Nebraska Public Power District

COOPER NUCLEAR STATION
P.O. BOX 98, BROWNVILLE, NEBRASKA 68321
TELEPHONE (402)825-3811
FAX (402)825-5205

NLS960232
December 13, 1996

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

Gentlemen:

Subject: Request for Revision of Reactor Vessel Surveillance Capsule Withdrawal Schedule
Cooper Nuclear Station, NRC Docket 50-298, DPR-46

The Nebraska Public Power District (District) requests that the NRC approve the revision to the Cooper Nuclear Station (CNS) reactor vessel surveillance capsule withdrawal schedule described below. Based on evaluation of the reactor vessel surveillance results obtained to date, the inventory of test capsules remaining, the estimated current surveillance capsule fluence, and the expected and potential remaining plant life, the District requests NRC approval to defer removal of the third surveillance capsule from its current schedule of 15 Effective Full Power Years (EFPY) of fluence to 22 EFPY. The basis for this request is detailed in the attachment.

To support the District's plans for the upcoming refueling outage, the District requests that the NRC respond to this request by January 15, 1997.

Should you have any questions concerning this matter, please contact me.

Sincerely,

P D Graham

P. D. Graham
Vice President - Nuclear

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/mjb
Attachment

cc: Regional Administrator
USNRC - Region IV

Senior Project Manager
USNRC - NRR Project Directorate IV-1

Senior Resident Inspector
USNRC

NPG Distribution

REVISION OF REACTOR VESSEL MATERIAL SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE

I. INTRODUCTION

10 CFR 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," Section III.B.3 requires proposed reactor vessel material capsule withdrawal schedules be submitted to the NRC with an accompanying technical justification, and approved by the NRC prior to implementation. The purpose of the surveillance program is to monitor neutron radiation effects on reactor vessel materials to assist in protecting against brittle fracture. The results of the surveillance program are reflected as necessary in the reactor vessel pressure-temperature limitation curves, which ensure operation is maintained with adequate margin in the vessel ductile region.

As detailed further below, the Nebraska Public Power District (District) has removed and analyzed specimens contained in two reactor vessel material surveillance capsules to date, and has two additional capsules (one reconstituted) remaining in the CNS vessel. By the end of the current cycle, the estimated fluence will be approximately 15 Effective Full Power Years (EFPY). Based on the data obtained to date, the remaining capsules available, the estimated fluence of the remaining capsules, and additional material performance information which will become available through the District's participation in the Boiling Water Reactors Owners' Group (BWROG) Supplemental Surveillance Program, extension of the withdrawal schedule for the third surveillance capsule is technically justified and appropriate. The bases for this conclusion is provided below.

II. BACKGROUND

CNS was designed and fabricated to the Winter 1966 Addenda of the 1965 ASME Code. At the time of CNS vessel design and fabrication, ASTM E-185-66 was the current standard for vessel surveillance programs. ASTM E-185-66 recommended withdrawal of specimens at three or more separate times, with one capsule corresponding to exposure near the end of vessel design life. Therefore, CNS originally had three surveillance capsules fabricated and installed in the vessel.

The first surveillance capsule was withdrawn in 1985 following 6.8 EFPY of operation. The results of the testing and analysis performed on the first capsule are contained in General

Electric (GE) GE Report MDE-103-0986[1], submitted to the NRC by letter dated July 6, 1987.[2] At that time, Regulatory Guide (RG) 1.99, Revision 1 was the existing guidance for predicting nil-ductility transition reference temperature (RT_{NDT}) shift.[3] The results of this testing and analysis showed a shift in the CNS vessel plate material greater than that predicted by RG 1.99, Revision 1. Therefore, the CNS vessel material predicted shifts were adjusted upward to address the deviation. Following this testing and analysis, the District submitted a proposed change to the CNS Technical Specifications to revise the CNS pressure-temperature operating limit curves (P-T Curves) in accordance with the predictions developed using the RG 1.99 Revision 1 guidance.

In its safety evaluation approving Amendment No. 120 to the CNS operating license[4] the NRC recommended, based on the greater than expected transition temperature shifts measured, and to meet ASTM E 185-82 as closely as possible, that the District accelerate the withdrawal schedule of the second surveillance capsule to 12 EFPY, and consider insertion of a fourth capsule into the CNS vessel, possibly with reconstituted specimens from an earlier capsule. Following various communications, and in support of a license change application to extend the operating license expiration date to 40 years from receipt of the CNS operating license, the District committed to 1) remove the second surveillance capsule during the 1991 refueling outage, and 2) reconstitute the specimens from this capsule and re-insert the reconstituted specimens during the 1993 outage. The District also indicated that the withdrawal schedule for the third capsule would be based on the results of testing and analysis of the second surveillance capsule.[5]

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1. General Electric Report MDE-103-0986, T. A. Caine, et. al., *Cooper Nuclear Station Reactor Pressure Vessel Surveillance Materials Testing and Fracture Toughness Analysis*, May, 1987.

