NRR file

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

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MEMORANDUM FOR: Vincent Noonan, Chief, Engineering Branch, Division of Operating Reactors

FROM: Paul S. Check, Chief, Reactor Safety Branch, Division of Operating Reactors

SUBJECT: EVALUATION OF ACCURACY OF FLUENCES USED IN THE PROPOSED INDIAN POINT UNIT 2 PRESSURE-TEMPERATURE LIMITS

Summary: The Reactor Safety Branch, with the assistance of our consultant at Brookhaven National Laboratory, has evaluated the neutron dosimetry involved in arriving at the 1/4T fluence for Indian Point Unit 2.

Our detailed evaluation, which is enclosed, indicates several unresolved issues regarding the methods used to obtain the 1/4T fluence. Both plant specific and generic concerns have been identified. Based on our estimates of the uncertainties involved, we recommend that the plant specific issues be resolved before operation with the proposed limits beyond four effective full power years.

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Attachment:
As stated

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Introduction

The Reactor Safety Branch has conducted a review of the neutron dosimetry aspects of the proposed pressure-temperature limits for Indian Point Unit 2 (IP2) for the period from three to five effective full power years (EFPY). Our review has considered only the accuracy of the evaluated fluence of neutrons with energy above 1 MEV at the one-quarter thickness (1/4T) of the pressure vessel wall, which is the limiting position with regard to brittle fracture. We have been assisted in this effort by our consultant at Brookhaven National Laboratory (BNL) under an agreement between NRC and BNL (memorandum from V. Stello, NRC, to R. H. Bauer, Energy Research and Development Administration, November 8, 1978).

Our review included an examination of data and results presented in the IP2 FSAR and the document "Reactor Vessel Material Surveillance Program for Indian Point Unit No. 2 Analysis of Capsule T" which was prepared by Southwest Research Institute for Consolidated Edison Company in support of the proposed IP2 pressure-temperature limits. We also discussed the information in this document and the FSAR with IP2 in two telephone conservations.

Discussion

The evaluated fluences for IP2 are based on dosimetry measurements from Capsule T. This capsule contained copper and nickel dosimeters and 32 Charpy v-notch specimens. Dosimetry data from five of the Charpy specimens (iron) were used to obtain a value for the flux of neutrons with energy above 1 MEV at the Capsule T location. The lead factor (2.9) used to extrapolate the flux at Capsule T to the maximum flux at the inner vessel wall was calculated using transport theory. Attenuation of neutrons within the vessel wall was based on attenuation factors evaluated by NRC consultants and previously accepted by the staff. Based on the dosimetry analysis and application of the lead factor and attenuation factor the licensee identified the limiting belt line plate material and the RT_{NDT} for that material at the 1/4T location up to five EFPY. The RT_{NDT} at 1/4T for the limiting plate material was determined to be 170°F at a fluence of 1.5×10^{18} n/cm^2. Based on this value of RT_{NDT}, pressure-temperature operating limits in accordance with the procedures given in Appendix G to ASME Code, Section III were calculated.

During telephone conservations with Indian Point 2, it was learned that the use of 2.9 for the lead factor represents a change from the lead factor (2.6) documented in the plant FSAR. However, the adequacy

of the new lead factor, which is less conservative than the original value, has not been documented. Also, the licensee used only iron dosimetry data for the analysis and did not use data from the nickel and copper dosimeters. Furthermore, we have not been able to conclude how the perturbation of neutron flux due to the presence of the capsule itself has been treated.

To estimate the upper bound on the uncertainty in 1/4T fluence, we have used the nickel dosimetry data for which there was only one sample, increased by the standard deviation from the five iron samples, and have used the FSAR lead factor, reduced by 10% to compensate for the lack of benchmarking of transport theory codes and cross sections. We have not included any correction related to perturbation of flux by the capsule. This procedure gives an upper bound estimate of the fluence uncertainty of 48%.

A lower, yet reasonable, estimate of the fluence can be obtained by using a weighted average of the dosimetry data from the iron, copper and nickel, increased by 1.5 standard deviation of all the data, and using the FSAR lead factor without a correction. This gives a correction to the fluence of 22%.

Conclusions

Based on our review of the Indian Point Unit 2 submittal and other information available regarding application of neutron dosimetry to pressure vessel embrittlement, we have reached the following conclusions:

(1) The use of a lead factor of 2.9 as a substitute of the FSAR value (2.6) has not been justified.

(2) The use of iron dosimetry data and neglect of copper and nickel dosimetry data (which would result in higher fluences) has not been justified.

(3) The method of treating the perturbation of neutron flux due to the presence of the dosimetry capsule has not been described or justified adequately.

(4) Transport theory codes, cross section sets, and neutron dosimetry practices in general have not been tested against reliable experimental benchmarks and this applies to those used for the IP2 analysis.

(5) Taking at face value all the specific numerical information obtained during our review, we estimate the fluences at the quarter thickness of the vessel wall could be under-estimated by 22% to 48%.

We recommend that the concerns indicated in items (1), (2) and (3) above be resolved before operation of IP2 under the proposed pressure-temperature limits beyond four EFPY. Our consultant at BNL will be working to resolve the more generic concerns indicated in item (4) under the agreement mentioned above. The evaluation by BNL (Attachment 1) discusses details regarding these generic activities.