3.10.5 Rod Misalignment Limitations

3.10.5.1 At least once per shift (allowing one hour for thermal soak after rod motion) the position of each control or shutdown rod shall be determined:

a. For operation less than or equal to 85% of rated thermal power, the indicated misalignment between the group step counter demand position and the analog rod position indicator shall be less than or equal to 18 steps. A control or shutdown rod indicating a misalignment greater than 18 steps shall be realigned within one hour or the core peaking factors shall be determined within two hours and the requirements of Specification 3.10.2 applied.

b. For operation greater than 85% of rated thermal power, the indicated misalignment between the group step counter demand position and the analog rod position indicator shall be ±12 steps for less than or equal to 212 steps and +17, -12 steps for greater than 212 steps. A control or shutdown rod indicating a misalignment greater than the above mentioned steps shall be realigned within one hour or the core peaking factors shall be determined within two hours and the requirements of Specification 3.10.2 applied.

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.

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(e.g. rod misalignment) affect $F_{\Delta H}^{N}$, 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 $F_{\Delta H}^{N}$ 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 by tighter axial control, but compensation for $F_{\Delta H}^{N}$ is less readily available. When a measurement of $F_{\Delta H}^{N}$ is taken, no additional allowances are necessary prior to comparison with the limit of section 3.10.2. A measurement uncertainty of 4% has been allowed for in determination of the design DNBR value.

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 group step counter demand position (operating at greater than 85% of rated thermal power with no accounting for peaking factor margin), or 18.75 inches (operating at less than or equal to 85% of rated thermal power). An indicated misalignment limit of 12 steps precludes a rod misalignment no greater than 15 inches with consideration of instrumentation error and 18 steps indicated misalignment corresponds to 18.75 inches with 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.

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 infrequency 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 calculations and place the knowledge 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 hypothetical 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 assumed control rod drop time in the safety analysis is 2.40 seconds, consisting of 1.80 seconds for normal rod drop time plus a plant specific allowance of 0.60 seconds for a seismic event. The required control rod drop time in Section 3.10.8 is therefore consistent with that assumed in the 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."
4. WCAP-14668, "Conditional Extension of the Rod Misalignment Technical Specification for Indian Point Unit 3," October 1996 (Proprietary).

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.~~ **See Insert A**

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.

(e.g. rod misalignment) affect $F_{\Delta H}^{N}$, 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 $F_{\Delta H}^{N}$ 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 by tighter axial control, but compensation for is less readily available. When a measurement of $F_{\Delta H}^{N}$ is taken, no additional allowances are necessary prior to comparison with the limit of section 3.10.2. A measurement uncertainty of 4% has been allowed for in determination of the design DNBR value.

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.~~ **See Insert B**

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.

Insert "A"

3.10.5.1 At least once per shift (allowing one hour for thermal soak after rod motion) the position of each control or shutdown rod shall be determined:

a. For operation less than or equal to 85% of rated thermal power, the indicated misalignment between the group step counter demand position and the analog rod position indicator shall be less than or equal to 18 steps. A control or shutdown rod indicating a misalignment greater than 18 steps shall be realigned within one hour or the core peaking factors shall be determined within two hours and the requirements of Specification 3.10.2 applied.

b. For operation greater than 85% of rated thermal power, the indicated misalignment between the group step counter demand position and the analog rod position indicator shall be ±12 steps for less than or equal to 212 steps and +17, -12 steps for greater than 212 steps. A control or shutdown rod indicating a misalignment greater than the above mentioned steps shall be realigned within one hour or the core peaking factors shall be determined within two hours and the requirements of Specification 3.10.2 applied.

Insert "B"

1. Control rods in a single bank move together with no individual rod insertion differing by more than 15 inches from the group step counter demand position (operating at greater than 85% of rated thermal power with no accounting for peaking factor margin), or 18.75 inches (operating at less than or equal to 85% of rated thermal power). An indicated misalignment limit of 12 steps precludes a rod misalignment no greater than 15 inches with consideration of instrumentation error and 18 steps indicated misalignment corresponds to 18.75 inches with instrumentation error.