2. Letter to U. S. Nuclear Regulatory Commission from G. A. Trevors (NPPD) dated July 6, 1987, "Reactor Vessel Material Surveillance Program."

3. NRC Regulatory Guide 1.99, Revision 1, dated April, 1977, "Effects of Residual Elements on Predicted Radiation Damage to Reactor Vessel Materials."

4. Letter to G. A. Trevors (NPPD) from W. O. Long (NRC) dated April 26, 1988, "Cooper Nuclear Station - Amendment No. 120 to Facility Operating License No. DPR-46 (TAC 65793)."

5. Letter to U. S. Nuclear Regulatory Commission from G. R. Horn (NPPD) dated June 7, 1991, "Response to Questions on License Extension to 40 Years from Operating License Issuance."

In its safety evaluation accompanying Amendment No. 143 to the CNS operating License which extended the CNS license expiration date to January 18, 2014,[6] the NRC acknowledged the District's commitment to reconstitute the surveillance capsule withdrawn during the 1991 refueling outage. The NRC stated further that the reconstitution of the capsule withdrawn in 1991 is equivalent to a fourth capsule and thereby makes the District surveillance program consistent with the requirements of ASTM E-185-82 and 10 CFR 50 Appendix H. The NRC also acknowledged that the withdrawal schedule for the original third capsule and the reconstituted fourth capsule should be based on the results of the analysis of the second capsule.

The District withdrew the second surveillance capsule from the CNS reactor vessel during the 1991 refueling outage following 11.2 EFPY of operation. The results of testing and analysis of those surveillance materials are documented in GE Report GE-NE-523-1292[7] submitted to the NRC by letter dated February 25, 1993.[8] The GE analysis was based on RG 1.99, Revision 2,[9] which became effective in May, 1988. As part of this testing and analysis, GE tested archived CNS vessel plate material charpy specimens to develop more representative unirradiated vessel plate data. The limiting vessel plate material initial RT_{NDT} was originally based on Certified Material Test Report (CMTR) data which may not have been representative of the vessel plate material and surveillance material, as a result of potentially differing heat treatment. Reanalysis of the first capsule test data and analysis of the second capsule data, using the new vessel plate material baseline data resulted in measured transition temperature shifts for each material, including vessel plate material, bounded by that predicted using the RG 1.99, Revision 2 methodology. New PT Curves were generated based on the results of this analysis.

On December 10, 1993, the District submitted Proposed Change No. 119 to the CNS Technical Specifications requesting revision of the PT Curves based on the results of the testing and analysis performed on the second surveillance capsule and reanalysis of the first capsule.[10] The

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6. Letter to G. R. Horn (NPPD) from P. W. O'Connor (NRC) dated July 5, 1991, "Cooper Nuclear Station - Amendment No. 143 to Facility Operating License No. DPR-46 (TAC No. 74843)."

7. GE-NE-523-159-1292, *Cooper Nuclear Station Vessel Surveillance Materials Testing and Fracture Toughness Analysis*, dated February 1993.

8. Letter to U. S. Nuclear Regulatory Commission from G. R. Horn (NPPD) dated February 25, 1993, "Submittal of Reactor Vessel Surveillance Test Results."

9. NRC Regulatory Guide 1.99, Revision 2, dated May, 1988, "Radiation Embrittlement of Reactor Vessel Materials."

10. Letter from G. R. Horn (NPPD) to U. S. Nuclear Regulatory Commission dated December 10, 1993, "Proposed Change No. 119 to Technical Specifications, Revision

revised PT curves, based on RG 1.99 Revision 2, with a surveillance adjustment, were less restrictive than the existing CNS Technical Specification curves, which were based on RG 1.99, Revision 2 predictions with no surveillance adjustment. However, by letter dated September 8, 1995,[11] the District withdrew this and other amendment requests based on its plans to begin an improved Technical Specifications conversion program, which removes the PT Curves from the Technical Specifications.

As committed in its June 7, 1991 letter[5], the District installed a fourth capsule during the 1993 refueling outage containing specimens reconstituted from those previously contained in the second surveillance capsule. The original third capsule and the reconstituted fourth capsule currently remain in the CNS vessel.

III. DISCUSSION

As discussed above, the original surveillance capsule withdrawal schedule was accelerated because of apparent anomalous radiation effects. However, subsequent testing has shown material behavior to be bounded by that predicted using RG 1.99, Revision 2 methodology, the current accepted NRC guidance.

