A. Alan Blind
Vice President

Consolidated Edison Company of New York, Inc.
Indian Point Station
Broadway & Bleakley Avenue
Buchanan, NY 10511
Telephone (914) 734-5340
Fax: (914) 734-5718
blinda@coned.com

October 15, 2000

Re: Indian Point Unit No. 2
Docket No. 50-247
NL 00-126

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop P1-137
Washington, D.C. 20555-0001

SUBJECT: Additional Information for the Proposed Amendment to the Technical Specifications for Cycle 15 to Allow Extended RPI Deviation Limits and On-Line Calibration of the RPI Channels

References:

1. Con Edison letter (NL 00-108) to NRC dated August 22, 2000, "Proposed Amendment to the Technical Specifications for Cycle 15 to Allow Extended RPI Deviation Limits and On-Line Calibration of the RPI Channels"

2. Con Edison letter (NL 00-122) to NRC dated October 3, 2000, "Supplemental Information for the Proposed Amendment to the Technical Specifications for Cycle 15 to Allow Extended RPI Deviation Limits and On-Line Calibration of the RPI Channels"

Transmitted herewith is additional information as discussed with the NRC staff during a meeting on October 10, 2000 associated with the proposed amendment submitted in Reference 1 and supplemented by Reference 2. The proposed amendment seeks approval of changes to the Technical Specifications necessary to allow extended rod position indication (RPI) deviation limits and on-line calibration of the RPI channels for Cycle 15.

Further clarification of the information provided in Reference 2 is provided to assist with the review of the amendment request. The information provided in Tables 1 and 2

AP01

represent over 6000 control rod configurations which were analyzed at three points in core life for rods misaligned as much as plus or minus 24 steps from demanded control rod bank positions. The control rod bank positions were also assumed to be misaligned by as much as 24 steps. This results in a 48 step deviation being an analyzed condition for operation at IP2. It must be realized that this was done for purposes of analysis only. Plant operators have redundant and diverse indications, such as quadrant power tilt, axial flux difference, rod group step counters and loop T average which can be utilized to detect actual misalignments approaching these magnitudes.

To better understand Tables 1 and 2, the following detailed description may be useful. Note that, unless otherwise indicated, the rows in Table 1 are for misalignments at 100% of rated power. Row 1 of Table 1 describes a set of unique control rod misalignment configurations that could theoretically occur at 100% of rated power. Per the column "Misalignment Cases", D-Bank is assumed to be misaligned at four different elevations relative to the demand elevation, per the next four columns. The last column, "Position of Other RCCAs", indicates that, for each of these four bank alignments, an individual rod in D-Bank is assumed to be independently misaligned at four different elevations relative to the demand elevation. Per the three "Core Burnup" columns in Table 1, this row represents a total of 112 x 3 (burnups) = 336 control rod configurations.

As another example, row 3 of Table 1 assumes that all of C-Bank is misaligned at three different elevations relative to the demand elevation, per the next four columns. Per the last column, the remainder of the RCCAs are fully withdrawn, except for D-Bank, which is at the bite position. Per the three "Core Burnup" columns, this row represents a total of 3 (bank misalignments) x 3 (burnups) = 9 control rod configurations. In contrast to this small number for row 3, the last row in Table 1 represents over 900 unique control rod misalignment configurations, while the rows in Table 2 represents over 1800 unique control rod misalignment configurations each.

Tables 3 and 4 of Reference 2 Attachment A (proprietary) and Attachment B (non-proprietary) were compiled from two separate computer programs. The output of NODE-P2 was filtered by the use of a post-processor which identified the most limiting cases for further evaluation. To ensure that the information displayed in these tables was valid, the output of the post-processor was reviewed independently to ensure that the calculated results reflected the expected results incorporating such factors as core geometry and symmetry, core power level, rod position, and core physics.

Attachment A to this letter contains proprietary information that more fully describes the on-line RPI calibration process as well as the evaluation that supports performing the calibration on-line. Attachment B is the non-proprietary version of Attachment A.

Attachment C to this letter contains proprietary information and is provided to allow evaluation of the NODE-P2 code used in the analysis methodology, with emphasis on its uncertainty in calculating core peaking factors. In particular, Attachment C shows that,

while NODE-P2 can exhibit higher than usual uncertainties in some results (as was observed in comparisons with operating data in Cycle 14), these uncertainties are predictable, and are predicted to be smaller in Cycle 15 for significant (non-peripheral) assemblies. To further quantify the uncertainty in calculations for Cycle 15 (which can not be compared with operating data since the cycle has yet to occur), a comparison was made between NODE-P2 predictions for Cycle 15 and Westinghouse predictions based on their ANC code. In particular, the relative difference between the two codes is shown in Figures 1 and 2 of Attachment C. The two figures were selected to compare the results at 1) the time in core life when NODE-P2 results for Cycle 14 showed the greatest uncertainty; and 2) the time in core life when the NODE-P2 code showed the greatest difference relative to the ANC code. With respect to the second figure, a review of predictions for other times in Cycle 15 shows this time step to have the greatest difference between the two codes.