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 infrequency 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 calculations and place the knowledge 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 hypothetical 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 assumed control rod drop time in the safety analysis is 2.40 seconds, consisting of 1.80 seconds for normal rod drop time plus a plant specific allowance of 0.60 seconds for a seismic event. The required control rod drop time in Section 3.10.8 is therefore consistent with that assumed in the 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."
4. **WCAP-14668, "Conditional Extension of the Rod Misalignment Technical Specification for Indian Point Unit 3," October 1996 (Proprietary).**

ATTACHMENT II TO IPN-97-082

SAFETY EVALUATION FOR

PROPOSED TECHNICAL SPECIFICATION CHANGES

REGARDING CONTROL ROD MISALIGNMENT

AND ROD POSITION INDICATION

NEW YORK POWER AUTHORITY
INDIAN POINT 3 NUCLEAR POWER PLANT
DOCKET NO. 50-286
DPR-64

SAFETY EVALUATION OF TECHNICAL SPECIFICATION CHANGES REGARDING CONTROL ROD MISALIGNMENT AND ROD POSITION INDICATION

This application for amendment to the Indian Point 3 Technical Specifications (TS) proposes to amend Sections 3.10.5 and the associated Bases. The proposed amendment would permit changing the indicated control rod misalignment from the current limit of ±12 steps to an indicated misalignment of ±18 steps when the core power is less than or equal to 85% of rated thermal power (RTP). For core power above 85% of RTP, the proposed amendment would permit ±12 steps misalignment for less than or equal to 212 steps withdrawn and +17, -12 steps for greater than 212 steps withdrawn taking into account the physical geometry of the core (dead region). The proposed change is based on an evaluation performed by Westinghouse in WCAP-14668.

SECTION I- Description Of Change

The proposed changes are:

Revise Section 3.10.5.1 to read as follows:

3.10.5.1 At least once per shift (allowing one hour for thermal soak after rod motion) the position of each control or shutdown rod shall be determined:

a. For operation less than or equal to 85% of rated thermal power, the indicated misalignment between the group step counter demand position and the analog rod position indicator shall be less than or equal to 18 steps. A control or shutdown rod indicating a misalignment greater than 18 steps shall be realigned within one hour or the core peaking factors shall be determined within two hours and the requirements of Specification 3.10.2 applied.

b. For operation greater than 85% of rated thermal power, the indicated misalignment between the group step counter demand position and the analog rod position indicator shall be ±12 steps for less than or equal to 212 steps and +17, -12 steps for greater than 212 steps. A control or shutdown rod indicating a misalignment greater than the above mentioned steps shall be realigned within one hour or the core peaking factors shall be determined within two hours and the requirements of Specification 3.10.2 applied.

In the Bases Section, revise the following items to read:

Page 3.10-10 1. Control rods in a single bank move together with no individual rod insertion differing by more than 15 inches from the group step counter

demand position (operating at greater than 85% of rated thermal power with no accounting for peaking factor margin), or 18.75 inches (operating at less than or equal to 85% of rated thermal power). An indicated misalignment limit of 12 steps precludes a rod misalignment no greater than 15 inches with consideration of instrumentation error and 18 steps indicated misalignment corresponds to 18.75 inches with instrumentation error.

Page 3.10-16 Add Reference 4, WCAP-14668, "Conditional Extension of the Rod Misalignment Technical Specification for Indian Point Unit 3," October 1996 (Proprietary).

