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Dominion®

January 20, 2009

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Serial No.	08-0736
NLOS/GAW	R0
Docket No.	50-336
License No.	DPR-65

DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 2
10 CFR 50.55a RELIEF REQUEST RR-89-65 and 89-66; TEMPORARY NON-CODE REPAIR, CLASS 3 SERVICE WATER SYSTEM EMERGENCY DIESEL GENERATOR JACKET WATER HEAT EXCHANGER X-45A AND AIR COOLER HEAT EXCHANGER X-83B

Dominion Nuclear Connecticut, Inc. (DNC) requests relief from the Section XI requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, pursuant to 10 CFR 50.55a(g)(5)(iii). This request is based upon the impracticality of performing required ASME code repair/replacement activities to the Millstone Power Station Unit 2 (MPS2) "A" Emergency Diesel Generator (EDG) Jacket Water Heat Exchanger outlet channel head X-45A and MPS2 "B" Emergency Diesel Generator (EDG) Air Cooler Heat Exchanger inlet channel head X-83B. Attachment 1 to this letter describes the temporary compensatory actions taken by DNC and the basis for the proposed request for X-45A. Attachment 2 describes the temporary compensatory actions taken by DNC and the basis for the proposed request for X-83B. A permanent code replacement for the identified channel heads eliminating the flaw will be completed no later than the end of the next refueling outage currently scheduled for the fall 2009.

If you have any questions regarding this submittal, please contact Geoffrey A. Wertz at (804) 273-3572.

Sincerely,

J. Alan Price
Vice President – Nuclear Engineering

Attachment 1: Relief Request RR-89-65, Temporary Non-Code Repair Class 3 Service Water System Emergency Diesel Generator Jacket Water Heat Exchanger X-45A

Attachment 2: Relief Request RR-89-66, Temporary Non-Code Repair Class 3 Service Water System Emergency Diesel Generator Air Cooler Heat Exchanger X-83B

Commitments made in this letter: None

cc: U.S. Nuclear Regulatory Commission
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NRC Senior Resident Inspector
Millstone Power Station

ATTACHMENT 1

RELIEF REQUEST RR-89-65, TEMPORARY NON-CODE REPAIR CLASS 3 SERVICE WATER SYSTEM EMERGENCY DIESEL GENERATOR JACKET WATER HEAT EXCHANGER X-45A

MILLSTONE POWER STATION UNIT 2
DOMINION NUCLEAR CONNECTICUT, INC.

ATTACHMENT 1

RELIEF REQUEST RR-89-65, TEMPORARY NON-CODE REPAIR CLASS 3 SERVICE WATER SYSTEM EMERGENCY DIESEL GENERATOR JACKET WATER HEAT EXCHANGER X-45A

CONTENTS

ENCLOSURE 1

Typical Sketches of Millstone Power Station Unit 2, Emergency Diesel Generator Jacket Water Heat Exchanger X-45A and Channel Head Flaw Area

ENCLOSURE 2

ACRONYMS

1. ASME – American Society of Mechanical Engineers
2. ASTM – American Society for Testing and Materials
3. AWO – Automated Work Order
4. CFR – Code Of Federal Regulations
5. CR – Condition Report
6. DNC – Dominion Nuclear Connecticut, Inc.
7. EDG – Emergency Diesel Generator
8. ERC – Engineering Record of Correspondence
9. GL – Generic Letter
10. gpm – gallons per minute
11. ISI – Inservice Inspection
12. LCO – Limiting Condition for Operation
13. MPS2 – Millstone Power Station Unit 2
14. NDE – Nondestructive Examination
15. NRC – U. S. Nuclear Regulatory Commission
16. P&ID – Piping and Instrumentation Diagram
17. psig – pounds per square inch gauge
18. RT – Radiographic Test
19. SW – Service Water
20. TE – Technical Evaluation
21. TRM – Technical Requirements Manual
22. UT – Ultrasonic Test

RELIEF REQUEST RR-89-65, TEMPORARY NON-CODE REPAIR CLASS 3 SERVICE WATER SYSTEM EMERGENCY DIESEL GENERATOR JACKET WATER HEAT EXCHANGER X-45A

Relief Request
In Accordance with 10 CFR 50.55a(g)(5)(iii)

- Code Repair/Replacement Impracticality -

1.0 ASME CODE COMPONENT(S) AFFECTED

On November 6, 2008, Operations personnel identified a corrosion product buildup on the ASME Class 3 Service Water (SW) outlet channel head of the Millstone Power Station Unit 2 (MPS2) "A" Emergency Diesel Generator (EDG) Jacket Water Heat Exchanger, X-45A. Following removal of the buildup, normal system pressure was applied. One localized area (<1" in diameter) was observed to have wetness, with an estimated leakage rate at 1 drop per 15 minutes. Visual observation did not identify any specific external defect in this localized area. The wetness was observed on the neck of the 6" diameter flanged outlet nozzle connected to the outlet piping.

Based on the results of Ultrasonic Test (UT) and Radiographic Test (RT) examinations, and external surface direct visual examinations as described above, the leak is assessed to be associated with a small casting defect indicated by the presence of a rounded indication (< 1/16" diameter). Additionally, assessment indicates this rounded indication (<1/16" diameter) and other minor casting imperfections allowed sea water to migrate along a tortuous path to the outside surface of the channel head. The channel head is made from an aluminum bronze sand casting fabricated per ASTM B148 alloy C95400 that has been temper annealed. Temper annealing of aluminum bronze castings has been shown to reduce the susceptibility of aluminum bronzes to dealloying in seawater environments. In this application, the dealloying of the aluminum bronze casting is being managed by heat treatment.