Attachment C also performs an error analysis based on the uncertainties discussed. This error analysis is highly conservative in that it assumes that NODE-P2 is being used to compute actual peaking factors. In actual practice, it is used to compute relative changes in peaking factors, a calculation which has a significantly smaller uncertainty associated with it. Regardless, the conservative error analysis shows that, for the power level of 50% for the increased RPI band and the power level of 35% for on-line calibration, there is significant margin via these power reductions to accommodate the increases in peaking factors.

Attachment D to this letter is the non-proprietary version of Attachment C. Attachments A and C will only be distributed to those persons requiring the proprietary information for purposes of implementing the required review of the proposed Technical Specification amendment. These attachments are supported by an affidavit which sets forth the basis on which the information may be withheld from public disclosure by the Commission, and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.790 of the Commission's regulations. Accordingly, it is requested that the information to which Con Edison asserts proprietary claims be withheld from public disclosure in accordance with 10 CFR Section 2.790 of the Commission's regulations. The affidavit addressing the proprietary nature of the attached materials is provided in the Enclosure to this letter.

Attachment E to this letter provides a figure depicting the control rod pattern and bank configuration, as requested.

The original amendment request was evaluated in accordance with 10CFR50.91(a)(1), using the criteria in 10CFR50.92(c), and was determined to not involve any significant hazards consideration. The attached proposed changes do not impact that determination and the conclusions are still valid.

In accordance with 10 CFR 50.91, a copy of this letter and the associated non-proprietary attachments are being submitted to the designated New York State official.

There are no commitments contained in this submittal. Should you or your staff have any questions regarding this submittal, please contact Mr. John F. McCann, Manager, Nuclear Safety and Licensing at (914) 734-5074.

Very truly yours,

A. Alan Blind

Subscribed and sworn to
before me this 15th day
of October 2000.

Elizabeth A. Melanson
Notary Public

ELIZABETH A. MELANSON
Notary Public, State of New York
No. 01ME4878094
Qualified in Orange County
Commission Expires Feb. 9, 2001

Enclosure and Attachments

cc:

Regional Administrator
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. Patrick D. Milano, Project Manager
Project Directorate I-1
Division of Reactor Projects I/II
US Nuclear Regulatory Commission
Mail Stop O-8-2C
Washington, DC 20555

NRC Senior Resident Inspector
US Nuclear Regulatory Commission
PO Box 38
Buchanan, NY 10511

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

Mr. Paul Eddy
NYS Department of Public Service
3 Empire Plaza
Albany, NY 12223

Mr. William F. Valentino, President
NYS ERDA
Corporate Plaza West
286 Washington Ave. Extension
Albany, NY 12223-6399

Mr. Jack P. Spath, Program Director
NYS ERDA
Corporate Plaza West
286 Washington Ave. Extension
Albany, NY 12223-6399

ENCLOSURE TO NL 00-126

PROPRIETARY AFFIDAVIT

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC
INDIAN POINT UNIT NO. 2
DOCKET NO. 50-247

AFFIDAVIT

STATE OF NEW YORK)
) ss:
COUNTY OF WESTCHESTER)

Before me, the undersigned authority, personally appeared A. Alan Blind, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this affidavit on behalf of Consolidated Edison Company of New York, Inc., and that the averments of fact set forth in this affidavit are true and correct to the best of his knowledge, information, and belief.

A. Alan Blind
Vice President - Nuclear Operations

Subscribed and sworn to
before me this 15th day
October 2000.

ELIZABETH A. MELANSON
Notary Public, State of New York
No. 01ME4878094
Qualified in Orange County
Commission Expires Feb. 9, 2001

Elizabeth A. Melanson
Notary Public

(1) I am the Vice President - Nuclear Operations at Consolidated Edison Company of New York, Inc. I have been specifically delegated the function of reviewing proprietary information to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of Consolidated Edison Company.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.790 of the Commission's regulations.

(3) The proprietary information sought to be withheld is Attachment A, " On-Line Calibration of the RPI Channels," and Attachment C, "Evaluation of the Node P2 Code," which are transmitted herewith by a Con Edison letter.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following information is furnished for consideration by the Commission in determining whether it should be withheld from public disclosure.

(i) Pursuant to Con Edison approved corporate procedures; Arthur P. Ginsberg and James P. Mooney obtained US Patent No. 5,011,649 for extended RPI Deviation Limits and the online, at power recalibration procedure of RPI channels in pressurized water reactors.

(ii) The information sought to be withheld from public disclosure comprises the application of the procedures developed in such patent as they pertain to Indian Point Unit 2. Such information is owned and has been held in confidence by Con Edison, Arthur P. Ginsberg and James P. Mooney.

