$, (b) the operator has a direct influence on $F_Q$ through movement of rods, and can limit it to the desired value, he has no direct control over $F^N_{\Delta}H$ (c) an error in the predictions for radial power shape, which may be detected during startup physics tests can be compensated for in $F_Q$ by tighter axial control, but compensation for $F^N_{\Delta}H$ is less readily available. When a measurement of $F^N_{\Delta}H$ is taken, experimental error must be allowed for and 4 percent is the appropriate allowance for a full core map taken with the movable incore detector flux mapping system with 38 or more thimbles available. As shown in Figure 3.10-6, the measurement allowances will be linearly increased from 4 percent to 5 percent at 29 thimbles available.

Measurements of the hot channel factors are required as part of startup physics tests, at least each effective full power month of operation, and whenever abnormal power distribution conditions require a reduction of core power to a level based on measured hot channel factors. The incore map taken following initial loading provides confirmation of the basic nuclear design basis including proper fuel loading patterns. The periodic monthly incore mapping provides additional assurance that the nuclear design bases remain inviolate and identify operational anomalies which would, otherwise, affect these bases.

For normal operation, it is not necessary to measure these quantities. Instead it has been determined that, provided certain conditions are observed, the 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. An indicated misalignment limit of 12 steps precludes a rod misalignment no greater than 15 inches with consideration of maximum instrumentation error.

2. Control Rod banks are sequenced with overlapping banks as described in Technical Specification 3.10.4.

3. The control rod bank insertion limits are not violated.

4. Axial Power Distribution Control Procedures, which are given in terms of flux difference control and control bank insertion limits 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 as the difference in normalized power between the top and bottom halves of the core.

The permitted relaxation in $F^N_{\Delta}H$ allows radial power shape changes with rod insertion to the insertion limits. It has been determined that provided the above conditions through 4 are observed, these hot channel factors limits are met. In Specification 3.10.2, $F_Q$ is arbitrarily limited for $P \leq 0.5$ (except for low power physics tests).

The procedures for axial power distribution control referred to above are designed 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 ($\Delta I$) and a reference value which corresponds to the full power equilibrium value of Axial Offset (Axial Offset = $\Delta I$/fractional power). The referenced value of flux difference varies with power level and burnup but expressed as axial offset it varies only with burnup.

The technical specifications on power distribution control assure that $F_Q$ upper bound envelope of 2.20 times Figure 3.10-2 is not exceeded and xenon distributions are not developed which at a later time, would cause greater local power peaking even though the flux difference is then within the limits specified by the procedure.

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 difference is noted with the control rod bank more than 190 steps withdrawn (i.e. normal full power operating position appropriate for the time in life, usually withdrawn farther as burnup proceeds). 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% $\Delta I$ are permitted from the indicated reference value. During periods where extensive load following is required, it may be impractical 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 or during required, periodic, excore calibrations which require larger flux differences than permitted. Therefore, the specifications on power distribution control are not applied during physics tests or excore calibrations; this is acceptable due to the low probability of a significant accident occurring during these operations.

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 consequences 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 to -14 percent (+11 percent to -11 percent indicated) increasing by $\pm$ 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.

If, for any reason, flux difference is not controlled within the $\pm$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 procedure 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 boron system to position the control rods to produce the required indicated flux difference.

For FSAR Section 14.1 events, the core is protected from overpower and a minimum DNBR of the applicable design limit DNBR by an automatic protection system. Compliance with operating procedures is assumed as a precondition for FSAR Section 14.1 events. However, operator error and equipment malfunctions are separately assumed to lead to the cause of the transients considered.

Quadrant power tilt limits are based on the following considerations. Frequent power tilts are not anticipated during normal operation, as this phenomenon is caused by some asymmetric perturbation, e.g., rod misalignment, or inlet temperature mismatch. A dropped or misaligned rod will easily be detected by the Rod Position Indication System or core instrumentation per Specification 3.10.6, and core limits are protected per Specification 3.10.5. A quadrant tilt by some other means would not appear instantaneously, but would build up over several hours and the quadrant tilt limits are met to protect against this situation. They also serve as a backup protection against the dropped or misaligned rod. Operational experience shows that normal power tilts are less than 1.01. Thus, sufficient time is available to recognize the presence of a tilt and correct the cause before a severe tilt could build up. During startup and power escalation, however, a large tilt could be initiated. Therefore, the Technical Specification has been written so as to prevent escalation above 50 percent power if a large tilt is present. The numerical limits are set to be commensurate with design and safety limits for DNB protection and linear heat generation rate as described below.

