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Dominion®

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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 3
RESULTS OF THE REACTOR PRESSURE VESSEL HEAD INSPECTIONS REQUIRED BY NRC ORDER EA-03-009

Dominion Nuclear Connecticut, Inc. (DNC) hereby provides as Enclosure 1 the results of inspections performed in accordance with U.S. Nuclear Regulatory Commission (NRC) Order EA-03-009, "Issuance of First Revised NRC Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated February 20, 2004.

If you have any questions regarding this submittal, please contact Mr. David W. Dodson at (860) 447-1791, extension 2346.

Very truly yours,

J. Alan Price
Site Vice President – Millstone

Commitments in this letter: None

Enclosure: (1)

A101

NRR

cc: U.S. Nuclear Regulatory Commission
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Mr. R. I. Treadway
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STATE OF CONNECTICUT)
)
COUNTY OF NEW LONDON)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by J. Alan Price, who is Site Vice President – Millstone, of Dominion Nuclear Connecticut, Inc. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 13 day of July, 2007.

My Commission Expires: DIANE M PHILLIPO NOTARY PUBLIC MY COMMISION EXPIRES 12/31/2010 ← 12/31/2010

Diane M. Phillipo

Notary Public

State of Connecticut
New London County

(SEAL)

ENCLOSURE 1

RESULTS OF THE REACTOR PRESSURE VESSEL HEAD INSPECTIONS REQUIRED BY NRC ORDER EA-03-009

DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 3

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1.0 SUMMARY:

The results of inspections performed to meet the requirements of U.S. Nuclear Regulatory Commission (NRC) Order EA-03-009, "Issuance of First Revised NRC Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated February 20, 2004, are provided in this enclosure. The inspections were conducted for Millstone Power Station Unit 3 (MPS3) during the spring refueling outage for operating cycle 11 (3R11). MPS3 returned to operation following 3R11 on May 17, 2007.

Dominion Nuclear Connecticut, Inc. (DNC) has concluded that the reactor pressure vessel (RPV) head penetration nozzles are not degraded and there has been no wastage of the RPV head (vessel head). Based on the degradation free inspection results, low head temperature, and operating schedule, DNC will continue to follow a Low Susceptibility category to primary water stress corrosion cracking for the future inspection frequencies.

2.0 NRC REQUIRED INFORMATION:

NRC Order EA-03-009 [the Order] requires that, for each inspection required in Section IV.C of the Order, the Licensee shall submit a report detailing the inspection results within 60 days after returning the plant to operation. For each inspection required in Section IV.D of the Order, the Licensee shall submit a report detailing the inspection results within 60 days after returning the plant to operation if a leak or boron deposit was found during the inspection.

3.0 INSPECTIONS REQUIRED BY THE ORDER:

The MPS3 vessel head is in the Low Susceptibility category of the Order, for plants with less than 8 effective degradation years (EDY) and no previous inspection findings requiring a classification in the High Susceptibility category. The MPS3 vessel head has accrued 2.72 EDY at the end of operating cycle 11. The Order has inspection requirements involving visual and nonvisual nondestructive examinations (NDE).

3.1 Visual Inspection Requirements - IV.C (5)(a) and IV.D of the Order:

3.1.1 Section IV.C (5)(a) of the Order:

Requirements of Section IV.C (5)(a) include a bare metal visual examination of 100% of the vessel head surface (including 360°

around each of its penetration nozzles). This bare metal visual examination for a Low Susceptibility category must be completed at least every third refueling outage or every five (5) years, whichever occurs first.

3.1.2 Section IV.D of the Order:

During each refueling outage, the Order requires visual inspections be performed to identify potential boric acid leaks from pressure-retaining components above the vessel head. For any boron deposits on the surface of the vessel head or related insulation, discovered either during the inspections required by this Order or otherwise and regardless of the source of the deposit, before returning the plant to operation DNC shall perform inspections of the affected vessel head surface and penetrations appropriate to the conditions found to verify the integrity of the affected area and penetrations.

3.2 Nonvisual NDE Inspection Requirements – IV.C (5)(b) of the Order:

Requirements of Section IV.C (5)(b) include a nonvisual nondestructive examination (NDE) with ultrasonic testing, eddy current testing/dye penetrant, or a combination of the techniques. The requirements of Section IV.C (5)(b) were modified for MPS3, as described in NRC correspondence dated May 2, 2007.(1) Therein, the NRC approved a modified inspection plan for five penetrations that have the least nozzle material extending below the J-groove weld in the MPS3 vessel head, (nozzles 74 through 78). The Low Susceptiblity category, requires this nonvisual NDE be completed at least once prior to February 11, 2008, and thereafter, at least every four (4) refueling outages or every seven (7) years, whichever occurs first.

4.0 INSPECTION RESULTS:

The inspection results involving visual and nonvisual nondestructive examinations (NDE) are provided herein.