(iii) The information is of a type customarily held in confidence by Con Edison and not disclosed to the public. Con Edison has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine whether to hold certain types of information in confidence. Under that system, information is held in confidence if the release may result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals distinguishing aspects of a patented method. The use of such information by others without a license would constitute a loss to Con Edison of a competitive economic advantage over other nuclear utilities, and a direct loss of protected patent rights to Con Edison.

(b) Use of such information by a competitor would reduce its expenditure of resources and improve its competitive position in licensing a similar product.

Additionally, there are sound policy reasons behind Con Edison's system, which include the following:

(a) As per corporate procedure and policy, Con Edison obtains patents for its employees and encourages them to market them.

(b) The information sought to be protected is valuable and marketable commercial information. The extent that such information is available to others without license would diminish the ability of the individual co-owners to sell products and services involving the use of the information.

(c) Each piece or component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total package of proprietary information. If competitors acquire components of proprietary information, any one component may be the key to the entire package; thereby depriving the owners of the proprietary information of a competitive advantage.

(iv) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.790, it is to be received in confidence by the Commission.

(v) The information sought to be protected is not available in public sources and, to the best of our knowledge and belief, has not been previously employed in the same original manner or method.

This information will enable Con Edison to:

(a) Provide documentation of the analyses and methodology used in extending the RPI deviation limits and performing on-line RPI calibrations.

(b) Obtain NRC approval of the proposed Technical Specification Amendments.

Further, this information has substantial commercial value because:

(a) The method allows a utility to continue operating its nuclear power plant and not shut down completely should the rod position indicators drift beyond their current limits as stated in the proposed Technical Specifications. This will result in significant operational benefits and enhanced unit availability. This also represents substantial savings as the utility would avoid having to purchase replacement power.

(b) The method allows a utility to return to service more quickly following an outage, again avoiding additional replacement power costs.

(c) The method is an alternative to purchasing expensive replacement equipment.

The development of the technology described in the proprietary report is the result of intensive efforts and the expenditure of considerable monies by Con Edison. Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Con Edison because it would enhance the ability of other nuclear utilities to provide similar licensing services for commercial power without incurring commensurate expense. Also, public disclosure of the information would enable other nuclear utilities to utilize the information to meet NRC requirements for licensing documentation to extend RPI deviation limits and perform on-line calibration of the RPI channels without purchasing the right to use the information.

ATTACHMENT B TO NL 00-126

ON-LINE CALIBRATION OF THE RPI CHANNELS

(Non-Proprietary Version)

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC
INDIAN POINT UNIT NO. 2
DOCKET NO. 50-247

ON-LINE CALIBRATION OF THE RPI CHANNELS

Introduction

Calibration of the Rod Position Indicator (RPI) channels was previously performed with the reactor at hot zero power. The analyses presented in this attachment demonstrate that at-power calibration is permissible at intermediate power levels. The procedure will involve first bringing the reactor to a suitable intermediate power level and then inserting specific RCCAs to the fully inserted position followed by RCCA withdrawal. When the analysis methodologies described here were applied to a previous cycle, it was determined that core power would likely be restricted to 50% of rated power by other factors in the Plant Technical Specifications (PTS), such as core quadrant tilt and/or axial flux difference restrictions. Thus, the analysis for Cycle 15 specifically addresses on-line recalibration from 50% power. Note that, as requested in the application, on-line calibration is actually performed at approximately 30% of rated power. Therefore, the application of the results here is conservative.

On-Line Calibration Plant Procedure

At hot shutdown conditions, all rods are de-energized so that they are at the bottom. At this point all RPIs are calibrated for the fully inserted position by adjusting the zero indication to read zero.

Following reactor startup, the reactor is brought to approximately 30% power. The calibration procedure requires all rods except those of control bank D to be fully withdrawn. At this point, all RPIs except for control bank D are calibrated to the fully withdrawn position using the span adjustment. Control bank D is then calibrated to its current position using the span adjustment.

When at power, should a full RPI calibration be needed for one of the rods, the power would be brought to approximately 30%. The rod needing calibration would be inserted fully to re-perform the zero adjustment. The rod would then be fully withdrawn and recalibrated using the span adjustment.

Scope of Analyses

To assess the impact of on-line calibration of RCCAs on core safety limits, a matrix of calculations shown in Table 1 were completed in NODE-P2. Individual RCCAs were inserted in two node increments (of the 24 axial nodes modeled) from the fully withdrawn position to 0 steps, followed by withdrawal back to 225 steps. At each insertion step the core peaking factors, core axial flux difference, and quadrant tilt were calculated. During RCCA insertion, the core power level was held constant via boron dilution and boration during subsequent RCCA withdrawal. Note that, in application, the power level is allowed to drift down while the boron concentration is held constant. This means that the analyses here are performed at a higher power level than is observed in application; therefore, the application of the results here is conservative.