The radial power distribution within the core must satisfy the design values assumed for calculation of power capability. Radial power distributions are measured as part of the startup physics testing and 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 reactor operation would continue with a power tilt condition which exceeds the radial power asymmetry considered in the power capability analysis.

The quadrant tilt power deviation alarm is used to indicate a sudden or unexpected change from the radial power distribution mentioned above. The two percent tilt alarm setpoint represents a minimum practical value consistent with instrumentation errors and operating procedures. This asymmetry level is sufficient to detect significant misalignment of control rods. Misalignment of control rods is considered to be the most likely cause of radial power asymmetry. The requirement for verifying rod position once each shift is imposed to preclude rod misalignment which would cause a tilt condition less than the 2% alarm level.

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 condition 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 moveable detector system. For a tilt condition $\leq 1.09$, 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 three 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 a tilt condition of $\leq 1.09$ 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 tilt ratio greater than 1.09 occurs which is not due to a misaligned rod, the reactor 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 (3% for each one percent the tilt ratio exceeds 1.0) for two hours to correct the rod misalignment.

Trip shutdown reactivity is provided consistent with plant safety analysis assumptions. One percent shutdown is adequate except for steam break analysis, which requires more shutdown if the boron concentration is low. Figure 3.10-1 is drawn accordingly.

Rod insertion limits are used to assure adequate trip reactivity, to assure meeting power distribution limits, and to limit the consequence of a hypothetical rod ejection accident. The available control rod reactivity, or excess beyond needs, decreases with decreasing boron concentration because the negative reactivity required to reduce the core power level from full power to zero is largest when the boron concentration is low.

The intent of the test to measure control rod worth and shutdown margin (Specification 3.10.4) 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 worth. These measurements will augment the normal fuel cycle design calaculations and place the knowlege of shutdown capability on a firm experimental as well as analytical basis.

The rod position indicator channel is sufficiently accurate to detect a rod ±7 inches away from its demand position. An indicated misalignment less than 12 steps does not exceed the power peaking factor limits. If the rod position indicator channel is not operable, the operator will be fully aware of the inoperability of the channel, and special surveillance of core power tilt indications, using established procedures and relying on excore nuclear detectors, and/or moveable incore detectors, will be used to verify power distribution symmetry. These indirect measurements do not have the same resolution if the bank is near either end of the core, because a 12 step misalignment would have no effect on power distribution. Therefore, it is necessary to apply the indirect checks following significant rod motion.

One inoperable control rod is acceptable provided that the power distribution limits are met, trip shutdown capability is available, and provided the potential hypothethical ejection of the inoperable rod is not worse than the cases analyzed in the safety analysis report. The rod ejection accident for an isolated fully inserted rod will be worse if the residence time of the rod is long enough to cause significant non-uniform fuel depletion. The 5 day period is short compared with the time interval required to achieve a significant, non-uniform fuel depletion.

The required drop time to dashpot entry is consistent with safety analysis.

REFERENCE


1. WCAP-8576, "Augmented Startup and Cycle 1 Physics Program:, August 1975
2. FSAR Appendix 14C
3. Letter from J.P. Bayne to S.A. Varga dated April 23, 1985, entitled "Proposed Technical Specifications Regarding the Cycle 4/5 Refueling".

## TABLE 3.10-1

## ACCIDENT ANALYSES REQUIRING REEVALUATION IN THE EVENT OF AN INOPERABLE FULL LENGTH ROD

Rod Cluster Control Assembly Insertion Characteristics

Rod Cluster Control Assembly Misalignment

Loss of Reactor Coolant From Small Ruptured Pipes Or From Cracks In Large Pipes Which Actuates The Emergency Core Cooling System

Single Rod Cluster Control Assembly Withdrawal At Full Power

Major Reactor Coolant System Pipe Ruptures (Loss Of Coolant Accident)

Major Secondary System Pipe Rupture

Rupture of a Control Rod Drive Mechanism Housing (Rod Cluster Control Assembly Ejection)

