UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 182 TO FACILITY OPERATING LICENSE NO. DPR-26

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

INDIAN POINT NUCLEAR GENERATING UNIT NO. 2

DOCKET NO. 50-247

1.0 INTRODUCTION

By letter dated June 1, 1994, as supplemented by letters dated January 25, 1995, April 7, April 19, and April 26, 1995, the Consolidated Edison Company of New York (Con Edison or the licensee) submitted a request for changes to the Indian Point Nuclear Generating Unit No. 2 Technical Specifications (TSs). The requested changes would revise TS Section 3.10 to allow extended Rod Position Indication (RPI) deviation limits and on-line calibration of the RPI channels. The January 25, 1995, April 7, April 19, and April 26, 1995, letters provided clarifying information that did not change the initial proposed no significant hazards consideration determination and was within the scope of the original Federal Register notice.

Specifically, the initial proposed changes would have allowed extended RPI deviation limits of ±24 steps for power levels up to 85% power and on-line calibration of the RPI channels for power levels not to exceed 50%. As detailed in the evaluation that follows, Con Edison limited its request to allow the RPI deviation limits of ±24 steps for power levels up to 50% not 85% as initially requested and on-line calibration of the RPI channels at a nominal power level of 30% (not to exceed 35%) not the 50% requested. The April 26, 1995 submittal limited the request for use in cycle 13 only. Thus, the approved changes are within the original FEDERAL REGISTER notice.

The RPI system at Indian Point Unit No. 2 (IP2) provides the actual position (axial elevation) of each rod cluster control assembly (RCCA) relative to the bank demand position. The present TSs for IP2 permits deviations of ±12 steps (±7.5 inches) between the RPI channel output and the bank demand position over most of the range from fully inserted to fully withdrawn. During plant startup, particularly from the cold condition, the RPI channels may be subject to instabilities and drift until the control rod drive assemblies come to thermal equilibrium at operating temperature. These thermal instabilities cause indications that the RCCAs are misaligned from the bank demand position when in fact there is no actual deviation between actual RCCA position and the bank demand position. If such deviations indicate that there is more than a ±12 step misalignment in more than one channel per RCCA group or two channels per RCCA bank, the TSs require that the reactor be brought subcritical and the deviating RPI channels recalibrated. This process involves fully inserting RCCAs followed by withdrawal of the RCCAs with deviating RPIs. During withdrawal, the RPI signal is measured and recorded as a function of RCCA position to produce a new calibration.

In order to eliminate the loss of availability of IP2, Con Edison proposes an extended RPI deviation band and a procedure to allow on-line calibration of deviating RPI channels. The report submitted in support of this proposal describes the analyses and evaluation which were conducted to demonstrate the application of an extended RPI deviation band for lower powers and the on-line calibration of the RPI channels at low power. The NODE-P2 code was used to calculate the impact on core peaking factors of the extended deviation band. The calculated core peaking factors were compared with limits in the IP2 TSs to justify an extended band for powers less than 85%. In the same manner the NODE-P2 model was used to calculate the core peaking factors during on-line calibration of the RPI channels. Calculated values were compared with the IP2 TS limits at lower power levels to justify on-line calibration. Calculated core peaking factors were found to be acceptable for a power level of 50%.

In order to assure that the on-line calibration would not affect fuel reliability, fuel rod thermal mechanical duty during on-line calibration was evaluated and assessed. For this evaluation Con Edison used the FRAPCON computer code to model those fuel rods which are subject to the greatest power cycling during the RCCA insertion and withdrawal. The analyses demonstrated that on-line calibration of the RPI channels would have insignificant impact on fuel rod thermal mechanical duty. Furthermore, all postulated plant accidents and transients described in Chapter 14 of the IP2 Final Safety Analysis Report (FSAR) were reviewed and evaluated. This review focused on the potential consequences in the event that the accident or transient were initiated during calibration. The results showed that the consequences were no more severe than those analyzed in Chapter 14 of the FSAR.