The RCCA calibration strategies were assessed at beginning of cycle (BOC), middle of cycle (MOC), and end of cycle (EOC). The BOC cases were completed at a burnup of 150 MWD/MTU with xenon at equilibrium. Core state point calculations were performed prior to initiation of calibration exercises, at two node (twelve inch) increments of RCCA insertion during the calibration, and at the completion of calibration. For the analysis matrix shown in Table 1 this results in some 2067 state point calculations.

Results of the RCCA RPI Calibration Analysis

<u>"Worst Case" RCCA Calibration During Cycle 15</u>

To illustrate the impact of single rod insertion on core peaking factors and global core power distributions, the NODE-P2 results are presented for "worst case" RCCAs. For Cycle 15 the RCCA [ ]^{a,b} results in a maximum quadrant tilt of [ ]^{a,b}. The core quadrant tilt during calibration is shown in Figure 1. When this RCCA is fully inserted, the core quadrant tilt reaches [ ]^{a,b} which can be compared with the PTS alarm limit of 1.02 for power operation. The implications of a single RCCA calibration on core quadrant tilt limits are discussed subsequently.

Figure 2 is a plot of the worst case core axial flux difference during the calibration. For Cycle 15 the RCCA [ ]^{a,b} results in a maximum flux difference of [ ]^{a,b}. The calculated flux difference is compared with the target value and the ±5% operating band specified by the PTS. It is noted that the calibration of this RCCA causes the operating band to be exceeded. This behavior is typical of the EOC cases, but most BOC and MOC cases are within the operating band. In application, exceeding the band is of no consequence since the PTS permits operations while exceeding the operating band at or below 50% of rated power.

Figure 3 contains a plot of the worst case fractional change in nodal F_Q during calibration. For Cycle 15 the RCCA [ ]^{a,b} results in a maximum fractional change in pin F_Q of [ ]^{a,b}. The calculated values of F_Q are compared to the PTS limits. Two F_Q limits are shown: one for K(z) = 1.0 and one for K(z) = 0.925; these depend on the axial elevation at which the peak heat flux occurs. Figure 3 shows that the limits on F_Q are constant below 50% of rated power. This figure indicates that limits on F_Q are easily met for calibrations of single RCCAs at 50% power.

Figure 4 contains a plot of the worst case fractional change in pin $F_{\Delta H}$ during calibration along with the PTS limits. For Cycle 15 the RCCA [ ]^{a,b} results in a maximum fractional change in pin $F_{\Delta H}$ of [ ]^{a,b}. For operation at 50% power, the PTS limit for $F_{\Delta H}$ is increased by 0.15 over the full power limit. From Figure 4 it is concluded that the PTS limit is met with substantial margin for the calibration of this RCCA. This figure indicates that limits on $F_{\Delta H}$ are easily met for calibrations of single RCCAs at 50% power.

Composite Results of RCCA Calibration During Cycle 15

Table 2 contains a summary of results for the analyses of the NODE-P2 simulated on-line calibration of all 53 RCCAs during fuel cycle 15. This table contains the peak increase in $F_{\Delta H}$ and F_Q during the calibration exercise as well as the peak value of core quadrant tilt and maximum deviation from the target value of the axial flux difference for each of the 53 RCCAs. The results shown for each RCCA are the worst across the BOC, MOC, and EOC cases.

Table 3 has been distilled from Table 2 and contains the maximum value of the quadrant tilt and the maximum change in F_Q, $F_{\Delta H}$, and axial flux difference for the core loading pattern for Cycle 15.

Discussion

The results contained in Table 3 lead to the following conclusions for Cycle 15:

- The limiting core parameter with respect to on-line calibration of individual RCCAs is [ ]^{a,b}. When initiated from 50% power a [ ]^{a,b} is calculated.

- At 50% power the PTS limits on F_Q and $F_{\Delta H}$ are met.

- RCCA calibration has a varying effect on core axial flux difference depending on the core average burnup. For BOC and MOC calibration the

±5 operating band is not exceeded. For the EOC cases, the operating band is exceeded by a small amount. Exceeding the operating band at the power level proposed in the Amendment Request has no operational impact and is permitted by the current PTS. All current PTS limitations on axial flux difference will be met during the RPI calibration process; i.e., penalty minutes will be accrued if required.

With respect to core quadrant tilt limits, Section 3.10.3 of the PTS limits the core quadrant tilt to 1.02 for operation above 50% of rated power. If the tilt exceeds 1.02 but is less than or equal to 1.09, core power level must be restricted three percent of rated value for every one percent the tilt exceeds 1.0 within 2.0 hours. Also, the power range high flux setpoint must be restricted in a similar manner. If the tilt cannot be restored within 24 hours, the power level must be reduced to 50% of rated power and the power range high flux setpoint reduced to 55% of rated power.