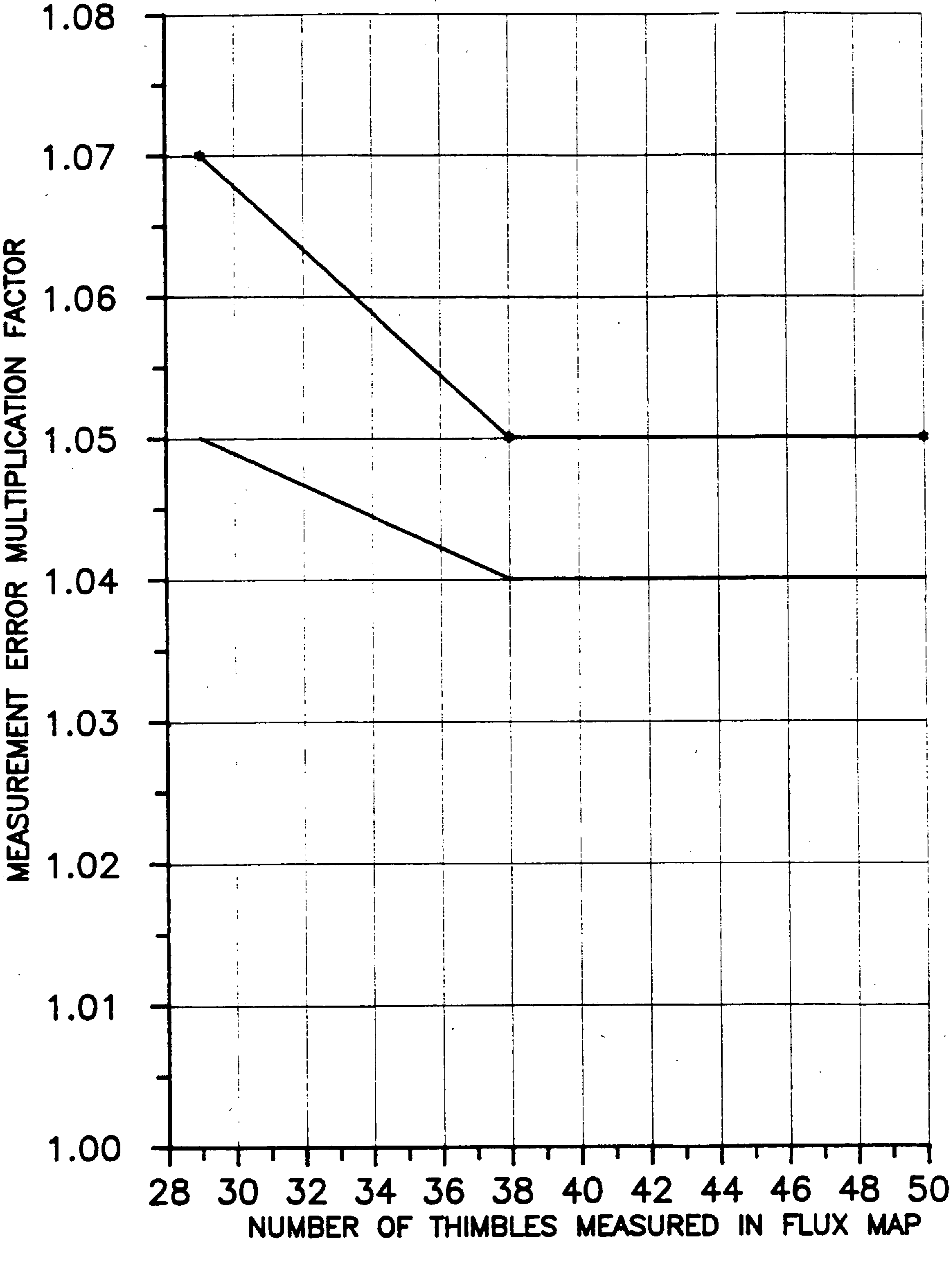


Figure 3.10-6

MEASUREMENT ERROR MULTIPLICATION FACTORS FOR $F_Q$ AND $F_{\Delta H}$

## 3.11 MOVABLE IN-CORE INSTRUMENTATION

Applicability

Applies to the operability of the movable detector instrumentation system.

Objective

To specify functional requirements on the use of the in-core instrumentation system, for the recalibration of the excore neutron flux detection system, and for the measurement of the core hot channel factors.

Specification

A. During the incore/excore calibration procedure, all full core flux maps will be made only when at least 29 movable detector guide thimbles are operable. A minimum of four guide thimbles per quadrant must be operable if less than 38 thimbles are operable.

B. During the measurement of the core hot channel factors, at least 29 movable detector guide thimbles must be operable . A minimum of four guide thimbles per quadrant must be operable if less than 38 thimbles are operable.