Enclosure 1 contains a typical sketch of the EDG channel head and observed flaw area.

2.0 APPLICABLE CODE EDITION AND ADDENDA

MPS2 is currently in the third 10-year inservice inspection (ISI) interval, which started on April 1, 1999. The 1989 Edition of Section XI with No Addenda (Reference 8.1) applies to the ISI program. The 1998 Edition of Section XI with No Addenda[(1)] (Reference 8.2) is used as the primary ASME Code Edition for

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(1) NRC letter, "Millstone Power Station, Unit Nos. 2 and 3 RE: Request to Use 1998 Edition, with No Addenda, of ASME Section XI for Repair/Replacement Activities (TAC Nos. MC7347 and MC7348)," dated September 13, 2005, (ADAMS Accession No. ML052210033).

Section XI repair/replacement activities. This Temporary Non-Code Repair of the leaking channel head is not in compliance with ASME Section XI, 1998 Edition, IWA-4000, nor does it meet the accepted analysis methods contained in NRC Generic Letter (GL) 90-05, (Reference 8.3). Additionally, the NRC approved Code Case N-513-2 (Reference 8.4) is not applicable because the flaw is in a component (the heat exchanger channel head) which is specifically excluded from the scope of the Code Case. However, for comparison purposes, a pro forma structural evaluation per the Code Case is provided in Enclosure 2.

The channel head design code was ASME Code Section VIII, Division 1, 1992 Edition with No Addenda (Reference 8.5).

3.0 APPLICABLE CODE REQUIREMENT

The ASME Code requirements for which this relief request is being submitted are those associated with Section XI, 1998 Edition, No Addenda, (Reference 8.2) and contained in Article IWA-4000, Repair/Replacement Activities.

4.0 IMPRACTICALITY OF COMPLIANCE

A Code repair (replacement or weld repair) would require isolation and draining of the SW system to the "A" EDG heat exchanger and thus would have to be implemented within a 14 day allowable outage window for the affected emergency diesel per the MPS2 Technical Specifications. A weld repair is not recommended as discussed below. Procurement of a replacement component is expected to take several months (see below).

5.0 BURDEN CAUSED BY COMPLIANCE

5.1 ***Replacement*** - Preliminary discussions with the channel head manufacturer indicated a lead time for a replacement channel head of approximately 6 months is required.

5.2 ***Weld Repair*** - Welding of the cast aluminum bronze material makes the component susceptible to accelerated dealloying of the aluminum bronze cast base material.

6.0 PROPOSED ALTERNATIVE AND BASIS FOR USE

6.1 ***Flaw Characterization and Results*** – In order to characterize the leak path and condition of the material surrounding the defect and area in which the wetness was observed, the following inspections were performed:

1. UT examination was performed under Automated Work Order (AWO) 53102205314 to determine wall thickness in the area of the leak.

2. Informational RT examination was performed under AWO 53102205321 to characterize the material condition of the leak location and surrounding metal.

<u>The following results were obtained</u>:

a) A wall thickness of 0.480" remains.
b) The RT showed
   - No lack of fusion in the weld repaired area
   - No shrinkage in the wall
   - Two (2) areas of possible minor casting weld repair from original manufacture. One weld repair area shows a rounded indication less than 1/16" diameter which is most likely part of the leak path. Both areas meet the standard casting acceptance criteria of ASME Section VIII. The density of the channel head was uniform indicating a uniform wall thickness.

Based on the results of the above inspections, the leak is most likely the result of several small pores (including the 1/16 inch indication) that linked to create a leak path from the inside to outside surface. The maximum estimated defect diameter is <1/16 inch, but for fluid leakage evaluations (see below) it has been assumed to be 1/4 inch diameter. For structural evaluation purposes, the defect is conservatively assumed to be a one inch diameter through wall defect surrounded by sound material. This larger assumed defect was chosen to provide additional assurance of the structural integrity.

As noted earlier these channel heads are made from aluminum bronze C95400. Aluminum bronze alloys are used in sea water applications because of their low general corrosion rate of 0.001 - 0.002"/year. This rate trends down with time (i.e., the rate is lower, the longer the test period). Aluminum bronzes have good resistance to erosion and their high copper content inhibits marine growth and microbiological effects. Pitting, other forms of localized corrosion or stress corrosion cracking are not of concern in a sea water environment. The operational experience at Millstone Power Station Units 2 and 3 with aluminum bronze valves and pumps has been free of any issues with pitting, other forms of localized corrosion or stress corrosion cracking.

There is one corrosion mechanism that can be an issue with castings made from aluminum bronzes including C95400. Research has shown, in sea water, the as-cast microstructure of aluminum bronzes is susceptible to dealloying where the aluminum rich phase is selectively attacked. Further research has shown a temper anneal at 1100 – 1300 degrees F greatly improves the resistance to dealloying by changing the microstructure. When these channel heads were procured, this information was known and these channel heads were temper annealed at 1200 - 1300 degrees F. With the temper anneal, the rate of dealloying will be of similar magnitude to the general corrosion rate, i.e., 0.002"/year. Therefore, the rate of corrosion between the areas of porosity which appear to have linked up to cause the leakage is very low and will take years to reach the evaluated size.