4.1 Visual Inspection Results - IV.C (5)(a) and IV.D of the Order:

During 3R11, DNC performed a visual inspection of pressure-retaining components above the RPV head (vessel head). Leakage was detected at the greylock coupling of penetration 26 for a heated junction thermocouple

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(1) NRC letter approval, "Millstone Power Station, Unit No. 3 - Request for Relaxation of the Requirements of Order EA-03-009 Regarding Reactor Pressure Vessel Head Inspections (TAC NO. MD1735)," May 2, 2007 (ADAMS Accession No. ML070790231).

(HJTC) probe. The HJTC was removed and reinstalled and parts of the greylock clamp were inspected for damage. No boron deposits were observed on the surface of the vessel head.

The required bare metal visual examination of the Order was performed on 100% of the vessel head surface (including 360° around each vessel head penetration nozzle). No evidence of boric acid leakage or vessel head degradation was detected.

Qualified VT-2 examiners were used to perform the visual examination of the vessel head. The VT-2 examiners were certified in the VT-2 examination method, according to the guidelines of ASNT Recommended Practice CP-189 (1991), with additional experience in detecting control rod drive mechanism (CRDM) leakage.

4.2 Nonvisual, NDE Inspection Results - Section IV.C (5)(b):

During 3R11, DNC performed the nonvisual, NDE inspections required under Section IV.C (5)(b) of the Order, as modified by the NRC in its May 2, 2007 letter. The inspection, using the modified requirements of the May 2, 2007 NRC letter, achieved its required coverage on each penetration in the vessel head which includes the 78 penetrations used for control rod drive mechanism (CRDM) nozzles and the one penetration used for the vessel head vent line nozzle. An ultrasonic examination was performed on each of the vessel head penetration nozzles and an eddy current examination was performed on the vent line J-Groove weld. There were no indications of leak paths identified in vessel head penetrations and there were no recordable indications of detectable degradation. A wear pattern was detected on the inside surface on some CRDM nozzles from thermal sleeve centering tabs. DNC evaluated the wear pattern detected during 3R11 and concluded the wear was acceptable. Additional details surrounding the DNC examinations into the wear pattern are discussed in Appendix A to this enclosure.

APPENDIX A

DETAILS FROM THERMAL SLEEVE CENTERING TAB WEAR PATTERN EXAMINATIONS

1.0 SUMMARY:

During the course of the nonvisual NDE inspections, incomplete ultrasonic coverage was initially obtained on nine of the 78 nozzles (nozzles 1 through 9) above their welds. Considering the results of examinations described in the balance of this attachment, DNC concluded the data was consistent with thermal sleeve centering tab wear patterns. Examination results show that the wear pattern at some nozzles can reasonably be described as a 360-degree area. A thermal sleeve has three (3) centering tabs (120 degrees apart). Consequently, DNC concludes that the wear is caused by the rotation of the thermal sleeves due to their relatively "loose fit" inside penetration nozzles, the flexible cantilevered configuration, and normal fluid turbulence in the upper head area. The wear, which is geometrically limited to the original thickness of the tabs, is considered to be minor and was found to be acceptable based on review of the existing Code analysis.

2.0 WEAR PATTERN EXAMINATIONS:

Ultrasonic examinations of nozzles with wear patterns included an axial blade probe (ABP) and a circumferential blade probe (CBP). Eddy current examinations were also performed to further characterize the wear pattern on seven of the affected nozzles. The details of these examinations are discussed in the balance of this section.

2.1 Axial Blade Probe (ABP) Examination of Wear Pattern:

An axial blade probe (ABP) was the primary probe design for ultrasonic examination of vessel head penetration nozzles. The ABP consists of separate 5MHz transducer elements operated in a pitch-catch configuration. The elements of the probe are oriented circumferentially with respect to the nozzle being examined.

The ABP failed to achieve complete ultrasonic coverage in nine of the 78 CRDM nozzles, (nozzles 1 through 9). The area where incomplete coverage was obtained is consistent with the location of the thermal sleeve centering tabs. Analysis of the ultrasonic data indicated that the surface of the nozzle was diverting away from the transducer elements just prior to the loss of coverage. Since wear was also observed on the thermal sleeves in a circumferential area on the same lateral plane as the end of the nozzles, DNC concluded that the centering tabs had worn away some of the nozzle material inside surface, creating a surface irregularity that prevented the ultrasonic transducer elements of an ABP from coupling with the nozzles.

There are lower centering tabs located at 42 inches above the bottom of the thermal sleeve and upper tabs that are located 15.5 inches above the lower centering tabs. Three tabs 0.1075 inches thick, 0.75 inches wide and 0.56 inches long at 120-degree increments are located at each location. These tabs are a 304 stainless material welded full height about the perimeter.