C. A minimum of 2 thimbles per quadrant and sufficient movable in-core detectors shall be operable for the generation of quarter-core flux maps during re-calibration of the excore neutron flux detection system.

D. Power shall be limited to 90% of rated power if re-calibration requirements for excore neutron flux detection system, identified in Table 4.1-1 are not met.

Basis

The Movable In-core Instrumentation System [1] has six drives, six detectors, and 50 thimbles in the core. Each detector can be routed to sixteen or more thimbles. Consequently, the full system has a great deal more capability than would be needed for the calibration of the ex-core detectors.

To calibrate the excore detectors system, it is only necessary that the Movable In-core System be used to determine the gross power distribution in the core as indicated by the power balance between the top and bottom halves of the core.

After the excore system is calibrated initially, recalibration is needed only infrequently to compensate for changes in the core, due for example to fuel depletion, and for changes in the detectors.

If the recalibration is not performed, the mandated power reduction assures safe operation of the reactor as it will compensate for an error of 10% in the excore protection system. Experience at Beznau No. 1 and R.E. Gimma plants has shown that drift due to changes in the core or instrument channels is very slight. Thus the 10% reduction is considered to be very conservative.

The operability of the movable incore detectors with the specified minimum complement of equipment ensures that the measurements obtained from the use of this system accurately represent the spatial neutron flux distribution of the core. (2)

The requirement of a minimum of 4 operable thimbles per quadrant when less than 38 thimbles are operable increases the confidence of incore flux measurements obtained during a full core flux map. The requirement of 4 operable thimbles per quadrant must be satisfied in the 4 quadrants whose axes are coincident with the orthogonal axes of the core and in the 4 quadrants whose axes are coincident with the diagonal axes of the core.

Full core flux maps and quarter-core flux maps are used for the incore/excore detector calibration. Full core flux maps are also used for measuring the core hot channel factors.

Reference

(1) FSAR - Section 7.4
(2) Westinghouse Thimble Detection Study for Indian Point 3

Attachment II to IPN-88-015
Safety Evaluation of Proposed Technical Specification
Related to Movable Incore Neutron Detectors

Enclosure 1: Incore/Excore Recalibration
Thimble Deletion Evaluation

Enclosure 2: Hot Channel Factor Thimble
Deletion Evaluation

New York Power Authority
Indian Point 3 Nuclear Power Plant
Docket No. 50-286
DPR-64

I. Description of Change

This application seeks to amend Section 3.11 of Appendix A to the Operating License by revising the minimum number of operable movable incore neutron detector guide thimbles required for the incore/excore detector calibration. This application also seeks to establish a limit for the minimum number of operable thimbles required for the generation of the monthly full core flux map. The minimum number of operable incore guide thimbles required for the incore/excore detector calibration is being revised from 75% of the 50 thimbles (i.e. 38 thimbles) to 29 thimbles. However, to compensate for this decrease in the number of required operable thimbles distributed throughout the core, the proposed amendment will require that a minimum of four thimbles per quadrant be operable when less then 38 thimbles are operable. Additionally, reference to 3 loop operation is being deleted as such operation is currently prohibited by the Facility Operating License.

Section 3.10 of Appendix A to the Operating License is being revised to increase the measurement inaccuracy to be applied to the hot channel factors prior to the comparison to the applicable Technical Specification limits. This increase in the hot channel factors measurement inaccuracy will compensate for the measurement inaccuracy posed by the reduction in the number of operable thimbles from 38 to 29 thimbles.

II. Evaluation of Change

A. The minimum number of operable movable incore neutron detector guide thimbles required for the incore/excore calibration is being revised from the 75% of the 50 thimble (i.e. 38) to 29 guide thimbles. Enclosure 1 provides an evaluation of the impact on measurement accuracy posed by the proposed reduction in the required number of operable thimbles. To assess the impact on axial offset and quadrant tilt measurements utilized for the incore/excore calibration with 29 of the movable detector thimbles operable, 21 full core flux maps from various plants with various core pattern types were evaluated. Each of these reference full core flux maps were generated with greater than 80% of the movable thimbles operable. For each flux map, thimbles were randomly deleted such that 29 thimbles remained. The axial offset and quadrant tilt were quantified based on the detector measurements associated with those 29 thimbles. The axial offset and quadrant tilt based on the 29 thimble maps were then compared with those values based on the reference maps. The mean change in axial offset with 29 thimbles available was found to be -0.039% $\pm$ .04332%. The mean change in quadrant tilt with 29 thimbles available was found to be -0.16% $\pm$ .0691%.