2.0 EVALUATION

2.1 Rod Position Indicators and Power Distribution Limits

The IP2 TSs allow deviations between the RPI signal and the bank demand position of ± 12 steps for RCCA positions < 211 and - 12 to + 17 for RCCA positions >210 steps withdrawn. (This allows for an error in the sensing electronics of + 12 steps plus allowance for 5 steps which are not indicated due to the relationship of the RPI coil stack and the RCCA drive rod for indicated rod positions > 210 steps withdrawn.) The bases for the allowable deviation are the analyses of core power distributions under both steady state and anticipated transient conditions which are performed as part of the reload safety analysis for each fuel cycle. These analyses demonstrate that core peaking factor limits will not be exceeded under all anticipated steady state operating conditions and normal operational transients as permitted by the operating mode specified in the TSs, provided that no RCCA is misaligned from its bank by more than ± 12 steps. Compliance with the core peaking factors limits assures that the consequences of all postulated accidents as evaluated in the FSAR will be acceptable.

Implicit in the calculations for a fuel cycle is the assumption that the control rods in a particular bank move simultaneously and that all rods within the bank are in alignment within ± 12 steps. Misalignments in excess of ± 12 steps have the potential to increase the peaking factors. Thus, any increase in the range of permissible deviation between RPI signals and the bank demand position would have to be assessed in terms of the peaking factor limits in the TSs. The local core peaking factors are not routinely monitored during normal power operation. Surveillance of core power distribution is via the excore detectors which provide the core axial flux difference and core quadrant tilt.

2.2 Assessment of RPI Deviation Limits

For this analysis, Con Edison adopted the approach that the indicated misalignments represented actual rod misalignments and then calculated the resulting impact on core peaking factors and global core power distributions. The intention was to demonstrate that, even if the misalignments were actual, the resulting impact on core peaking is small and can be accommodated by limiting core power levels. Cycles 11, 12, and 13 were evaluated with respect to an extended RPI deviation band of ± 24 steps (15 inches). The effect of RCCA misalignment on core peaking factors was analyzed at beginning of cycle(BOC), mid cycle (MOC) and end of cycle (EOC). A large number of combinations of misaligned RCCAs were simulated at each of the three burnups with misalignments of up to ± 24 steps. These misalignments included individual RCCAs, symmetric and asymmetric groups of RCCAs and banks. The results of the RCCA misalignment analyses were summarized in tables which contain the maximum fractional change in nodal F_q and pin F delta H for each of the classes of misaligned rods. The fractional change in both of these peaking factors in relation to the current TS limit of ± 12 steps is shown. Con Edison proposed extending the ± 24 step limit to 85% power; however, the NRC staff did not consider the benchmarking of the NODE-P2 code (this will be discussed in Section 2.4) adequate to justify this high a power level, so the 50% power level was considered. The TS limit for F_q at 50% power is double that at 100% power. Since the maximum calculated fractional change in F_q is far less than 1, the misalignments of up to ± 24 steps is acceptable for power levels less than 50%. Similarly the allowed F delta H for 50% power is much greater than that calculated in the analysis. Based on the results of the analysis, Con Edison concluded that power operation with a RPI deviation limit of ± 24 steps provided the power level is limited to mitigate the increase in local peaking. The staff agrees that at power levels of 50% or below, RPI indications of ±24 steps are acceptable. For power levels above 50% the present misalignment limits will remain in effect.

2.3 On-Line Calibration of the RPI Channels

Calibration of the RPI channels is currently performed with the reactor at hot zero power. To assess the impact of on-line calibration of RCCAs on core safety limits, the NODE-P2 model was applied to cycles 12 and 13. Individual RCCAs were inserted in two node increments (24 axial nodes modeled in NODE-P2) to 0 steps withdrawn followed by withdrawal to 225 steps. At each insertion step, the core peaking factors, axial flux difference and quadrant tilt were calculated. The insertion/withdrawal of each of the 53 RCCAs was simulated at BOC, MOC and EOC.

Results were presented for the "worst case" RCCAs. A "worst case" RCCA is one which has a high reactivity worth resulting in the largest increase in local peaking factors and/or the greatest effect on global core power distributions. The results of the analysis lead to the following conclusions:

- The limiting core parameter with respect to on-line calibration of RCCAs is core quadrant tilt.
- At 30% power the TS limits on F_q and F delta H are met.
- RCCA calibration has some effect on core axial flux difference. For some cases the operating band is exceeded, the envelope is not. (Operation outside the band but within the envelope is permitted for 1 hour in 24 hours.)

It is anticipated that RPI calibration will require less than 2 hours. By conducting on-line calibration at a nominal 30% power level (not to exceed 35%) the quadrant tilt and axial flux difference TS limits should be met. The current TSs on quadrant tilt and axial flux difference will remain in effect during on-line calibration of the RPI channels and thus will stop the on-line calibration should these TS limits be approached.

