Carl L. Newman
Vice President

Consolidated Edison Company of New York, Inc.
4 Irving Place, New York, N. Y. 10003
Telephone (212) 460-5133

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January 29, 1976

Re Indian Point Unit No. 3
Docket No. 50-286

Mr. D. B. Vassallo, Chief
Light Water Reactor Branch No. 5
Division of Project Management
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Vassallo

As requested by members of the NRC Staff in a recent telephone conversation, a discussion of the effects of rod bowing on Indian Point Unit No. 3 fuel assemblies is presented in Attachment A. Based on this information, it is our conclusion that operation of Indian Point Unit No. 3 at 91% of rated power (2760 Mw(t)) more than adequately compensates for the penalties associated with rod bowing.

Very truly yours

Carl L. Newman

mrb

Carl L. Newman
Vice President

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Sworn to before me this
29 day of January, 1976.

David Watson
Notary Public

DAVID WATSON
Notary Public State of New York
No. 03-4604876
Qualified in Bronx County
Commission Expires March 30, 1977

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ATTACHMENT A

EFFECT OF ROD BOWING
ON INDIAN POINT UNIT NO. 3
FUEL ASSEMBLIES

A generic evaluation of the effect of rod bowing observed on Westinghouse Low Parasitic (LOPAR) fuel assemblies, as in Indian Point Unit No. 3, has been submitted by Westinghouse in Fuel Rod Bowing WCAP-8691 (proprietary) and WCAP-8692(Non-proprietary). An empirical rod bow correlation was developed based on data from irradiated assemblies and analyses performed with these conservative empirical predictions show that:

Generically identified DNBR margins are adequate to offset DNBR reductions due to rod bow,

The present design practice of increasing the highest calculated core peaking factor is sufficient to account for all deviations, including the effects of rod bow, and

Fretting and corrosion of bowed rods are negligible.

These conclusions indicate that fuel rod bowing results in no impact on plant safety or reliability.

CONSEQUENCE OF ROD BOW ON LOCA

An evaluation of the effect of rod bow on local power was submitted by Westinghouse in WCAP-8691 (proprietary) and WCAP-8692 (non-proprietary), and utilizing an extremely conservative design value of the rod bow factor, 3.93 percent from Table 5-4 of WCAP-8692 the current design F_Q conservatively accounts for rod bow effects and no additional penalty need be applied for operation at the license application rating of 3025 MWt. The 3.93 percent occurs in the second span of the Indian Point Unit No. 3 type array, and is conservative for operation to 33,000 MWD/MTU.

In addition, the limiting elevation for LOCA is typically in the top half of the core (6.5 feet elevation for Indian Point Unit No. 3) where the rod bow factor is considerably lower than at the bottom of the core - see Table 5-4. Additional conservatism is present as a maximum burnup was utilized (33,000 MWD/MTU) while present LOCA analysis, carried out for no rod bowing, demonstrates the lead rod (peak clad temperature) occurs for burnup well before 5,000 MWD/MTU. Although no benefit for this, or location of peak clad temperature, was utilized for Indian Point Unit No. 3 15 x 15 LOPAR fuel assemblies, the local power increase for span 4, at 5,000 MWD/MTU burnup, is only 1.81%.

For initial operation of the facility at 91% of rated power, the present LOCA analysis is conservative for a rod bow power increase of 9.9% (i.e., 100/91 = 1.099) which is considerably in excess of the highest local power increase due to rod bowing, even with no credit taken for demonstrated margins in the present design peaking factor.

CONSEQUENCES OF ROD BOW ON DNB MARGIN

A generic evaluation of the effect of rod bow on DNB was submitted by Westinghouse in Reference (1). The DNB penalty due to rod bow was evaluated using a previously approved(2) rod bow DNBR model. The DNBR penalty is related to the rod bowed contact DNB test correlation (3) which depends on hot rod heat flux or kw/ft. The end of cycle No. 3(EOC 3) DNBR penalty for the LOPAR fuel assembly with an average linear power density of 6.70 kw/ft was 5.5% based on a contact penalty of 9.9%.

Because the linear power density of Indian Point Unit No. 3 is only 6.25 kw/ft, the IP3 EOC 3 DNBR penalty based on a contact DNB penalty of 8.1% is 4.6%.

As discussed in Reference (1), the hot channel pitch reduction in the thermal-hydraulic design procedure provides an allowance of 3.3% DNBR which is available to offset the rod bow penalty. In addition, other DNB margins are described below which when added to the pitch reduction allowance provide more than enough margin to account for the rod bow penalty.

The DNBR margins which exist in LOPAR plant thermal-hydraulic designs are summarized in Table 5-2 of WCAP-8692. These margins are incorporated in all DNBR evaluations due to conservative application of test data results and correlations in the thermal-hydraulic design analyses. The references for the test data and/or NRC evaluations of the topical reports listed are also shown in Table 5-2, WCAP-8692.

The 15 x 15 margins are evaluated on a basis consistent with approved 17 x 17 margins, as discussed in WCAP-8185 and recognized

(1) Westinghouse letter NS-CE-828 Eicheldinger to Vassallo, October 28, 1975
(2) Letter, Vassallo to Eicheldinger July 10, 1975 Topical Report Evaluation of WCAP-8176 (Westinghouse Proprietary) and WCAP-8323 (Westinghouse Non-proprietary)
(3) WCAP-8176 P-A (Westinghouse Proprietary) and WCAP-8323-A (Westinghouse Non-proprietary) "Effect of a Bowed Rod on DNB" dated Feb.75, Hill, K.W, Motley, F.E. and Sadek, F.F. transmitted by Westinghouse letter NS-RS-531, dated Jan. 24, 1975 Salvatori,to Vassallo.

in the NRC Evaluation Report of WCAP-8185, using the test data from the listed topical reports applicable to the 15 x 15 design.

The NRC evaluation report contained in WCAP-7411L Rev. 1-P-A stated that a thermal diffusion coefficient value (TDC) of 0.038 could be used in LOPAR (or L grid) designs along with the L grid DNB correlation derived in WCAP-7988, instead of the current design value of TDC = 0.019. A sensitivity study (4) performed using the THINC code over a range of conditions on a typical 15 x 15 plant showed that there was a minimum of 3.2% DNBR conservatism due to the continued use of TDC = 0.019 in 15 x 15 design analyses. This margin is listed as 3% in Table 5-2 of WCAP-8692 to provide a generic number which covers variations in sensitivities at different plant conditions and small plant-to-plant variations.

In summary, the rod bow penalty is 4.6% on the basis of a contact DNB penalty of 8.1%. This is more than compensated for by the pitch reduction effect included in the safety evaluation and calculated to be 3.3%, the conservatism in TDC used in the safety evaluation and calculated to be 3%, and the margin in the DNB test data statistics of 4.8%. Thus, for operation at the license application rating of 3025 MWT existing DNB margins are sufficient to offset DNBR reductions due to rod bow.

(4) Westinghouse letter, Eicheldinger to Vassallo, NS-CE-856, Dec. 2, 1975