An internal visual inspection and hardness data were also taken on the B Emergency Diesel Generator Air Cooler Heat Exchanger X-83B, (ref. Attachment 2, RR-89-66), which is made of the same material and has been inservice in a similar environment for approximately the same period. As discussed in Attachment 2, the inside surface of the X-83B channel head was a uniform yellow bronze color with no areas of pink that would be indicative of dealloying. No areas of porosity were noted. The surface hardness test results for X-83B showed variability consistent with a casting. The OD measurements were harder than the ID measurements. The visual inspection results and hardness data along with the UT and RT data lead to the conclusion the amount of dealloying is limited to the near surface areas only.

6.2 ***Structural Integrity*** – Under MPS2 Technical Requirements Manual (TRM) 3.4.10, the structural integrity of an ASME component is determined in accordance with the ASME Section XI Code, approved Code Cases or regulatory approved methods of evaluation. There is no approved NRC accepted methodology for evaluating the structural integrity of this type of component (heat exchanger channel head). Therefore, the channel head (component) does not meet the structural integrity criteria of the TRM. However, the heat exchanger channel head and nozzle have cylindrical sections and are similar to piping, and the leaking location is highly localized. Additionally, this nozzle is operating at pressures of about 25 psig, much lower than its design pressure of 150 psig, and is protected from significant piping loads by an expansion joint. Therefore, the structural integrity of the component has been assessed by a pro forma application of Code Case N-513-2 structural integrity evaluation requirements (Enclosure 2). Using the branch reinforcement methodology, it shows a large margin (by a factor of about 19) between required and available reinforcement area. In addition, the measured wall thickness of 0.480 inches is much larger than the 0.022 inches required by the Code Case (a margin factor of 22)

Procedures which reflect other requirements of Code Case N-513-2 have been implemented or scheduled to ensure the defect is monitored and will not challenge the basis for operability of the heat exchanger.

Finally, to further confirm the stability of the defect over time, another RT reexamination will be performed at approximately 90 days from the last examination and (if no additional deterioration is evident) replacement no later than the end of the next refueling outage is adequate. On this basis, it is concluded the defect will remain stable under all design conditions, including seismic, and therefore has adequate structural integrity.

Thus, as demonstrated by the thickness measured during UT, the soundness of the surrounding material observed by radiography, the structural integrity evaluation and further confirmations as described above, the capability of the channel head to perform its intended function is considered to be maintained.

6.3 ***Flow Margin*** – Service water flow loss from the location of this leak will not adversely affect the ability of the SW system to provide cooling to the "A" EDG heat exchanger because the location is on the outlet channel head of the Jacket Water heat exchanger which is downstream of all three EDG heat exchangers. Accordingly, SW flow at this location has already performed its cooling function within the heat exchanger.

For the purposes of bounding the leakage rate at this location (allowing for further degradation), a through-wall hole of 1/4" diameter has been conservatively assumed. MPS2 Technical Evaluation (TE) M2-EV-08-0023 Revision 1 (Reference 8.6) was recently issued in response to a through-wall leak on the "B" EDG annubar flow element upstream of the heat exchangers. The TE calculated a flow rate through a 1/4" hole [assuming SW pressure of 25 pounds per square inch gauge (psig)] to be approximately 5.6 gallons per minute (gpm). Actual leakage would be less from the channel head leak area due to a lower operating pressure at this location (downstream of the heat exchanger). The estimated leakage flow of 5.6 gpm would have negligible impact on the overall system flow balance.

6.4 ***Spray Concerns*** – The leak is located on the south side of the 6" branch connection near the centerline of the horizontal run (approximately 9 feet above the floor). A leak would flow/spray out the hole to the south. A walk down of all components located in the assumed spray area and in the immediate vicinity was performed by System Engineering. Electrical junction box covers in the area are installed with gaskets. Additional electrical panels in the area have conduits entering on the side (not top) thus making water entry less likely. All other components at this end of the EDG are non-safety related. It was concluded, leakage at this location would not adversely impact any safety related components.

6.5 ***Flooding*** – MPS2 Engineering Record of Correspondence (ERC) 25203-ER-01-0068, "Evaluation of Flooding Consequences to EDG Rooms with Flood Door 205-14-01 Open", (Reference 8.7) states that no components in the EDG rooms can be damaged from water depths below 4" based on equipment location within the room. MPS2 TE M2-EV-04-0021, "Evaluation of EDG Flood Door," (Reference 8.8) provides calculations for flow out of the two floor drains in the room as well as flow under the outside door at the east end of the room to the outdoors. The total flow rate calculated in the ERC is 140 gpm based on a 6" water depth. Assuming a 4" water depth, the flow rate leaving the room would be approximately 115 gpm. Accordingly, flooding of the EDG room from the effects of the channel head leak is not a concern based upon the ability to remove sufficient water via the floor drains and outside door.

6.6 ***Extent of Condition*** – All the other identical EDG channel heads of the SW heat exchangers were visually examined at the time of the discovery of the leak of the X-45A channel head. As a result, an additional location on the inlet channel head of the "B" EDG air cooler X-83B heat exchanger has been identified to show a location of additional leakage. The condition of the X-83B heat exchanger is discussed in Relief Request RR-89-66.