SECTION II- Evaluation of Changes

Westinghouse performed an evaluation of the effects of increasing the allowed control rod indicated misalignment from ±12 steps to an indicated misalignment of ±24 steps when the core power is less than or equal to 85% of RTP and ±12 steps above 85% of RTP with the following considerations: when the group step counter demand position exceeds the top of active fuel (TAF), the acceptable deviation on the negative side may increase by 1 step for every additional step of group step counter demand position; when the group step counter demand position is below the TAF by no more than 12 steps, the acceptable deviation on the positive side may extend to the all-rods-out (ARO) position; the acceptable deviation may be further increased by up to 6 steps as a function of measured peaking factor margin. The results of this evaluation are reported in Westinghouse document WCAP-14668 and are summarized here. The number and type of rod misalignments were limited by the performance of an evaluation of the Failure Mode and Effects Analysis performed for the rod control system (Reference 1 of WCAP-14668). The evaluation was limited to single failures within the rod control system logic cabinets, power cabinets and the control rod drive mechanisms themselves. Multiple failures were not considered as reasonable precursors of rod misalignment since there is frequent surveillance of rod position to limit such occurrences. The evaluation concluded that there were six categories of failure mechanisms that warranted investigation. These categories are described in Section 2.0 of WCAP-14668. As a result of these failure mode categories, eight different cases of misalignment were analyzed. These cases involved single and multiple rod misalignments in a single group in either the insertion or withdrawal directions. These misalignments can be asymmetric. Other cases involved all rods in a group misaligned from the group step counter demand position. While this type of misalignment did not result in a rod to rod deviation, either the group did not move in the correct direction or the correct group did not move which for the purpose of this evaluation was considered a misalignment from the demand position. This type of misalignment is symmetric. The eight cases are described in detail in Section 3.3 of WCAP-14668.

The evaluation concluded that below 85% of RTP, indicated rod misalignments of up to ± 24 steps between the group step counter demand position and analog rod position indicator (ARPI)

may be allowed based on the magnitude of peaking factor margin that is introduced by the reduction in the power level.

The margin increases are provided by the equations of Specification 3.10.2.1, noted below for clarity:

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

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

$$F_{\Delta H}^N \leq [F_{\Delta H}^{RTP}]\,[1.0+(PF_{\Delta H})(1-P)]$$

The margin requirements are 3.5% in $F_{\Delta H}$ and 6.3% in $F_Q(Z)$ for a maximum control rod misalignment of 24 steps indicated. The increases in the limits for F_Q and $F_{\Delta H}$ exceed these values prior to operation at or below 85% of RTP (for P = 85%, the quantity [1.0 + 0.3(1-P)] equals 1.045 or an increase of 4.5% in $F_{\Delta H}$ and 1/P equals 1.176 or an increase of 17.6% in F_Q). Therefore, the increase in allowed indicated misalignment is considered reasonable and acceptable.

TS 3.10.5.1 has been modified to allow up to one hour after control rod motion to verify control rod position. This time period is based on the time deemed necessary to allow the control rod drive shaft to reach thermal equilibrium. Due to changes in the magnetic permeability of the drive shaft as a function of temperature, the indicated position is expected to change with time as the drive shaft cools on withdrawal. The one hour time period is consistent with NRC approved time extensions at other plants, specifically Salem Units 1 and 2 and Turkey Point Units 3 and 4, and allows for the position indication to stabilize prior to taking any action.

WCAP-14668 Section 3 identifies the effects of indicated rod misalignments greater than ±12 steps on the normal operation peaking factors. Section 4 of WCAP-14668 identifies the effects on the safety analyses. In summary, the increase in rod misalignment does not significantly affect the following: moderator or Doppler reactivity coefficients or defects, reactor kinetics data, boron worth or data generated for evaluation of boron dilution or boron system duty. Condition II transients, (rod out of position, dropped rod and single rod withdrawal) assume either all rods out (ARO) or rods at the insertion limit (RIL) as initial conditions. Since the precondition operation with the increased rod misalignment results in an $F_{\Delta H}$ increase of less than 2.0%, the transient $F_{\Delta H}$ increase due to the misalignment is expected to be bounded by the same magnitude.

Safety analyses parameters that are expected to be affected by the increased rod misalignment are the rod insertion allowance (RIA), the ejected rod $F_Q(Z)$ and the ejected rod worth ($\Delta\rho_{EJ}$). As noted in Section 4 of WCAP-14668, the maximum effect on the RIA will occur upon misalignment of all rods at the RIL in the inserted direction. Evaluation of this

misalignment was performed at full power, zero power and part-power conditions for both of the cycles evaluated for Indian Point Unit 3. The evaluation concluded that the RIA increased as a result of the misalignment and that the calculated RIA for the reload safety evaluation should be increased to 160 pcm to conservatively bound this effect. To determine the ejected rod effects, preconditioning with the maximum allowed misalignment was assumed for single rod, a group of rods and entire banks. The subsequent effects on $F_Q(Z)$ and $\Delta\rho_{EJ}$ for the two cycles were determined. It was noted that increases of 1.5% $F_Q(Z)$ and 3.0% $\Delta\rho_{EJ}$ must be included in the safety analyses to bound the projected effects when a cycle specific analysis is not performed.