If the tilt exceeds 1.09 and there is simultaneous indication of a misaligned RCCA (which would be the case for RCCA calibration), immediate power reduction of 3 percent of rated for every percent the tilt exceeds 1.0 or to a level less than 50% is required. If the tilt persists for more than 2 hours the power level must be restricted to less than 50% of rated. Within the next 4 hours, the power range high flux setpoint must be reduced to 55% of rated power in the event the tilt condition is not corrected.

For the "worst case" RCCA in Table 3 the peak tilt is [ ][a,b]. By paragraph 3.10.3.2a of the PTS, the maximum core power level would therefore need to be restricted to [ ][a,b] of rated. Since the on-line calibration is conducted at 50% of power, this restriction is not limiting. If the RCCA calibration required more than two hours, or if several RCCAs needed to be calibrated requiring more than 2 hours, the power level would have to be reduced to 50% of rated. In the event the calibration procedures were to require more than 4 hours, paragraph 3.10.3.2a requires that the power range high flux trip setpoint be reset at 55% of rated thermal power. The results in Table 2 provide a basis for anticipating the core quadrant tilt during single RCCA calibration of all 53 rods at BOC, MOC, and EOC.

Table 1

Analysis Matrix for On-Line RPI Calibration

a,b

[ ]

Table 2

Summary of Results: On-Line RPI Calibration - Fuel Cycle 15

a,b

Table 2, continued

Summary of Results: On-Line RPI Calibration - Fuel Cycle 15

a,b

Table 3

Summary of RPI Calibration Results

a,b

[ ]

Figure 1

Core Quadrant Tilt During Calibration of RCCA

a,b

QUADRANT TILT, QT

RCCA STEPS WITHDRAWN

Figure 2

Core Axial Flux Difference During Calibration of RCCA

a,b

FLUX DIFFERENCE, ΔI

RCCA STEPS WITHDRAWN

Figure 3

Fractional Change in F_Q During Calibration of RCCA

a,b

FRACTIONAL CHANGE IN PIN F_Q

RCCA STEPS WITHDRAWN

Figure 4

Fractional Charge in $F_{\Delta H}$ During Calibration of RCCA

a,b

FRACTIONAL CHANGE IN PIN $F_{\Delta H}$

RCCA STEPS WITHDRAWN

ATTACHMENT D TO NL 00-126

EVALUATION OF THE NODE-P2 CODE

(Non-Proprietary Version)

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC
INDIAN POINT UNIT NO. 2
DOCKET NO. 50-247

EVALUATION OF THE NODE-P2 CODE

NODE-P2 is a one energy group three dimensional nodal code with a closed channel thermal hydraulic model. While it may be used for fuel management calculations, in the current application is only used for calculating core peaking factors and global power distributions. In particular, it is being used to calculate the relative change in peaking factors with varied control rod positions. As with all numerical simulations, there is error between predicted and measured values. This error leads to uncertainty with respect to results from the numerical simulation. This uncertainty is best quantified by an *a posteriori* comparison of values measured during Indian Point Unit No. 2 (IP2) operations with NODE-P2 predictions. Prior to operations, this uncertainty is also assessed by comparing NODE-P2 predictions with a vendor's predictions using an independent code; this independent code is the Westinghouse ANC code.

With respect to values pertinent to this analysis, it is neither unusual nor significant for NODE-P2 or any other code to have worst case uncertainties of around 10% in assembly power. Worst case, in this context, refers to the maximum absolute value deviation between predicted values and measured values across every assembly in the core. Average uncertainties over all assemblies in the core are generally much smaller, typically less than 5% at BOC and even smaller as the cycle continues and the core power shapes become more uniform.

In comparing NODE-P2 with measured values for IP2 Cycle 14 in Reference 2, Attachments A (proprietary) and B (non-proprietary), it was noted that some of the worst case uncertainties exceeded 15%. This is attributable to the core design in Cycle 14, which is a transition core between introducing a new fuel design in Cycle 13 and Cycle 15, when all of the fuel will be of the same design. In addition, the new fuel design allows a lower leakage core configuration. These core design features can lead to large flux gradients between assemblies of significantly different reactivity (such as between a highly burned older design assembly and a fresh, high enrichment, new design assembly), and in the peripheral assemblies (because of high leakage), especially peripheral assemblies at "corners" (with more than one assembly face at the periphery). When reactivity gradients between assemblies occur between "outer" assemblies (near and/or at the core periphery), increased uncertainty is most pronounced. These increased gradients can cause the diffusion-theory based NODE-P2 to lose accuracy, leading to the observed increased uncertainty.

It is important to recognize that while there is increased uncertainty in some situations, it is predictable. A core design can be analyzed to look for strong gradients and increased uncertainty can be predicted for these assemblies. For example, in the core maps cited above comparing IP2 Cycle 14 data with NODE-P2, the worst case uncertainty occurred, as expected, in an outer fresh high enrichment new design assembly next to a depleted old design assembly, the latter being at the core periphery. The result was an over-prediction by NODE-P2 of the assembly power in the fresh assembly. As will be discussed in the next section, this over-prediction adds a significant conservatism to this

analysis. Note that, when considering only the inner assemblies where there are no leakage effects, the Cycle 14 versus NODE-P2 comparison shows a worst case uncertainty of just over 10% and an average uncertainty of less than 5%. Even when including the outer assemblies the average uncertainty is still less than 5%.