6.7 ***Compensatory Monitoring Plan*** – Leakage monitoring will be performed. The degraded channel head will be observed at least once per 12-hour shift during normal operator rounds and any significant increase in leakage will be evaluated. Approximately every 30 days a more formal visual examination will assess the leakage and structural integrity of the channel head. In addition to the initial RT examination used to characterize the defect, a follow-up RT approximately 30 days later showed no change from the original condition, confirming there is no significant defect growth. An additional follow-up Nondestructive Examination (NDE) using RT to monitor flaw growth will be performed approximately 90 days from the last examination. Any significant changes observed in the condition of the degraded channel head that could affect system operability will be evaluated. If this additional RT examination shows no flaw growth, then no further RT examinations will be performed until the channel head is replaced. Based upon observations from this monitoring plan, any required evaluations will determine if further remedial measures or corrective actions are necessary. The periodic observations, using visual examinations will continue until the degraded channel head is replaced.

6.8 ***Conclusion*** – Although the structural integrity of the channel head cannot be demonstrated in accordance with a regulatory approved methodology, it is concluded the integrity and functional requirements of the channel head will be maintained. Thus the "A" SW header will continue to be capable of providing required cooling water flow to meet all required cooling loads including the "A" EDG heat exchanger. There will be no adverse impact on neighboring equipment due to either spray or flooding. DNC will implement the compensatory monitoring plan above to ensure if any growth in the flaw occurs, appropriate action can be taken. Upon replacement of the degraded channel head a thorough characterization of the old channel head cast material and the leaking area will be performed to determine any future action required.

7.0 DURATION OF PROPOSED ALTERNATIVE

Preliminary discussions with the channel head manufacturer indicated a lead time for a replacement channel head of approximately 6 months. Based on these preliminary discussions, a permanent Code replacement for the identified channel head eliminating the flaw will be completed no later than the end of the next refueling outage. It is assessed the degraded channel head could remain in service until refueling outage 2R19 occurs, which is currently scheduled for the fall 2009.

8.0 REFERENCES

8.1 ASME Code Section XI, Division 1, 1989 Edition with No Addenda

8.2 ASME Code Section XI, Division 1, 1998 Edition with No Addenda

8.3 NRC Generic Letter GL 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping," June 15, 1990

8.4 Code Case N-513-2, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping," Section XI, Division 1, February 20, 2004

8.5 ASME Code Section VIII, Division 1, 1992 Edition with No Addenda

8.6 TE M2-EV-08-0023 Revision 1, "Best Estimate Fluid Inventory Loss Assuming Structural Failure of Filet Weld Associated with FE 6397"

8.7 ERC 25203-ER-01-0068, "Evaluation of Flooding Consequences to EDG Rooms with Flood Door 205-14-01 Open"

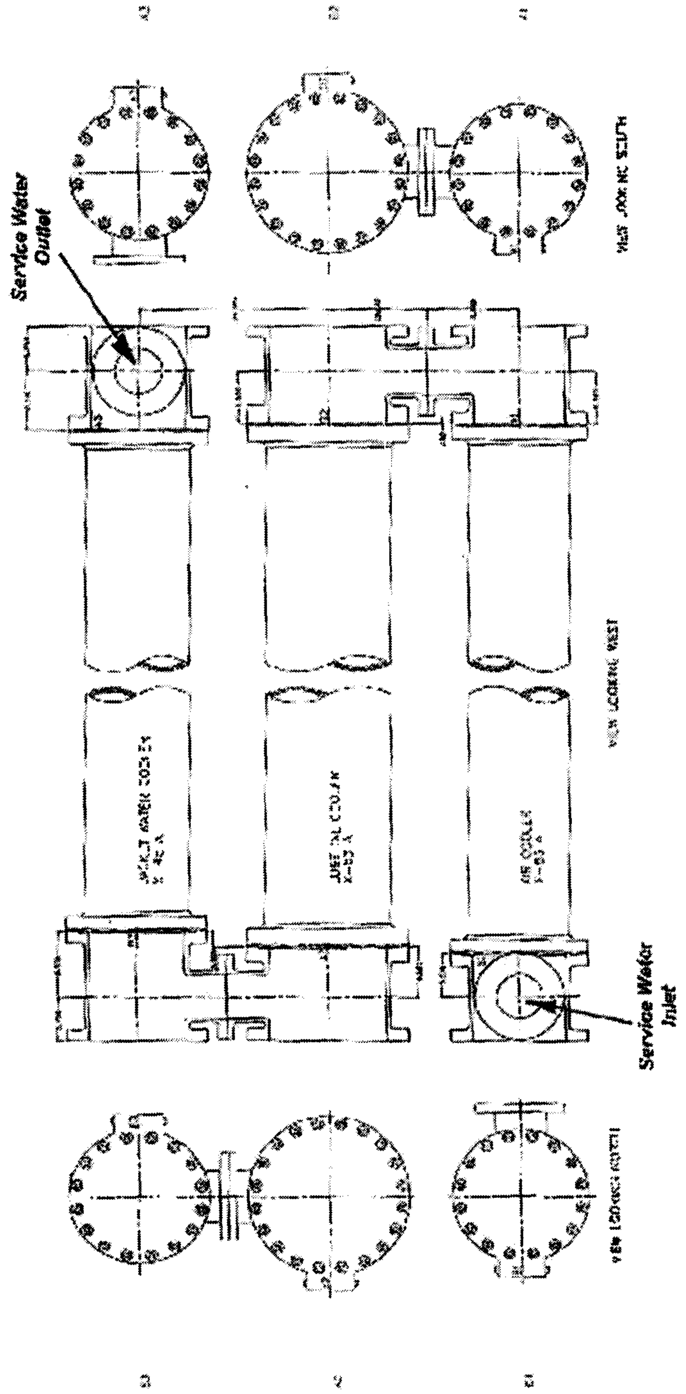
8.8 TE M2-EV-04-0021, "Evaluation of EDG Flood Door"