Most of the significant material effects are expected to occur early in reactor vessel life.[12] This is consistent with that predicted using RG 1.99, Revision 2. The first two surveillance capsules were removed at 6.8 EFPY (30° capsule) and 11.2 EFPY (300° capsule) respectively. The first two surveillance capsules received 21% and 25% of the estimated End-of-Life (EOL) peak vessel fluence (1/4T EOL fluence of 1.1×10^{18} n/cm^2) respectively, based on the fluence measured by each capsule's dosimetry. Based on the estimated lead factor[13] for the third surveillance capsule (1[illegible]0° capsule), the capsule will have received a fluence of 3.8×10^{17} n/cm^2 (or approximately 36% of the EOL fluence at the end of the current cycle). Removal and testing of the third surveillance capsule at the end of the current cycle (approximately 15 EFPY) would likely show RT_{NDT} shifts similar to that measured for the first two capsules, and would therefore not likely provide new information concerning the condition of the CNS vessel.

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to Pressure - Temperature Limitation Curves."

11. Letter to U. S. Nuclear Regulatory Commission from J. H. Mueller (NPPD) dated September 8, 1995, "Withdrawal Request of Proposed Change Nos. 66, 119, 120, 121, and 123."

12. GE-NE-523-159-1292, *Cooper Nuclear Station Vessel Surveillance Materials Testing and Fracture Toughness Analysis*, dated February 1993, Figure 7-4.

13. The lead factor is the ratio of surveillance capsule neutron fluence received, as measured by the flux wires contained therein to the estimated peak reactor vessel neutron fluence.

Therefore, the third capsule should be removed at approximately 50% of EOL fluence, or 5.5 x 10^{17} n/cm^2. Based on the estimated lead factor for the third capsule (120°), the 50% of EOL fluence will be reached at approximately 22 EFPY.

It should be noted that additional vessel plate surveillance specimens are, or will be available for further testing.[14] In addition to the reconstituted specimens installed during the 1993 refueling outage, the District is participating in the BWROG Supplemental Surveillance Program (SSP). The SSP is intended to provide BWR specific data to measure the effects of irradiation on fracture toughness near mid-life and end-of-life fluences. The SSP consists of seven capsules inserted into the Oyster Creek and CNS vessels. Each capsule contains plate and weld material from several BWRs, including CNS. Two Oyster Creek capsules were removed in September 1996, with two more capsules scheduled for withdrawal in 2000. The CNS SSP capsules are scheduled for removal in 2002. The results from the SSP will be applicable to CNS for three reasons:

- Generically, the SSP results will be from environmental conditions representative of BWRs, including CNS;

- Specifically, results will be developed which will provide information on the CNS plate material, and will be directly applicable to the CNS surveillance program;

- Several of the capsules are being irradiated in the CNS vessel, contain CNS-specific vessel materials, and will provide information directly relevant to the CNS vessel.

When tested, the SSP capsules will have been irradiated to between 5 x 10^{17} n/cm^2 (14.5 EFPY for CNS) and 2 x 10^{18} n/cm^2 (58 EFPY for CNS) which bounds the end-of-life (EOL) fluence for the CNS vessel of 1.1 x 10^{18} n/cm^2. Thus the results of the SSP are complementary to the CNS surveillance program such that extension of the current capsule withdrawal schedule will have minimal impact on the understanding of irradiation effects on the CNS vessel.

As discussed above, the measured irradiation effects, as reflected in the Adjusted Reference Temperature (ART), are used to update the PT curves as required. The ART is used to calculate the reference fracture toughness (K_{IR}) as required in accordance with 10 CFR 50 Appendix G. The K_{IR} correlation was developed from several sets of material data on pressure vessel steel and the K_{IR} curve drawn to bound the available data. Thus, the correlation has inherent conservatism. In addition, K_{IR} is conservative relative to crack initiation fracture toughness (K_{IC}) by approximately a factor of two for the vessel hydrotest, which is the most significant

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14. As discussed in GE Report GE-NE-523-159-1292, the reactor vessel plate material remains the limiting beltline material through 22 EFPY, based on conservative predictions.

low temperature, high pressure event for the BWR beltline. The hydrotest is the most significant because during other operating conditions, the vessel conditions follow the steam saturation curve, thereby keeping operating temperatures well in excess of the minimum required P-T curve temperature. Therefore, given the inherent conservatism of the P-T curve calculation and the plant specific data used to generate the current P-T curves, the current surveillance capsule withdrawal schedule can and should be modified.

IV. CONCLUSION

As discussed above, the original capsule withdrawal schedule was accelerated because of apparent anomalous radiation effects. However, subsequent testing has shown that CNS vessel materials are behaving consistent with RG 1.99 Revision 2 predictions. The first two surveillance capsules were used to identify potential anomalous effects early in plant life. The third capsule should therefore, be used to monitor the longer term effects of irradiation. Therefore, the District requests deferral of the withdrawal of the third capsule to 22 EFPY.

Correspondence No: NLS960232

The following table identifies those actions committed to by the District in this document. Any other actions discussed in the submittal represent intended or planned actions by the District. They are described to the NRC for the NRC's information and are not regulatory commitments. Please notify the Licensing Manager at Cooper Nuclear Station of any questions regarding this document or any associated regulatory commitments.

COMMITMENT	COMMITTED DATE OR OUTAGE
None	