Since Cycle 15 has yet to occur, it is not possible to compare NODE-P2 to IP2 operating data for it. However, since the uncertainties are predictable, the core design can be assessed for the effects of reactivity gradients and leakage effects. Further, NODE-P2 results can be compared to results from a vendor's independent code for Cycle 15.

With respect to gradient effects in the Cycle 15 core, the core design is more uniform in reactivity distribution than Cycle 14. This is because all of the assemblies are of the same design and started with similarly high enrichments. Thus, while there will still be reactivity gradients between fresh assemblies and depleted assemblies (since the burnup differences will be about the same), the overall effect will be more uniform than for Cycle 14. With respect to leakage effects in the Cycle 15 core, the gradients may slightly increase because the new design makes a lower leakage core possible. Thus, while uncertainties are predicted to be smaller for the inner assemblies, they will stay about the same or may slightly increase for assemblies adjacent to the core periphery. Note that uncertainty in the low power peripheral assemblies has no significant impact on the analysis of rod misalignment or RPI calibration, so this potential increased uncertainty, if realized, would have no significant impact.

To examine the above predictions, the NODE-P2 results for Cycle 15 can be compared to results from an independent code for Cycle 15. The comparison (computed as $[x_{NODE\text{-}P2} - x_{ANC}]/x_{ANC}$) is shown in Figures 1 and 2 in this attachment. Figure 1, at 6000 MWD/MTU, corresponds to the point in cycle where NODE-P2 showed the worst agreement with Cycle 14 data. Figure 1 shows that NODE-P2 is in very good agreement (less than 3% difference) with the independent code for the inner assemblies. The agreement with the outer assemblies is also generally good (less than 5% difference) with two exceptions. First, the corner assemblies show differences of -7% to -9%, which is not surprising because the largest leakage effects occur there. Because these occur in low-power peripheral assemblies, the associated uncertainty is not significant in this application. Second, the assembly in the (2,8) position (and its three symmetric counterparts) show differences of about 11%. These may be attributable to a synergy of leakage and gradient effects. Note that the 11% effects are positive and so, as will be discussed in the next section, are conservative in this analysis.

Figure 2, at 150 MWD/MTU, shows the largest differences between NODE-P2 and the independent code across Cycle 15. The agreement is generally acceptable except for some of the corner assemblies (with more than one face at the periphery), which range up to about a 15% difference. Again, this is where leakage effects are expected to be most pronounced and, being in low power assemblies at the core periphery, is not significant to this analysis.

ERROR ANALYSIS

The above discussion shows that, while there can be increased uncertainty associated with some NODE-P2 results, it is predictable, and it is predicted to be smaller for the non-peripheral assemblies in Cycle 15 than for Cycle 14. While the low power peripheral assemblies may have the same or greater uncertainty in Cycle 15, they do not have a significant impact on the results. The purpose of this section is to show that there are such significant conservatisms in the analysis methodology that all of the uncertainty is mitigated by these conservatisms.

The key element is that any increase in peaking factors is accounted for by at least a one to one reduction in reactor power. In calculating the power reduction, the maximum increase in either $F_{\Delta H}$ or F_Q is taken. In addition, the calculated power decrease is calculated relative to the PTS limit even though the relative error extracted from the calculations may be smaller. Further, if positive uncertainties yield absolute values of $F_{\Delta H}$ or F_Q beyond what is calculated by applying the increase to the PTS limit, the higher value is used in calculating the power reduction. Thus, the final power reduction is so large that it can easily accommodate all errors.

The power reduction is composed of the following:

1) Peaking factor increase due to either the on-line calibration or the increased misalignments;
2) Differences in the expected power distributions; and
3) Uncertainties in the calculational method.

These reductions (1) and uncertainties (2 and 3) can be quantified as follows:

a,b

Using the analysis methodology, the power level necessary to mitigate increases in peaking factors due to on-line calibration or increased misalignment was conservatively

a,b

calculated to be greater than [ ]^{a,b} of rated. Combining the reduction and average uncertainties described above gives a total reduction of

[ ] a,b

Thus, the requested power level of 50% for the increased RPI band, a [ ]^{a,b} reduction from that required, is conservative. Further, the requested power level of 35% for on-line calibration, a [ ]^{a,b} reduction from that required, is extremely conservative. Looking at the root mean square of the largest errors, regardless of sign, gives (using the precise values from Figures submitted)

[ ] a,b

Again, this extremely conservative calculation shows the margin in the calculation.