ENCLOSURE 1

TYPICAL SKETCHES OF MILLSTONE POWER STATION UNIT 2, EMERGENCY DIESEL GENERATOR JACKET WATER HEAT EXCHANGER X-45A AND CHANNEL HEAD FLAW AREA

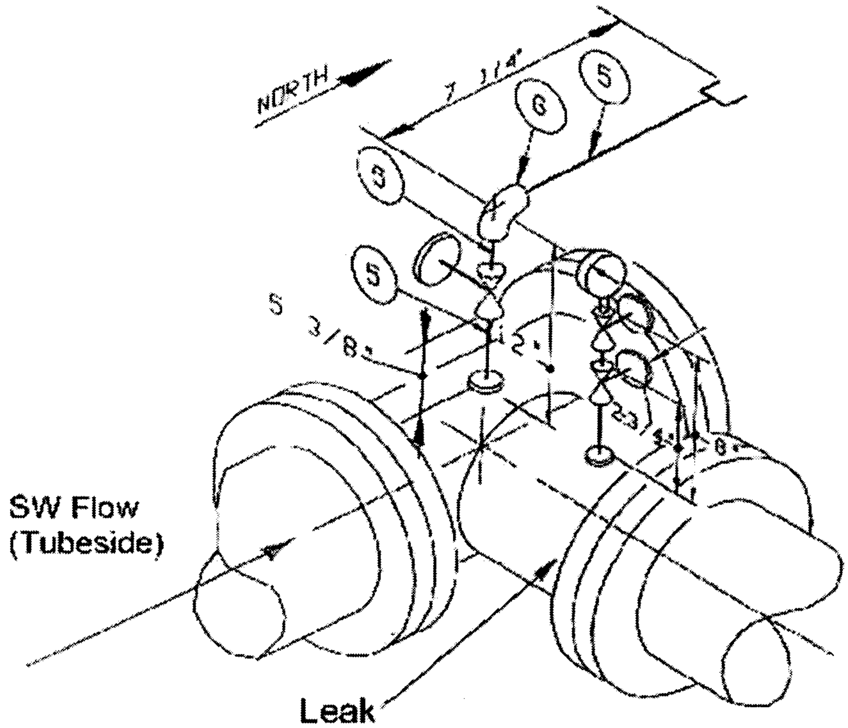
MILLSTONE POWER STATION UNIT 2
DOMINION NUCLEAR CONNECTICUT, INC.

SKETCH 1



Millstone Unit 2
'A' EDG Heat Exchanger Arrangement

SKETCH 2



Millstone Unit 2
'A' EDG Jacket Water Heat Exchanger X-45A
Outlet Channel Head

ENCLOSURE 2

PRO FORMA CODE CASE EVALUATION OF STRUCTURAL INTEGRITY OF X-45A CHANNEL HEAD

MILLSTONE POWER STATION UNIT 2
DOMINION NUCLEAR CONNECTICUT, INC.

Code Case N-513-2 3.0(e) Branch Reinforcement Evaluation (pro forma) of X-45A

$psig := psi \quad ksi := 1000 \cdot psi$

$P_d := 150 \cdot psig$ design pressure

$P_{max} := 100 \cdot psig$ conservative to normal operating pressure of less than approximately 25 psig

$S_{tbl} := 18.7 \cdot ksi$ ASME II 1992 Ed Table 1B for ASTM B-148 Alloy C95400 @ 250F

$QF := 0.8$ Casting quality factor per UG-24 (neglects benefit of radiographic NDE)

$S_{all} := QF \cdot S_{tbl}$ $S_{all} = 14.96 ksi$

$D_o := 6.625 \cdot in$ Nozzle diameter

Minimum Wall

$$t_{min} := \frac{P_{max} \cdot D_o}{2(S_{all} + .4 \cdot P_{max})}$$ N-513-2 eq. (4)

$t_{min} = 0.022 in$

Flaw characterization

Per radiographic and UT examination, the X-45A flaw has the following characterization:

Maximum size $L_{X45A} := 0.063 \cdot in$

Minimum thick $t_{adjX45A} := 0.48 \cdot in$

Based on the available radiographic, ultrasonic and surface appearance, the defects have characteristics that are structurally equivalent to through-wall pitting; i.e., there is no cracking or general area corrosion near the through-wall defect. For conservatism, the following are chosen for analysis, bounding the assumed equivalent flaw size of a 1/4" hole used for evaluation of system leakage and function.