The number and type of rod misalignments were limited by the performance of an evaluation of the Failure Mode and Effects Analysis performed for the rod control system (Reference 1 of WCAP-14668). The evaluation was limited to single failures within the control system logic cabinets, power cabinets and the control rod drive mechanisms themselves. Multiple failures were not considered as reasonable precursors for rod misalignment since there is frequent surveillance of rod position to limit such occurrences. These categories are described in Section 2.0 of WCAP-14668.

This proposed TS Amendment for changing the RPI deviation to ±18 steps for core power ≤ 85% of RTP and +17, -12 steps for greater than 212 steps for core power 〉 85% of RTP is bounded by the Westinghouse analysis submitted in Reference 1.

Section III - No Significant Hazards Evaluation

Consistent with the criteria of 10 CFR 50.92, the enclosed application is judged to involve no significant hazards based on the following information:

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

Response:

No. Based on the Westinghouse evaluation in WCAP-14668, the Authority has determined that all pertinent licensing basis acceptance criteria have been met, and the margin of safety as defined in the TS Bases is not reduced in any of the IP3 licensing basis accident analysis (even for misalignments to ±24 steps for core power ≤ 85% of RTP). Increasing the magnitude of allowed control rod indicated misalignment is not a contributor to the mechanistic cause of an accident evaluated in the FSAR. Neither the rod control system nor the rod position indicator function is being altered. Therefore, the probability of an accident previously evaluated has not significantly increased. Because design limitations continue to be met, and the integrity of the reactor coolant system pressure boundary is not challenged, the assumptions employed in the calculation of the offsite radiological doses remain valid. Therefore, the consequences of an accident previously evaluated will not be significantly increased.

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

Response:

No. Based on the Westinghouse evaluation in WCAP-14668, the Authority has determined that all pertinent licensing basis acceptance criteria have been met, and the margin of safety as defined in the TS is not reduced in any of the IP3 licensing basis accident analysis. Increasing the magnitude of allowed control rod indicated misalignment is not a contributor to the mechanistic cause of any accident. Neither the rod control system nor the rod position indicator function is being altered. Therefore, an accident which is new or different than any previously evaluated will not be created.

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

Response:

No. Based on the Westinghouse evaluation in WCAP-14668, the Authority has determined that all pertinent licensing basis acceptance criteria have been met, and the margin of safety as defined in the TS Bases is not reduced in any of the IP3 licensing basis accident analysis based on the changes to safety analyses input parameter values as discussed in WCAP-14668. Since the evaluations in Section 3.0 of WCAP-14668 demonstrate that all applicable acceptance criteria continue to be met, the proposed change will not involve a significant reduction in margin of safety.

Section IV - Impact of Changes

These changes will not adversely affect the following:
ALARA Program
Security and Fire Protection Programs
Emergency Plan
FSAR or SER Conclusions
Overall Plant Operations and the Environment

Section V - Conclusions

The incorporation of this change: a) will not significantly 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 create the possibility of a new or different kind of accident than any evaluated previously in the Safety Analysis Report; c) will not significantly reduce the margin of safety as defined in the bases for any technical specification; and d) involves no significant hazards considerations as defined in 10 CFR 50.92.

Section VI - References

a) IP3 FSAR
b) IP3 SER
c) WCAP-14668, "Conditional Extension of the Rod Misalignment Technical Specification for Indian Point Unit 3," October 1996 (Proprietary).

Summary of Commitments

Number	Commitment	Due Date
IPN-97-082-01	Revise affected Procedures and logs.	Upon approval of TS Amendment.
IPN-97-082-02	Revise algorithm for supervisory panel on rod deviation to match this amendment.	Upon approval of TS Amendment.