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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

OF AN AMENDED RESPONSE TO GENERIC LETTER 94-03

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

WPPSS NUCLEAR PROJECT NO. 2

DOCKET NO. 50-397

1.0 INTRODUCTION

By letter dated January 15, 1996, as supplemented by letters dated February 20, 1996, and March 14, 1996, the licensee stated its intention to modify their commitment, provided in their August 24, 1994, response to Generic Letter (GL) 94-03, to perform a followup inspection of the accessible circumferential stainless steel core shroud welds during the Spring 1996 refueling outage. The licensee stated their intention was to defer the inspection until the Spring 1998 refueling outage.

2.0 BACKGROUND

On July 25, 1994, the NRC issued Generic Letter 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors." The NRC staff requested in GL 94-03 that licensees take the following actions (1) inspect their core shrouds in their BWR plants no later than the next refueling outage; (2) perform materials related and plant specific consequence safety analyses with respect to their core shrouds; (3) develop core shroud inspection plans which address inspection of all core shroud welds and which takes into account the latest available inspection technology; (4) develop plans for evaluation and/or repair of their core shrouds; and (5) work closely with the BWR Owners Group with respect to addressing intergranular stress corrosion cracking of BWR internals.

GL 94-03 requested that licensees submit (1) a schedule for inspection of their core shrouds; (2) a safety analysis, including a plant specific safety analysis as appropriate, which supports continued operation of the facility until inspections are conducted; (3) a drawing(s) of the core shroud configurations; and (4) a history of shroud inspections completed to date. The GL also requested that licensees submit, no later than 3 months prior to performing their core shroud inspections, their scope for inspection of their core shrouds and their plans for evaluating and/or repairing their core shrouds based on their inspection results. The GL further requested licensees to submit their core shroud inspection results within 30 days of completing their shroud examinations.

On August 24, 1994, in its original response to Generic Letter 94-03, the licensee stated that a follow-up inspection of the accessible circumferential stainless steel core shroud welds would be performed during the Spring 1996 (R-11) refueling outage. In its letter of January 15, 1996, the licensee amended its response stating that additional inspection of the shroud would be deferred until the Spring 1998 (R-13) refueling outage.

3.0 DISCUSSION

The licensee stated that it is changing its commitment based on the following:

> This core shroud inspection rescheduling is supported by BWR inspection results for domestic BWR 5/6 plants, previous WNP-2 (BWR-5) core shroud inspections, low carbon stainless steel materials and the WNP-2 water chemistry history. Limited UT inspections performed on two other BWR 5/6 core shrouds of the same vintage as WNP-2 have revealed no cracking. WNP-2 performed a limited inspection during the Spring 1994 (R-9) refueling outage and found no cracking.
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> Since its inception of power operation, WNP-2 water conductivity has averaged below the BWR Water Chemistry Guidelines Action Level 1 value of 0.30 microS/cm. The average conductivity for the first five operating cycles at WNP-2 was 0.242 microS/cm as reported and the average conductivity for the second five cycles was 0.176 microS/cm.
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> WNP-2 has a low residual 304L stainless steel core shroud which was fabricated and installed at the vessel manufacturer's shop as opposed to being installed in the field.
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> Actual carbon contents of the plates ranged from 0.010 to 0.024%--well below the 0.030% maximum permitted. The certified material test reports also showed very low sulfur and phosphorus levels, indicative of clean steel... Also of importance are records showing that all plates were solution annealed and water quenched.
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> CBIN used welded plate rings in the core shroud assembly. These rings were joined to shell sections using double bevel weld designs. This design (compared to Brunswick's single bevel) reduces the residual stress in the surface of the ring segment (and) the resulting joint area is smaller... Again this is favorable from a residual stress standpoint.
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> Based on our water chemistry history, and the core shroud materials/fabrication history data and industry experience, the susceptibility of the WNP-2 core shroud to intergranular stress corrosion cracking (IGSCC) would be expected to be low. This was confirmed by the results of the WNP-2 ultrasonic inspection of the H-3 weld (high fabrication stress) and the H-4 weld (high fluence) during the R-9 refueling outage, in which no evidence of surface or volumetric cracking was identified.

IGSCC is unlikely in plants with less than 9.5 on-line years, although plants where significant core shroud cracking has been identified are generally those where stringent water chemistry requirements have not been adhered to throughout the life of the plant. Since the susceptibility of the WNP-2 core shroud welds to IGSCC is low from the viewpoints of material properties and water chemistry, the value of 9.5 years is taken as the threshold at which IGSCC might be expected to be first detectable at WNP-2. WNP-2 will be approximately 8.6 on-line years at the Spring 1996 (R11) outage, 9.4 on-line years at the Spring 1997 (R-12) outage, and 10.2 on-line years at the Spring 1998 (R-13) outage.

