Dominion Nuclear Connecticut, Inc.
Millstone Power Station
Rope Ferry Road
Waterford, CT 06385

Dominion

MAR 19 2002

Docket No. 50-336
B18616

RE: 10 CFR 50.55a(a)(3)(i)
10 CFR 50.55a(g)(5)(iii)
10 CFR 50.55a(g)(4)(iv)

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station, Unit No. 2
ASME Section XI Request (RR-89-34, Revision 1), Use of Alternative to Weld Repair Requirements and Relief Request (RR-89-36), Characterization and Successive Examinations of Remaining Flaws in Reactor Vessel Head Penetrations
(TAC No. MB 4223)
Response to Request for Additional Information

On March 13, 2002,[1] Dominion Nuclear Connecticut, Inc. (DNC), submitted additional information requested by the Nuclear Regulatory Commission (NRC) in regards to a relief request, dated February 25, 2002,[2] on the use of alternatives to weld repair requirements for the repair of Millstone Unit No. 2 reactor vessel head penetrations. Following review, the NRC supplied DNC with a request for additional information on March 15, 2002,[3] for discussion during a telephone conference call held on March 18, 2002. Included as Attachment 1 are the DNC responses to the questions discussed during the conference call.

---

(1) J. Alan Price letter to U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 2, ASME Section XI Request (RR-89-34, Revision 1), Use of Alternative to Weld Repair Requirements and Relief Request (RR-89-36), Characterization and Successive Examinations of Remaining Flaws in Reactor Vessel Head Penetrations (TAC No. MB 4223)," dated March 13, 2002.

(2) J. Alan Price letter to U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 2, Request to Use an Alternative to ASME Code Section XI Repair Welding Requirements by Employing Temper Bead Techniques," dated February 25, 2002.

(3) D. Starkey, U.S. Nuclear Regulatory Commission, facsimile to R. Joshi, "Follow Up NED Questions on Millstone 2 Response to NRC's Request for Additional Information Submittal, dated March 13, 2002," dated March 15, 2002.

A047

There are no regulatory commitments contained within this letter.

Should there be any additional questions regarding this submittal, please contact Mr. Ravi G. Joshi at (860) 440-2080.

Very truly yours,

DOMINION NUCLEAR CONNECTICUT, INC.

J. Alan Price
Site Vice President - Millstone

Attachments (1)

cc: H. J. Miller, Region I Administrator
R. B. Ennis, NRC Senior Project Manager, Millstone Unit No. 2
NRC Senior Resident Inspector, Millstone Unit No. 2

Docket No. 50-336
B18616

Attachment 1

Millstone Nuclear Power Station, Unit No. 2

Response to RAI Questions

Millstone Nuclear Power Station, Unit No. 2
Response to RAI Questions

Question 1

1. NB-4622.11 states "Whenever PWHT is impractical or impossible, limited weld repairs to dissimilar metal welds ... may be made without PWHT ...

Question 1. The licensee needs to discuss the impracticality or impossibility of meeting this Code requirement. For example, if radiation exposure is the reason for impracticality or impossibility, the licensee should provide a discussion that quantitatively describes the radiation exposure differences between a Code required repair and the proposed alternative. (Note: Other plants, including both Oconee-2 and TMI-1 have performed repairs using the Framatome process on their CRDMs with PWHT)

Answer to Question 1

The repair of three control rod drive mechanism penetrations on the Millstone Unit No. 2 vessel head using the machine ambient temper bead welding process is expected to incur a total personnel exposure of about 60 man-rem or about 20 man-rem per weld.

Because of the difficulty encountered in gaining access to the surface of the head due to the design of the insulation, it is estimated that removal of insulation, placement and removal of heating blankets, and conducting the necessary heating operations would add about 25 man-rem to personnel exposure.

Additionally, true post weld heat treatment (PWHT) of these repairs would require heating of a band around each repair weld to 1100° to 1250°F. This is not possible because it would cause unacceptable distortion of the reactor vessel (RV) head and expose adjacent J-welds to PWHT temperatures for which they were not qualified. This was expressed in attachment 2, page 3, of the March 13, 2002, submittal.

Please note that the repairs at Oconee-2 and TMI-1 were performed using the manual shielded-metal arc welding (SMAW) temper bead process which requires a post weld heating at 450° to 550°F for four hours after a minimum of 3/16 inch of weld is deposited. This is commonly referred to as a Hydrogen Bake-Out.