If necessary, the first on-line calibration of RPIs would be performed during startup of the cycle at the 30% hold point, where a incore flux map is taken. The results of this map provide further verification that all control rods are in alignment with their bank demand position.

2.4 Validation/Verification of the NODE-P2 Code

The NODE-P2 code was used for the analysis of the extension of the RPI deviations and the on-line calibration. This code is part of the ARMP-02 documentation submitted in EPRI NP-4574-CCM. While NRC has accepted the NODE-P2, Con Edison had not previously submitted any benchmarking justifying their use of the code. During this review, the NRC staff requested this documentation.

Con Edison supplied data from cycles 10-13. It consisted of comparisons of measured vs predicted as well as Con Edison predictions using NODE-P2 with predictions by their fuel vender using another code and some data comparing measured to both sets of predictions.

There were two problems with the benchmarking provided. First, the comparisons were fairly good, but not as good as would be expected. In some cases, particularly the initial boron concentration the deviation between Con Edison's predictions and the measured data and the deviation between Con Edison's predictions and the vender's predictions has gotten larger with each succeeding cycle. The deviation between the Con Edison's predictions and the measurement for cycle 12 was about twice that usually observed throughout the industry at the present time. The deviation between the Con Edison and vendor predictions for Cycle 13, the upcoming cycle, is also twice that usually observed. The second problem was that almost all the benchmarking was calculations involving a symmetric core. Whereas the misalignment and on-line calibration calculations involved asymmetric calculations, which are more difficult.

Con Edison's analysis had concluded that the ± 24 step misalignment was acceptable up to 85% power and that the on-line RPI calibration was acceptable up to 50% power. The NRC staff's review of the analysis and benchmarking did not find sufficient justification for these power levels. However, the margin gained in going to 50% for the ± 24 step misalignment and a nominal 30% for the on-line calibration would be sufficient to justify these lower power levels for Cycle 13.

2.5 Fuel Thermal/mechanical Duty During On-line RPI Calibration

On-line calibration of the RPI channels will require the insertion of RCCAs from the fully withdrawn position to the fully inserted position followed by subsequent RCCA withdrawal. This will be carried out over the time periods of a few minutes and from a reduced power level. As individual RCCAs are inserted, the core power distribution is shifted away from the RCCA causing a power peak in the diametrically opposed core octant. Thus, a few fuel rods may be subjected to a mild power cycle during the calibration exercise. This, however, is minimized by allowing the core power to drift downward as the RCCA is inserted and back up as the RCCA is withdrawn.

In order to assess the effect of such power cycling on the fuel rod thermal mechanical duty, a FRAPCON model of IP2 fuel was developed. The limiting rods which experience the greatest power cycle during on-line calibration, were identified by examining the NODE-P2 simulations. The limiting rod was defined as the rod which experienced the largest nodal power increase during on-line calibration exercises. This fuel rod was then evaluated with respect to fuel thermal mechanical duty and the following conclusions were reached.

- In the fuel rod subjected to the highest linear heat generation rate during calibration, the resulting power cycle is mild and the effect on fuel thermal/mechanical duty is insignificant.
- Some fuel rods in the assembly receiving the RCCA are subjected to a relatively large power cycle with no significant calculated effect on fuel rod thermal mechanical duty.
- There is no calculated increase in fission gas release due to the calibration exercise which would lead to an increase potential for stress corrosion cracking of the cladding.
- Clad stress levels during calibration are not increased significantly over the steady state values just prior to calibration.

The NRC staff has reviewed the data provided from the analysis and agrees with Con Edison's conclusions.

2.6 Validation and Verification of FRAPCON2/V1MOD5

FRAPCON2/V1MOD5 is the most recent in the FRAPCON series of fuel rod response modeling programs. This program was developed by EG&G Idaho Inc., and Pacific Northwest Laboratory. Northeast Technology Corporation (NETCO), a Con Edison contractor, has previously validated and verified the mainframe version of FRAPCON by simulating the power exposure histories of a number of commercial LWR fuel rods as well as instrumented rods irradiated at the Halden Test Reactor. A summary of that work was provided.