$d_{adj} := 1.0 \cdot in > L_{X45A} = 0.063 in$ $t_{adj} := .48 \cdot in > t_{min} = 0.022 in$

ND-3643.3 reinforcement requirements , as invoked by N-513-2 3.0(e)

$A_{reqd} = 1.07 \cdot t_{mh} \cdot d_1$

$t_{mh} := t_{min}$

$d_1 := d_{adj}$

$A_{reqd} := 1.07 \cdot t_{mh} \cdot d_1$

$A_{reqd} = 0.0236 in^2$

$A_{reinf} = (2 \cdot d_2 - d_1) \cdot (T_h - t_{tol} - t_{mh})$

$T_h := t_{adj} - 0.002 \cdot in$ reduction accounts for minor corrosion over one year from time of measurement

$t_{tol} := 0.0 \cdot in$ analysis based on actual thickness, so mill tolerance not required

$d_2 := \max\left(d_1, T_h + \frac{d_1}{2}\right)$

$A_{reinf} := (2 \cdot d_2 - d_1) \cdot (T_h - t_{tol} - t_{mh})$

$A_{reinf} = 0.456 in^2$

$A_{reinf} = 0.456 in^2$ >> $A_{reqd} = 0.024 in^2$ **acceptable, reinforcement meets ND-3643.3 requirements**

Summary :

$\frac{A_{reinf}}{A_{reqd}} = 19.29$

As shown, margins on required reinforcement area and Code minimum wall thickness are large.

$\frac{t_{adj}}{t_{min}} = 21.74$

Construction Code Stress Limits

N-513-2 3.0(e) requires satisfaction of primary stress limits of the Construction Code. ASME VIII Division 1 does not provide explicit primary stress limits for operating loads but does say that they must be considered. However the Design Specification does require seismic qualification of the component. The existing seismic analysis determines that the maximum stress for the channel head under pressure, deadweight plus seismic loads is 10443 psi as compared to the allowable of 16063 psi. The analysis assumes a limiting piping nozzle load of 175953 in-lb moment. However the inlet and outlet nozzles have expansion joints between the piping and nozzle, without tie rods, so the imposed nozzle bending moment is essentially zero. The small reduction in nozzle cross section represented by the assumed 1" hole is very small in comparison to the remaining margin between the calculated vs. allowable stress mentioned above. Therefore the seismic qualification remains valid and the Construction Code primary stress limits are satisfied.

ATTACHMENT 2

RELIEF REQUEST RR-89-66, TEMPORARY NON-CODE REPAIR CLASS 3 SERVICE WATER SYSTEM EMERGENCY DIESEL GENERATOR AIR COOLER HEAT EXCHANGER X-83B

MILLSTONE POWER STATION UNIT 2
DOMINION NUCLEAR CONNECTICUT, INC

ATTACHMENT 2

RELIEF REQUEST RR-89-66, TEMPORARY NON-CODE REPAIR CLASS 3 SERVICE WATER SYSTEM EMERGENCY DIESEL GENERATOR AIR COOLER HEAT EXCHANGER X-83B

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Typical Sketches of Millstone Power Station Unit 2, Emergency Diesel Generator Air Cooler Heat Exchanger X-83B and Channel Head Flaw Area

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RELIEF REQUEST RR-89-66, TEMPORARY NON-CODE REPAIR CLASS 3 SERVICE WATER SYSTEM EMERGENCY DIESEL GENERATOR AIR COOLER HEAT EXCHANGER X-83B

Relief Request
In Accordance with 10 CFR 50.55a(g)(5)(iii)

- Code Repair/Replacement Impracticality -

1.0 ASME CODE COMPONENT(S) AFFECTED

On November 25, 2008, Operations personnel identified a corrosion product buildup on the ASME Class 3 Service Water (SW) inlet channel head of the Millstone Power Station Unit 2 (MPS2) "B" Emergency Diesel Generator (EDG) Air Cooler Heat Exchanger, X-83B. One localized area was observed to have wetness, with an estimated leakage rate at less than 1 drop per 15 minutes. Visual observation did not identify any specific external defect in this localized area. The wetness was observed on the neck of the 6" diameter flanged inlet nozzle connected to the inlet piping. This condition was discovered during an augmented inspection of all 12 EDG heat exchanger channel heads for similar leakage initiated upon discovery of leakage in the X-45A jacket water cooler on the "A" EDG (See Attachment 1 of this letter). No other conditions have been identified.

Based on the results of Ultrasonic Test (UT) and Radiographic Test (RT) examinations, direct visual internal and external surface examinations, and hardness testing as described below, the leak is most likely associated with a small casting defect indicated by the presence of a shrinkage indication (about 1/2" diameter). The casting imperfection, which meets the acceptance criteria of the Construction Code, is likely part of the leak path to the outside surface of the channel head. The channel head is made from an aluminum bronze sand casting fabricated per ASTM B148 alloy C95400 that has been temper annealed. Temper annealing of aluminum bronze castings has been shown to reduce the susceptibility of aluminum bronzes to dealloying in seawater environments. Thus for the Millstone Power Station channel heads, the potential for dealloying of the aluminum bronze casting is managed by the heat treatment.

Enclosure 1 contains a typical sketch of the EDG channel head and observed flaw area.