Since the penetration nozzles extend approximately 3.25 inches below the head, and the thermal sleeves are all of the same length, the location of the centering tabs in reference to the bottom of the penetration nozzle vary depending on the nozzle location. Due to the limitation of the length of the probe and the fact that the centering tabs are located higher above the bottom of the nozzle as the distance from the center of the head increases, additional examinations of the nozzle to centering tab contact location beyond the center nine nozzles could not be obtained.

Although data on the additional penetration nozzles could not be obtained at the lower centering tab locations, DNC can reasonably expect that similar wear patterns are present for all nozzles that contain a thermal sleeve. (Note that no data was obtained at the upper centering tabs of any nozzles due to probe length restrictions.) The ABP results are shown in Table 1 on the next page.

2.2 Circumferential Blade Probe (CBP) Examination of Wear Pattern:

A circumferential blade probe (CBP) was used on the nine nozzles to obtain the required volumetric coverage and assess the material for discontinuities. The CBP has transducer elements oriented in the axial direction with respect to the nozzle, and thus allowed the transducers to be coupled on either side of the surface irregularities. With the transducer elements oriented axially, the CBP bridged the 'gap' created by the material loss in the wear patterns and provided the necessary coverage by successfully transmitting and receiving the lateral (surface wave) and back-wall (angle beam) signals.

Table 1: Areas Affected by Surface Irregularities (Wear) on Penetration Nozzles With the use of an Axial Blade Probe (Note 1)

Penetration Number	Axial Start	Axial Stop	Total Axial Extent	Circ Start	Circ Stop	Total Circumferential Extent
	Inches (Note 2)			Degrees (Note 3)		
1 (Note 4)	3.46	4.05	0.59	0 313	217 360	264
2	5.76	6.13	0.37	139	360	221
3	5.77	6.18	0.41	108	330	222
4	5.51	5.95	0.44	0 165	90 360	285
5	5.80	6.25	0.45	146	318	172
6	7.62	8.03	0.41	190	290	100
7	7.62	8.10	0.48	45	360	315
8	7.62	7.99	0.37	0 123	35 360	277
9	7.58	8.02	0.44	109	311	202

Notes:

1. Wear regions were observed 360° circumferentially with minimal interruption to ultrasonic response. Only areas of ultrasonic interruption are noted on this table. Measurements on this table were taken with the COAF (Axial) blade probe.
2. Axial Start is defined as the lowest axial position in the penetration where the wear region is detected ultrasonically. Axial Stop is defined as the highest axial position in the penetration where the wear region is detected ultrasonically. Total Axial Extent is defined as the Axial Stop minus the Axial Start.
3. Circ Start is defined as the circumferential position where the wear is first detected ultrasonically, where 0° is defined as the lowest axial position of the J-Groove weld. Circ Stop is defined as the circumferential position where the wear is last detected ultrasonically, where 0° is defined as the lowest axial position of the J-Groove weld. Total Circumferential Extent is defined as the Circ Stop minus the Circ Start.
4. For Penetration 1, the circumferential 0° is defined as probe position directly towards Penetration 4.

2.3 Eddy Current Examination of Wear Pattern:

In addition to the ultrasonic data collected, an eddy current examination was performed on seven of the nine nozzles with recorded surface irregularities before the wear pattern was concluded to be of limited depth, (refer to Section 3.0). The eddy current examination provided additional quantitative and qualitative information. The surface irregularities interrogated with eddy current were between 0.025 and 0.015 inches deep, with no indications of crack like discontinuities or abrupt (sharp) geometry changes. The eddy current examination detected the depths that are shown in Table 2.

Table 2: Depth of Nozzle Wear as Measured With Eddy Current Examinations

Nozzle Number	Maximum Depth (mil)
2	0.023
3	0.015
5	0.015
6	0.025
7	0.016
8	0.015
9	0.022

3.0 Assessment of Wear Pattern Examinations:

The wear, which is geometrically limited to the original thickness of the tabs, is considered to be minor and was found to be acceptable based on review of the existing Code analysis. DNC conservatively assumes that wear could have a depth equal to the original design thickness of the centering tab, which is 0.1075 inches and that the material loss is a full 360 degrees. Therefore, the minimum possible thickness that remains is also much greater than the minimum wall thickness allowed, (0.625 - 0.108 = 0.517 inches, verses a Code thickness of 0.204 inches). This assumes the wear is far greater than the results of the examinations and is considered a limiting amount of wear, since the wear on the penetration nozzle could not become greater than the thickness of the centering pad.

The examinations did not detect indications of crack like discontinuities or abrupt geometry changes, which would lead to more detailed analysis or consideration of stress concentration areas. Conservatively considering that a worst-case wear pattern could increase longitudinal bending stresses by 13%, a considerable margin would remain to the allowable in a stress analysis. Since the fatigue evaluation considers only the J-groove weld location significant from a fatigue standpoint, additional fatigue evaluation would not be required in the wear area of the nozzle.