The mainframe program was converted to execute on a microcomputer with 486 processor. This microcomputer version was validated and verified by simulating the same matrix of test rods as used for the validation and verification of the mainframe version. Details of the major conclusions on clad creep deformation, pellet relocation, fission gas release, fuel stack length and pellet density, fuel clad axial deformation, fuel temperatures, and ZrO_2 film were provided. Con Edison concluded that the FRAPCON2/V1MOD5 predictions with measured LWR fuel performance data serves to confirm that the code is providing accurate predictions of the fuel rod parameters key to reliable fuel performance. The NRC staff agrees with this conclusion.

2.7 Impact of On-Line Calibration on Postulated Plant Transients and Accidents

All postulated plant transients and accidents assessed in Section 14 of the IP2 FSAR have been reviewed and evaluated. This review was based on the assumption that each of the transients and accidents was initiated during the calibration of the RCCA at the point of RCCA insertion at which peaking factors are at their maximum values. The power level was 50% or rated or less and the reduced power would generally be expected to mitigate any increase in core peaking. The results of this analysis were presented in table form listing the event and the consequences. In all cases the consequences are no more severe than the bounding analyses documented in the FSAR.

3.0 SUMMARY

The analyses and evaluations completed for IP2 for fuel cycles 11, 12, and 13 demonstrate that the RPI deviation band can be extended to ± 24 steps for low power. As discussed in section 2.4, the validation /verification of the NODE-P2 code is not sufficient to justify the extended deviation band to the 85% power level,as initially proposed by Con Edison, for long-term operation. However, the benchmarking provided, together with the increase in allowable peaking factors for lower power and the core monitoring of quadrant tilt and axial flux difference by the ex-core dectors, is sufficient to allow the RPI deviation band to be extended to ± 24 steps for power levels below 50% for cycle 13 only.

Similarly, the NRC staff does not find sufficient justification for the 50% power level initially proposed by Con Edison for on-line calibration. The nominal power level of 30% (not to exceed 35%) is acceptable for on-line calibration of the RPI channels for cycle 13 only.

Therefore, the revised Con Edison request for changes to TS 3.10 to reflect extended RPI deviation limits of ± 24 steps for up to 50% power and on-line calibration of the RPI channels at a nominal power level of 30% (not to exceed 35%) is acceptable for cycle 13 only. The NRC staff also finds the update of the TS Bases, to reflect these changes, acceptable.

In order to justify the ± 24 step misalignment for the 85% power level and/or allow the on-line calibration at the 50% power level for future cycles, as initially requested, the NRC staff requires further benchmarking including comparisons of NODE-P2 calculations with calculations by the vendor or with measurements for asymmetric cases as well as comparisons with the measured data for cycle 13. Discrepancies between NODE-P2 predictions and other predictions and between NODE-P2 predictions and measurements must be adequately explained.

It should be further noted that the calculated peaking factors for the ± 24 step misalignment and the on-line calibration varied significantly between cycles 11, 12, and 13. Thus, prior to startup of each future cycle, these calculations would need to be repeated to ensure that the peaking factors were being maintained.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the New York State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (59 FR 37069). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: Margaret Chatterton

Date: April 28, 1995

Stephen E. Quinn
Consolidated Edison Company
of New York, Inc.

Indian Point Nuclear Generating
Station Units 1/2

cc:

Mayor, Village of Buchanan
236 Tate Avenue
Buchanan, NY 10511

Ms. Donna Ross
New York State Energy Office
2 Empire State Plaza
16th Floor
Albany, NY 12223

Mr. Charles W. Jackson
Manager of Nuclear Safety and
Licensing
Consolidated Edison Company
of New York, Inc.
Broadway and Bleakley Avenue
Buchanan, NY 10511

Senior Resident Inspector
U. S. Nuclear Regulatory Commission
P.O. Box 38
Buchanan, NY 10511

Mr. Brent L. Brandenburg
Assistant General Counsel
Consolidated Edison Company
of New York, Inc.
4 Irving Place - 1822
New York, NY 10003

Charles Donaldson, Esquire
Assistant Attorney General
New York Department of Law
120 Broadway
New York, NY 10271

Mr. Peter Kokolakis, Director
Nuclear Licensing
Power Authority of the State
of New York
123 Main Street
White Plains, NY 10601

Mr. Walter Stein
Secretary - NFSC
Consolidated Edison Company
of New York, Inc.
4 Irving Place - 1822
New York, NY 10003

Regional Administrator, Region I
U. S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406