Because the Spring 1994 (R-9) outage inspection of the welds identified no cracking of the most susceptible welds, and the average water conductivity has been below the BWR Water Chemistry Guidelines Action Level throughout plant life, thereby limiting the driving force for IGSCC, significant cracking is not expected in either the welds inspected during the R-9 outage or in the less susceptible welds.

The Supply System has concluded that continued safe operation of WNP-2 through the Spring 1998 (R-13) outage will occur without additional core shroud inspections. This conclusion is based on: 1) results of the core shroud inspections performed at WNP-2 and other domestic BWR 5/6 plants, 2) 304L metal used for shroud fabrication, 3) core shroud fabrication and installation technique, 4) plant water chemistry history, 5) low susceptibility to significant cracking, 6) low projected crack propagation rates, and 7) training provided to the operations personnel.

In its letter of February 20, 1996, the licensee submitted information about the margin of safety of the core shroud with respect to IGSCC. The licensee stated that it bounded the depth of hypothetical core shroud cracks at 0.4 inches as of outage R-11 (Spring 1996). The licensee stated:

That amount of cracking would be approximately 20% of the full 360 degree flaw depth that would (be considered) as being the limit at which the core shroud's structural margin would remain available. This bounding evaluation was conservative in that it postulated crack initiation immediately after the partial inspection performed during the R-9 outage.

The UT inspection performed during the R-9 outage of 35% of the H3 and 18% of the H4 weld ligaments showed no indications of weld cracking. Therefore this supplemental evaluation assumes, as before, that cracking began after the R-9 outage which would be approximately 40 hot operation months previous to the R-13 outage scheduled to occur in the Spring of 1998...The data would indicate a hypothetical crack depth of approximately one inch if the 40 month hot operation period between the R-9 and R-13 outages were considered.

An alternate approach for projecting a crack depth involves consideration of hypothetical crack growth rates over the same 40 month period used above. If a crack initiated in 1994 after the R-9 outage, the depth would be approximately 1.44 inches at the Spring 1998 R-13 outage based on continual growth over the 40 month hot operation period at the 5 x 10exp(-5) inches/hour rate.

The core structural margins are maintained for 360 degree cracking with average crack depths up to 90% of shroud thickness. The WNP-2 shroud has a nominal 2.0 inch thickness; the limiting tolerable crack depth would be 1.80 inches. Since the evaluation indicates that the maximum hypothetical worst case crack depth projected at R-13 would be approximately 1.44 inches, significant structural margin would remain in the Spring of 1998 at the R-13 outage.

4.0 EVALUATION

The licensee's inspection plan deviates from the staff approved guidance developed by the industry for core shroud inspections and defined in the BWR Core Shroud Inspection and Flaw Evaluation Guidelines, GENE-523-113-0894, Revision 1, dated March 1995, prepared by GE Nuclear Energy for the BWR Vessel and Internals Project. According to the guidelines, WNP-2 would be newly classified as a Category B plant because it will have just completed 8 years of operation. Category B plants, according to the guidelines are:

> Plants with 304L shroud material with hot operating time of 8 years or more but with average conductivity for the first five fuel cycles at or below the BWR Water Chemistry Guidelines Action Level 1 value of 0.30 microS/cm. A Category B plant has some limited but low potential for shroud cracking. In general, Category B plants have exceeded the initial screen for operating time, but are significantly less susceptible to cracking than Category C plants. This is due to better-than-average water chemistry (early conductivity averaging 0.3 microS/cm or less) and the use of low carbon materials in fabrication. The welds chosen for inspection are those representative of each region of the shroud where significant cracking has been seen to date, namely H3, H4, and H5. In addition, H7 is included due to its unique combination of a bimetallic weld.

As a Category B plant, WNP-2 is expected to have some limited, but low susceptibility to cracking. Postponing the inspections originally committed would not affect safety based on the low susceptibility of the plant's core shroud welds to cracking as well as on plant specific considerations described below:

- UT inspections performed at WNP-2 of the most susceptible welds found no evidence of cracking. Moreover, results of more extensive inspections of similar plants (BWR Models 5/6s classified as Category B plants) showed minor or no cracking.

- The core shroud materials and fabrication also indicated low susceptibility to cracking. Favorable factors are the low carbon and residual contents and the use of a double bevel weld that reduces residual stess.

- The water conductivity was significantly better (averaging 0.176 microS/cm for the second five cycles) than the 0.30 microS/cm that is considered better than average in the industry guidelines. Laboratory data has shown that the lower the conductivity, the lower the likelihood of cracking.

- The licensee's crack growth analyses showed that a sufficient margin of safety exists for the shroud under various crack growth scenarios. Its evaluation showed that the worst case crack depth would be about 1.4 inches, which is less than the limiting tolerable crack depth of 1.80 inches.

4.0 CONCLUSION

On the basis of the above discussion, the staff concludes that the licensee's plan to inspect the WNP-2 core shroud welds during the Spring 1998 outage is acceptable.

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Date: April 18, 1996