Question 2

2. NB-4622.11(c)(6) discusses specific electrode diameters and crown removal for specific layers. Identify the electrode diameter and explain why the weld crown is not significant to this process. Include any technical data that correlates weld layer thickness (and other essential variables) with an acceptable tempered microstructure.

Answer to Question 2

The gas-tungsten arc welding (GTAW) process used for the repairs on the Millstone Unit No. 2 reactor head is fundamentally different than the SMAW process. The SMAW process uses a consumable covered electrode which is also the filler metal. Code Section NB-4622.11(c)(6) applies to the manual SMAW process and specifies electrode diameters (3/32" first layer, 1/8" second layer, $\leq$ 5/32" subsequent layers) to control the relative heat input of specific layers. Generally the larger diameters will deposit larger weld beads with higher heat inputs. The progressively larger electrode diameters are intended to produce similarly progressive increases in heat input which provide tempering of the heat affected zone (HAZ) and weld deposit from the previous layer. Unfortunately the actual parameters (i.e. voltage, travel speed, and heat input) are not readily measured and are subject to considerable variation due to the manual control inherent in the SMAW process.

Because the heat input and filler metal deposition rate can not be independently controlled in the SMAW process NB-4622.11(c)(6) specifies that the weld bead crown shall be removed by grinding before depositing the second layer. This is required because the thickness of the first layer (1/16" to 3/32") must be reduced somewhat to allow the second layer to produce full tempering of the first layer HAZ. The actual amount of weld to be removed is not exact and some other Code sections specify removal of half of the first layer rather than the weld bead crown. These measurements are subjective and imprecise and are strongly influenced by the individual performing the welding and/or grinding. Even relatively small changes in parameters controlled by the welder (i.e. arc length, travel speed, and location of each bead) when combined can have a large effect on the weld thickness, bead shape, and the amount and effectiveness of tempering imparted on previous layers.

The machine GTAW process has the following advantages over the manual SMAW process:

1. The heat input and welding deposition rate (wire feed speed) can be controlled independently and precisely so that the thickness of weld deposit is not greater than optimum. Thus the weld bead crown does not have to be removed prior to depositing the next layer to achieve optimum conditions for tempering. For our application 0.030 to 0.033 inches is typically deposited in the first layer.

2. All welding parameters are easily measured and precisely controlled by the machine. Once the parameters are set there is essentially no variation due to either the operator or the process.

3. The location of the welding head and placement of each weld bead is precisely controlled by the machine. Measurements of location are made digitally and confirmed with video cameras mounted on the welding head.

The Machine GTAW process does not rely on the less precise methods of changing electrode diameters or removal of the weld bead crown as required for the manual SMAW temper bead technique. The precise control afforded by the machine GTAW process allows the best method to produce a uniform and optimum temper bead weld repair.

Question 3

This question intentionally left blank.

Question 4

4. Attachment 2/Page 3 states that selected portions of the 1992 Edition of Section XI will be used in place of the 1989 Edition of Section XI. Attachment 2/Page 7 identifies IWA-4700 and Attachment 2/Page 14 identifies IWA-3600 as using the 1992 Edition of Section XI, hence in need of relief. However, the section on the Code requirements for which relief is requested does not address IWA-3600. A discussion relative to IWA-3600 needs to be provided.

Answer to Question 4

The section on Code requirements for which alternatives are requested should have addressed the use of IWB-3600 from the 1992 Edition of Section XI with a discussion of how it was going to be used. A discussion relative to the requirements of NB-5330 and the use of IWB-3600 is provided below:

- The final liquid penetrant and ultrasonic examination of the repair weld will be performed in accordance with the acceptance criteria of NB-5350 and NB-5330 of Section III. If ultrasonic indications are identified from a triple point anomaly and are not acceptable in accordance with NB-5330(b) then as part of the proposed alternative the IWB-3600 flaw evaluation criteria of the 1992 Edition of Section XI reference (4) will be used.

Question 5

5. Attachment 2/Page 14 and 23 state that there is a potential for a crack to occur at the triple point and that this crack will be evaluated according to IWA-3600. From the description in the submittal, this defect is not well understood and is indeterminate. In the absence of additional technical information on this condition, the staff is unable to determine the safety significance of this defect. Therefore, this item in the submittal will not be evaluated. In the event that cracking is identified at the triple point, a separated request for relief for NB-5330(b) will have to be submitted. The staff will not approve relief from this Code requirement before the condition is shown to have occurred.

Answer to Question 5

After completion of the ultrasonic examination of the temper bead repair welds with no recordable indications detected, the request for relief from NB-5330 is not applicable and is therefore withdrawn.