2.0 APPLICABLE CODE EDITION AND ADDENDA

MPS2 is currently in the third 10-year inservice inspection (ISI) interval, which started on April 1, 1999. The 1989 Edition of Section XI with No Addenda (Reference 8.1) applies to the ISI program. The 1998 Edition of Section XI with

No Addenda[1] (Reference 8.2) is used as the primary ASME Code Edition for Section XI repair/replacement activities. This Temporary Non-Code Repair of the leaking channel head is not in compliance with ASME Section XI, 1998 Edition, IWA-4000, nor does it meet the accepted analysis methods contained in NRC Generic Letter (GL) 90-05, (Reference 8.3). Additionally, the NRC approved Code Case N-513-2 (Reference 8.4) is not applicable because the flaw is in a component (the heat exchanger channel head) which is specifically excluded from the scope of the Code Case. However, for comparison purposes, a pro forma structural evaluation per the Code Case is provided in Enclosure 2.

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A Code repair (replacement or weld repair) would require isolation and draining of the SW system to the "B" EDG heat exchanger and thus would have to be implemented within a 14 day allowable outage window for the affected emergency diesel per the MPS2 Technical Specifications. Procurement of a replacement component is expected to take several months (see below).

5.0 BURDEN CAUSED BY COMPLIANCE

5.1 ***Replacement*** - Preliminary discussions with the channel head manufacturer indicated a lead time for a replacement channel head of approximately 6 months is required.

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6.1 ***Flaw Characterization and Results*** – In order to characterize the leak path and condition of the material surrounding the defect and area in which the wetness was observed, the following inspections were performed:

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(1) NRC letter, "Millstone Power Station, Unit Nos. 2 and 3 RE: Request to Use 1998 Edition, with No Addenda, of ASME Section XI for Repair/Replacement Activities (TAC Nos. MC7347 and MC7348)," dated September 13, 2005, (ADAMS Accession No. ML052210033).

a) UT examination was performed under Automated Work Order (AWO) 53102213583 to determine wall thickness in the area of the leak.
b) Informational RT examination was performed under AWO 53102213609 to characterize the material condition of the leak location and surrounding metal.
c) Visual examination of the inside surface was performed to look for evidence of dealloying.
d) Surface hardness measurements were taken on the OD and ID of the channel head.

<u>The following results were obtained</u>:

a) A wall thickness of 0.420" remains.
b) Radiography showed an area of possible casting weld repair from original manufacture. The area includes a casting discontinuity (shrinkage area) which may be part of the possible leak path. This indication area measures approximately ¼" by ½" and is acceptable to ASME Section VIII criteria. The density of the channel head was uniform indicating a uniform wall thickness.
c) After cleaning and buffing, the inside surface of the channel head was a uniform yellow bronze color with no areas of pink that would be indicative of dealloying. No areas of porosity were noted.
d) Surface hardness test results showed variability consistent with a casting. The OD measurements were harder than the ID measurements.

Based on the results of the above inspections, the leak is most likely the result of several small pores which linked to create a leak path from the inside to the outside surface. It is likely the leak path includes the shrinkage area, which has an estimated size of about 1/2 inch in the plane of the casting but is not surface breaking so there is no surface defect that would permit leakage of more than a few drops per minute. The leakage is thus limited by the size of the interconnected pores. Based on the negligible actual leakage and the periodic leakage monitoring initiated, fluid leakage evaluations (see below) are based on an assumed through-wall defect of 1/4 inch diameter. For structural evaluation purposes, the defect is conservatively assumed to be a one inch diameter through-wall defect surrounded by sound material. This larger assumed defect was chosen to provide additional assurance of the structural integrity.

As noted earlier these channel heads are made from aluminum bronze C95400. Aluminum bronze alloys are used in sea water applications because of their low general corrosion rate of 0.001 - 0.002"/year. This rate trends down with time (i.e., the rate is lower, the longer the test period). Aluminum bronzes have good resistance to erosion and their high copper content inhibits marine growth and microbiological effects. Pitting, other forms of localized corrosion or stress corrosion cracking are not of concern in a sea water environment. The operational experience at Millstone Power Station Units 2 and 3 with aluminum bronze valves and pumps has been free of any issues with pitting, other forms of localized corrosion or stress corrosion cracking.

There is one corrosion mechanism which can be an issue with castings made from aluminum bronzes including C95400. Research has shown, in sea water, the as cast microstructure of aluminum bronzes is susceptible to dealloying where the aluminum rich phase is selectively attacked. Further research has shown a temper anneal at 1100 – 1300 degrees F greatly improves the resistance to dealloying by changing the microstructure. When these channel heads were procured, this information was known and these channel heads were temper annealed at 1200 - 1300 degrees F. With the temper anneal, the rate of dealloying will be of similar magnitude to the general corrosion rate, i.e., 0.002"/year. Therefore, the rate of corrosion between the areas of porosity appearing to have linked up to cause the leakage, is very low and will take years to reach the evaluated size.

Taken together, the UT, RT, visual examination and hardness measurements support the assumption that dealloying is not a concern. As discussed above, the inside surface of the X-83B channel head was a uniform yellow bronze color with no areas of pink that would be indicative of dealloying. No areas of porosity were noted. The surface hardness test results for X-83B showed variability consistent with a casting. The OD measurements were harder than the ID measurements. It would be expected the UT would measure only the sound metal and not the dealloyed material. While the hardness data suggest some dealloying has occurred, the visual examination and the UT data would conclude the amount of dealloying is limited to the near surface areas only.