A representative flux map for Indian Point 3 was evaluated assuming 5 different random thimble deletions to 29 thimbles available. The results based on the 29 thimble maps were compared to the values based on the reference map. The mean change in axial offset with 29 thimbles available was found to be 0.018%. The mean change in quadrant tilt with 29 thimbles available was found to be 0.03%.

As noted above, the guide thimbles were deleted randomly not systematically, from the reference maps. The stated results do not apply to a situation where the thimbles were deleted on a systematic basis in order to achieve a greater variance between the axial offset and core tilt based on the 29 thimble maps and those values based on the reference maps. The current Technical Specifications have a requirement of 2 operable thimbles per quadrant. As described in Enclosure 1, the proposed requirement of a minimum of 4 operable thimbles per quadrant when less than 38 thimbles are operable minimizes the likelihood of systematic thimble deletion events. Furthermore, the confidence of the quantified impact on axial offset and quadrant tilt measurements is increased provided that at least 4 thimbles per quadrant are operable.

B. The current Technical Specifications do not have a requirement on the minimum number of operable movable detector guide thimbles during the generation of the full core flux map pursuant to the full power monthly surveillance on the hot channel factors. The Westinghouse Standard Technical Specifications (WSTS) require that 75% of the thimbles be operable during the measurement of the hot channel factors. Enclosure 2 provides an evaluation of the impact on hot channel factor measurement accuracy posed by a reduction in the required number of operable thimbles from the WSTS required 75% of the total thimbles to 29 thimbles. This evaluation provides the basis for the proposed requirement for a minimum of 29 thimbles.

The evaluation to determine the impact on the hot channel factor measurement accuracy was performed in the same manner as was the axial offset and quadrant tilt. For each of the 21 reference flux maps, thimbles were randomly deleted such that 29 thimbles remained for each map. The hot channel factors were quantified based on the detector measurement associated with those 29 thimbles. The hot channel factors based on the 29 thimble maps were then compared with those values based on the reference maps. The mean change in $F_Q$ with 29 thimbles available was found to be -0.4374%. The mean change in $F_{\Delta H}$ with 29 of the thimbles available was found to be -0.3358%.

A representative flux map for Indian Point 3 was evaluated assuming 5 different random thimble deletions so that only 29 thimbles were available. The results based on the 29 thimble maps were compared to the values based on the reference map. The mean change in $F_Q$ with 29 thimbles available was found to be 0.3692%. The mean change in $F_{\Delta H}$ was found to be -0.3747%. In order to compensate for this additional measurement inaccuracy, the total measurement inaccuracy factor, which is applied to the measured hot channel factor prior to comparison to the Technical Specification limit, will be increased by 1.0% for $F_{\Delta H}$ and 2.0% for $F_Q$ when only 29 thimbles are available. This additional inaccuracy factor linearly increases from 0% with 38 or more thimbles available to 1.0% for $F_{\Delta H}$ and 2.0% for $F_Q$, with 29 thimbles available.

As was the case for the flux maps utilized in the incore/excore calibration, a minimum of 4 operable thimbles per quadrant is required when less than 38 thimbles are operable. The proposed requirement of a minimum of 4 operable thimble per quadrant increases the ability to distinguish between random and systematic thimble deletion events. Furthermore, the confidence of the impact on the hot channel factor measurements is increased provided that at least 4 thimbles per quadrant are operable.

C. The aforementioned evaluations concern thimble operability requirements for the generation of full core flux maps. These evaluations do not impact the current Technical Specification requirements on thimble operability during the generation of quarter-core flux maps.

D. The requirement that plant operations shall be limited to 65% of rated power for 3 loop operation if the re-calibration requirements are not met, is being deleted as the Facility Operating License currently prohibits 3 loop operation.

III. No Significant Hazards Evaluation

1) Does the proposed license amendment involve a significant increase in the probability or consequences of an accident previously evaluated?

Response

The proposed change would allow the generation of full core flux maps with a minimum of 29 operable thimbles. The additional inaccuracy in axial offset, quadrant tilt and hot channel factor measurements posed by the proposed change will be insignificant.