Figure 1

Relative Difference between NODE-P2 and an independent code
6000 MWD/MTU, HFP, Cycle 15,

6000 MWD/MTU, HFP

				-8.5	-5.3	-0.8	-2.2	3.2	-4.5	-7.9				
		-4.7	-3.4	2.0	4.8	4.5	10.7	4.8	5.1	2.3	-3.1	-4.8		
	-2.3	1.4	-3.7	-1.2	-1.8	0.4	0.9	0.0	-1.7	-0.6	-3.5	1.4	-2.2	
	-2.9	-3.7	-2.8	-2.7	0.0	-0.6	1.1	-0.8	-0.3	-2.6	-2.8	-3.8	-3.2	
-8.2	2.1	-1.1	-2.7	-0.9	-1.4	0.1	-0.9	-0.2	-1.9	-0.9	-2.8	-1.7	1.7	-8.8
-5.2	4.9	-1.5	0.1	-1.2	1.0	-0.4	1.6	-0.5	1.0	-0.7	0.4	-1.5	4.7	-6.0
-0.8	4.6	1.0	-0.1	0.4	-0.1	1.5	-1.7	1.5	0.0	0.7	0.1	1.4	4.3	-4.7
-2.2	10.7	0.9	1.1	-0.9	1.6	-1.7	2.0	-1.7	1.6	-0.9	1.1	0.9	10.7	-2.2
-4.8	4.3	1.4	0.1	0.7	0.0	1.5	-1.7	1.5	-0.1	0.4	-0.1	1.0	4.6	-0.8
-6.0	4.7	-1.5	0.4	-0.7	1.0	-0.5	1.6	-0.4	1.0	-1.2	0.1	-1.5	4.9	-5.2
-8.8	1.7	-1.7	-2.8	-0.9	-1.9	-0.2	-0.9	0.1	-1.4	-0.9	-2.7	-1.1	2.1	-8.2
	-3.2	-3.8	-2.8	-2.6	-0.3	-0.8	1.1	-0.6	0.0	-2.7	-2.8	-3.7	-2.9	
	-2.2	1.4	-3.5	-0.6	-1.7	0.0	0.9	0.4	-1.8	-1.2	-3.7	1.4	-2.3	
		-4.8	-3.1	2.3	5.1	4.8	10.7	4.5	4.8	2.0	-3.4	-4.7		
				-7.9	-4.5	3.2	-2.2	-0.8	-5.3	-8.5				

	ALL	INNER	OUTER
MAXIMUM DIFFERENCE=	10.7	2.0	10.7
RMS DIFFERENCE=	3.5	1.5	4.3
MINIMUM DIFFERENCE=	-8.8	-2.8	-8.8
AVG DIFFERENCE	-0.60	-0.50	-0.67

Figure 2

Relative Difference between NODE-P2 and an independent code
150 MWD/MTU, HFP, Cycle 15