Question 6

6. Attachment 2/Page 23 states the phrase "to the maximum practical extent." This phrase lacks specificity. Identify the total volume percent (defined by your submittal) of Figures 4a through 4e that will be examined (i.e. what percent of the base metal HAZ will not be examined)

Answer to Question 6

The applicable volume percent of the HAZ region volumetrically examined in Figures 4a through 4e are 100%, 89.4%, 89.4%, 70.8% and 70.8%, respectively. It should be noted that while each of the 45 degree UT beams independently achieve 89.4% coverage of the HAZ, together they represent 100% coverage due to one upward and one downward beam. The same can be said for the 70 degree UT beam which independently achieve 70.8% coverage.

Question 7

7. Attachment 2/Page 15 presents a discussion on the corrosion of the carbon steel base metal. Discuss the effects that the findings of the cavity in the RPV head at Davis Besse will affect your discussion. Explain why cracks left exposed to the primary water environment will not create a similar condition like Davis Besse's RPV head.

Answer to Question 7

The findings at Davis Besse have minimal bearing on the reactor vessel penetration repairs being done at Millstone Unit No. 2. The conditions that appear to have been present in the Davis Besse reactor vessel head and those that would be present in a repaired nozzle penetration in the Millstone Unit No. 2 reactor vessel head are significantly different. The exposed carbon steel adjacent to a repaired nozzle at Millstone Unit No. 2 will be exposed to stagnant primary coolant which has a very low oxygen content. The carbon steel in the Davis Besse reactor vessel head would have been exposed to flowing conditions and an increasing concentration of boric acid as the water changed to steam and left the head. The velocity of the steam leaving the head would also tend to increase the corrosion rate. The oxygen content would also tend to be increasing as the cavity increased in size and became more open to the surface.

The Boric Acid Corrosion Guide Book from EPRI, TR-104748, is an excellent source of data on boric acid corrosion for a variety of conditions. The corrosion rate of boric acid solutions is strongly dependant upon temperature and the amount of oxygen that is present. The corrosion rate of deoxygenated boric acid solutions typical of PWR water are around .001"/year or less at temperatures up to 590°F. Much of this data was generated as a result of finding breaches in the cladding at a domestic plant in 1965. An extensive testing program found that the corrosion rates were very low. The data also shows that the corrosion rate was lower for longer tests. Hence the corrosion rate for the repaired nozzle at Millstone Unit No. 2 would be expected to be even less than the number above. Any crack in the exposed carbon steel would only be expected to grow at the general corrosion rate of less than .001"/year.

The situation with the cracked control rod drive mechanism (CRDM) nozzle at Davis Besse has many similarities with the geometry presented by a leaking flange. In both cases the leakage is very small, less than one gallon per minute, and the coolant will immediately flash to steam because of the large pressure drop. Although all CEDM nozzles are shrink-fit into the head, analysis has shown that a small gap does exist at normal operating conditions. It would appear that as a portion of the gap around a CEDM nozzle becomes larger due to corrosion, the area can be considered an oxygenated environment with a subsequent dramatic increase in the corrosion rate. The corrosion rate of aerated boric acid solutions has been shown to be much higher than the non-aerated solutions. Corrosion rates of .007" to .024"/year have been reported for typical PWR water chemistries, but with oxygen. In testing where the concentration of the boric acid was increasing at temperatures over 212°F due to the boiling and evaporation of the water, corrosion rates of up to several inches/year have been reported. The EPRI Guidebook covers numerous instances where corrosion of up to an inch has been discovered on the fasteners of leaking joints. In these situations the concentration of the boric acid solution is increasing with time and oxygen is present. Damage to reactor coolant pump studs found at a United States plant in 1980 and 1981 reduced the diameter of a 3.5" stud to 1.5". This is in contrast to the damage from a conoseal weld in an instrument nozzle found at a different domestic plant in 1986. The unit was run with this leak for approximately 1 year which deposited 500 lbs.

of boric acid onto the vessel head. The corrosion damage to the head was limited to about .25".

Question 8

8. Attachment 3/Page 3 is requesting relief from IWB-3142.4 pertaining to the successive examination of the triple point anomaly. The staff considers this as an extension of question 5, and therefore, will not be approved prospective of the need.

Answer to Question 8

After completion of the ultrasonic examination of the temper bead repair welds with no recordable indications detected, the request for relief from NB-5330 is not applicable and is therefore withdrawn.