For Indian Point 3, the proposed change was shown to result in a total uncertainity of 5.4% in $F_Q$ measurement and 4.3% in $F_{\Delta H}$ measurements. The Technical Specifications currently limit $F_Q$ at 2.20 and $F_{\Delta H}$ at 1.55, at full power. The LOCA was analyzed assuming a $F_Q$ of 2.20. In order to assure plant operations within the bounds of the LOCA analysis, a full power monthly surveillance is performed on $F_Q$ and $F_{\Delta H}$. A measured value of $F_Q$ and $F_H$ is obtained from the full core flux map. Per Technical Specification 3.10.2.2., the measured $F_Q$ value is currently increased by 3% to account for manufacturing tolerance and further increased by 5% to account for measurement error. The measured $F_{\Delta H}$ value is currently increased by 4% to account for measurement error. The resulting values of $F_Q$ and $F_{\Delta H}$ are then compared to the applicable Technical Specification limit. In order to compensate for the additional measurement inaccuracy posed by the proposed change, the total measurement inaccuracy factor will be increased by 1.0% for $F_{\Delta H}$ and 2.0% for $F_Q$ when only 29 thimbles are available. This additional inaccuracy factor linearly increases from 0% with 38 or more thimbles available to 1.0% for $F_{\Delta H}$ and 2.0% for $F_Q$, with 29 thimbles available. This increase in the measurement inaccuracy factors will insure that plant operations will continue to be bounded by the LOCA analysis.

The FSAR non-LOCA transients were analyzed assuming a $F_Q$ of 2.32. The Technical Specification $F_Q$ limit of 2.20 provides a substantial margin to that $F_Q$ value assumed in the non-LOCA transient analyses. Additionally, the aforementioned increase in the measurement inaccuracy factors will insure that plant operations will continue to be bounded by the non-LOCA transient analyses.

The proposed change involves the establishment of a limit on the minimum number of thimbles utilized in the generation of a full core flux map. The proposed change does not involve a physical change to any plant equipment utilized in the generation of a flux map.

Axial offset and quadrant tilt values are not considered in any of the FSAR accident analyses. Axial offset provides an indication of the axial power distribution. The $F_Q$ limit restricts the axial power distribution from becoming too skewed to one of the axial halves of the core. The quadrant tilt measurements are a backup indication of a dropped or misaligned rod. However, no credit is taken for quadrant tilt indication in the FSAR analysis of these transients.

Therefore, the proposed change does not involve a significant increase in the probability or consequences previously evaluated.

2) Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?

Response

The proposed change involves the establishment of a limit on the minimum number of thimbles utilized in the generation of a full core flux map. The proposed change does not involve a physical change to any plant equipment utilized in the generation of a flux map.

The proposed change does not involve a physical change to any other plant systems, structures or components. The proposed change does not adversely affect the manner in which the plant is operated. Hence, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3) Does the proposed amendment involve a significant reduction in a margin of safety?

Response

The proposed change results in the introduction of a slight inaccuracy in the measurement of $F_Q$ and $F_{\Delta H}$. However, this slight inaccuracy has been compensated for by increasing the measurement inaccuracy factor to be applied to the measured value, prior to comparison to the applicable Technical Specification limit. The $F_Q$ values assumed in the FSAR analyses ensure an acceptable margin of safety. The proposed changes do not result in plant operation with hot channel factor in excess of those assumed in the FSAR analyses.

Axial offset and quadrant tilt values are not considered in any of the FSAR accident analysis. Axial offset provides an indication of the axial power distribution. The $F_Q$ limit restricts the axial power distribution from becoming too skewed to one of the axial halves of the core. The quadrant tilt measurements are a backup indication of a dropped or misaligned rod. However, no credit is taken for quadrant tilt indication in the FSAR analysis of these transients. Hence, the proposed change does not involve a significant reduction in a margin of safety.

IV. Impact of Change

This change will not adversely impact the following:

1) ALARA Program
2) Security and Fire Protection Programs
3) Emergency Plan
4) FSAR and SER Conclusions
5) Overall Plant Operations and the Environment

V. Conclusion

The incorporation of this change: a) will not increase the probability nor the consequences of an accident or malfunction of equipment important to safety as previously evaluated in the Safety Analysis Report; b) will not increase the possibility for an accident or malfunction of a different type than any evaluated previously in the Safety Analysis Report; c) will not reduce the margin of safety as defined in the bases for any Technical Specification; d) does not constitute an unreviewed safety question; and e) involves no significant hazards considerations as defined in 10 CFR 50.92.

VI. References

1. IP-3 FSAR
2. IP-3 SER

Enclosure 1 to Safety Evaluation
Incore/Excore Recalibration Thimbles Deletion Evaluation

New York Power Authority
Indian Point 3 Nuclear Power Plant
Docket No. 50-286
DPR-64