150 MWD/MTU, HFP

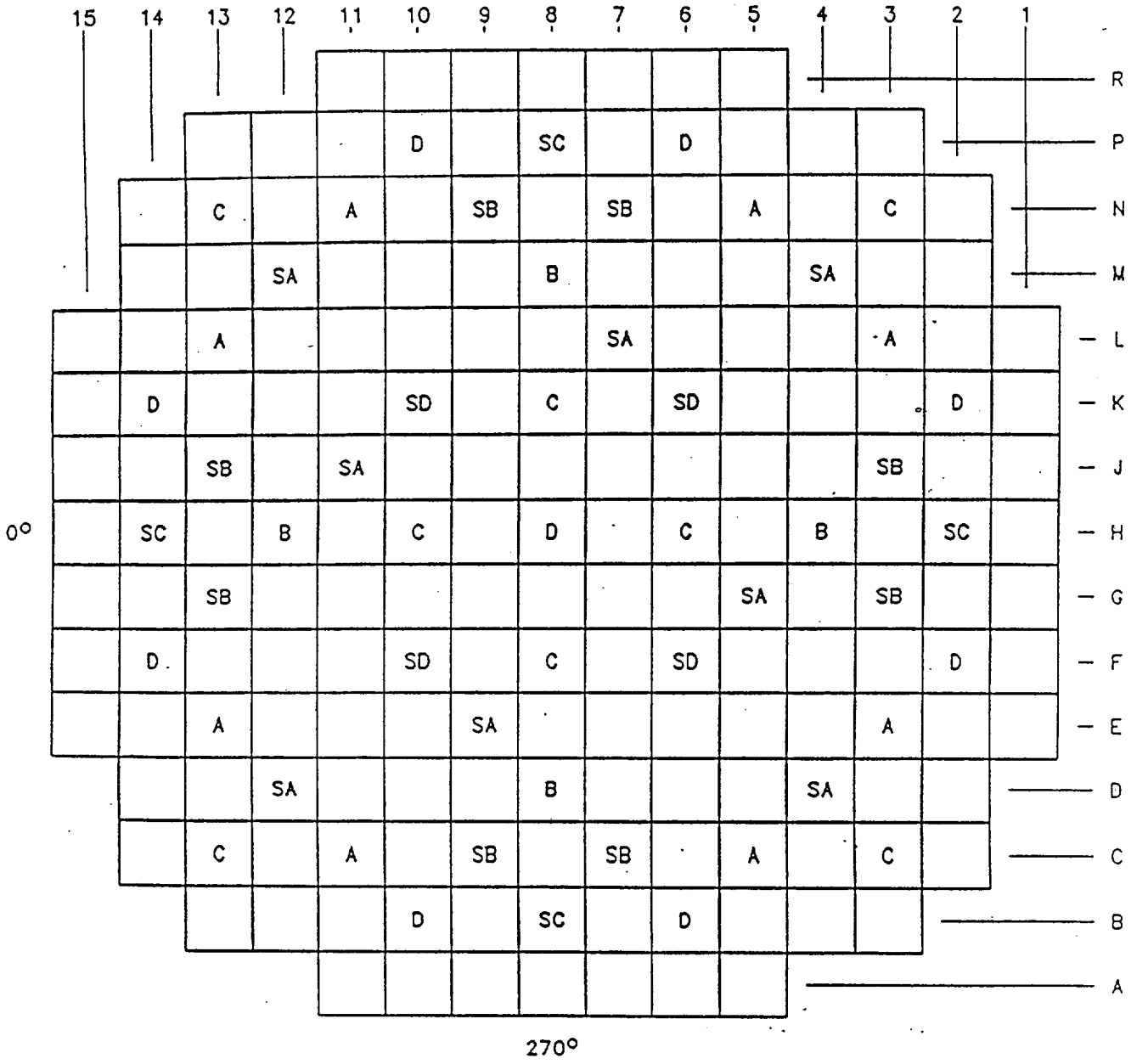
				-11.7	-9.6	-1.3	2.5	3.2	-8.7	-15.1				
		-8.3	-9.2	-7.7	-1.4	4.0	10.1	4.3	-1.1	-7.3	-8.9	-8.6		
	-5.8	-9.7	-7.6	-6.3	-2.2	1.4	4.6	0.9	-2.2	-5.7	-7.4	-9.7	-5.5	
	-8.9	-7.5	-7.2	-2.4	0.1	1.9	2.6	1.6	-0.3	-2.3	-7.2	-7.8	-9.2	
-11.7	-7.5	-6.2	-2.3	1.2	4.0	3.2	5.8	2.8	3.4	1.2	-2.4	-6.9	-7.9	-12.3
-5.9	-1.4	-2.1	0.4	4.3	6.1	5.5	5.7	5.4	6.1	4.9	0.8	-2.1	-1.7	-6.9
2.7	4.2	2.1	2.4	3.5	5.9	5.5	7.2	5.5	5.9	3.9	2.7	2.7	3.9	-1.6
6.3	10.1	4.6	2.6	5.8	5.7	7.2	7.9	7.2	5.7	5.8	2.6	4.6	10.1	6.3
-1.6	3.9	2.7	2.7	3.9	5.9	5.5	7.2	5.5	5.9	3.5	2.4	2.1	4.2	2.7
-6.9	-1.7	-2.1	0.8	4.9	6.1	5.4	5.7	5.5	6.1	4.2	0.4	-2.1	-1.4	-5.9
-12.3	-7.9	-6.9	-2.4	1.2	3.4	2.8	5.8	3.2	4.0	1.2	-2.3	-6.2	-7.5	-11.7
	-9.2	-7.8	-7.2	-2.3	-0.3	1.6	2.6	1.9	0.1	-2.4	-7.2	-7.6	-8.9	
	-5.5	-9.7	-7.4	-5.7	-2.2	0.9	4.5	1.4	-2.2	-6.3	-7.6	-9.7	-5.8	
		-8.6	-8.9	-7.3	-1.1	4.3	10.1	4.0	-1.4	-7.7	-9.2	-8.3		
				-11.1	-5.0	7.4	6.3	3.0	-5.9	-11.7				

	ALL	INNER	OUTER
MAXIMUM DIFFERENCE=	10.1	7.9	10.1
RMS DIFFERENCE=	6.0	4.5	6.8
MINIMUM DIFFERENCE=	-15.1	-7.2	-15.1
AVG DIFFERENCE	-0.81	2.48	-3.20

ATTACHMENT E TO NL 00-126

Control Rod Pattern and Bank Configuration

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC
INDIAN POINT UNIT NO. 2
DOCKET NO. 50-247



BANK IDENTIFIER	NUMBER OF LOCATIONS	BANK IDENTIFIER	NUMBER OF LOCATIONS
A	8	SA	8
B	4	SB	8
C	8	SC	4
D	9	SD	4

Control Rod Pattern and Bank Configuration