6.2 ***Structural Integrity*** –Under MPS2 Technical Requirements Manual (TRM) 3.4.10, the structural integrity of an ASME component is determined in accordance with the ASME Section XI Code, approved Code Cases or regulatory approved methods of evaluation. There is no approved NRC accepted methodology for evaluating the structural integrity of this type of component (heat exchanger channel head). Therefore the channel head (component) does not meet the structural integrity criteria of the TRM. However, the heat exchanger channel head and nozzle have cylindrical sections and are similar to piping, and the leaking location is highly localized. Additionally, this nozzle is operating at pressures of about 25 psig, much lower than its design pressure of 150 psig, and is protected from significant piping loads by an expansion joint. Therefore the structural integrity of the component has been assessed by a pro forma application of Code Case N-513-2 structural integrity evaluation requirements (Enclosure 2). Using the branch reinforcement methodology, it shows a large margin (by a factor of about 17) between required and available reinforcement area. In addition, the measured wall thickness of 0.420 inches is much larger than the 0.022 inches required by the Code Case (a margin factor of 19).

Procedures which reflect other requirements of Code Case N-513-2 have been implemented or scheduled to ensure the defect is monitored and will not challenge the basis for operability of the heat exchanger. In particular, the augmented examinations for similar conditions are complete and no additional adverse conditions have been identified.

Finally, to further confirm the stability of the defect over time, another RT reexamination at approximately 90 days from the last examination and (if no additional deterioration is evident) replacement no later than the end of the next refueling outage is adequate. On this basis it is concluded the defect will remain stable under all design conditions, including seismic, and therefore has adequate structural integrity.

Thus, as demonstrated by the thickness measured during UT and the soundness of the surrounding material observed by radiography, the structural integrity evaluation and further confirmations as described above, the capability of the channel head to perform its intended function is considered to be maintained.

6.3 ***Flow Margin*** – The location is on the inlet channel head of the Air Cooler Heat Exchanger which is upstream of all three EDG heat exchangers. Therefore, SW flow to the cooling loads is somewhat reduced and requires evaluation.

For the purposes of bounding the leakage rate at this location (allowing for further degradation), a through-wall hole of 1/4" diameter has been conservatively assumed. MPS2 Technical Evaluation (TE) M2-EV-08-0023 (Reference 8.6) was recently issued in response to a through-wall leak on the "B" EDG annubar flow element upstream of the heat exchangers. The TE calculated a flow rate through a 1/4" hole [assuming SW pressure of 25 pounds per square inch gauge (psig)] to be approximately 5.6 gallons per minute (gpm). The maximum potential leakage of the annubar connection, identified in the referenced TE, was 28 gpm. Therefore, the total estimated leakage flow would be 33.6 gpm. Existing system flow calculations show there is a minimum margin of approximately 133 gpm in delivered service water flow to the diesel, so the estimated maximum leakage flow is well within system margins. Also, the leakage flow diversion would have negligible impact on the overall system flow balance. Accordingly, service water flow loss from the location of this leak will not adversely affect the ability of the SW system to provide cooling to the 'B' EDG heat exchangers.

6.4 ***Spray Concerns*** – The leak is located on the south side of the 6" branch connection near the centerline of the horizontal run (approximately 4 feet above the floor). A 5.6 gpm leak would flow/spray out the hole to the south. A walk down of all components located in the assumed spray area and in the immediate vicinity was performed by System Engineering. Electrical junction box covers in the area are installed with gaskets. Additional electrical panels in the area have conduits entering on the side (not top) thus making water entry less likely. All other components at this end of the EDG are non-safety related. It was concluded that leakage at this location would not adversely impact any safety related components.

6.5 ***Flooding*** – MPS2 Engineering Record of Correspondence (ERC) 25203-ER-01-0068, "Evaluation of Flooding Consequences to EDG Rooms with Flood Door 205-14-01 Open", (Reference 8.7) states that no components in the EDG rooms can be damaged from water depths below 4" based on equipment location within the room. MPS2 TE M2-EV-04-0021, "Evaluation of EDG Flood Door," (Reference 8.8) provides calculations for flow out of the two floor drains in the room as well as flow under the outside door at the east end of the room to the outdoors. The total flow rate calculated in the ERC is 140 gpm based on a 6" water depth. Assuming a 4" water depth, the flow rate leaving the room would be approximately 115 gpm. Accordingly, flooding of the EDG room from the effects of the channel head leak is not a concern based upon the ability to remove sufficient water via the floor drains and outside door.

6.6 ***Extent of Condition*** – All the other identical EDG channel heads of the SW heat exchangers were visually examined at the time of discovery of the leak of the X-45A channel head, and only the "B" EDG Air Cooler X-83B Heat Exchanger has been identified to show a location of additional leakage.

6.7 ***Compensatory Monitoring Plan*** – Leakage monitoring will be performed. The degraded channel head will be observed at least once per 12-hour shift during normal operator rounds and any significant increase in leakage will be evaluated. Approximately every 30 days a more formal visual examination will assess the leakage and structural integrity of the channel head. In addition to the initial RT examination used to characterize the defect, a follow-up RT approximately 50 days later showed no change from the original condition, confirming there is no significant defect growth. An additional follow-up RT to monitor flaw growth will be performed approximately 90 days from the last examination. Any significant changes observed in the condition of the degraded channel head that could affect system operability will be evaluated. If this additional RT examination shows no flaw growth, then no further RT examinations will be performed until the channel head is replaced. Based upon observations from this monitoring plan, any required evaluations will determine if further remedial measures or corrective actions are necessary. The periodic observations, using visual examinations will continue until the degraded channel head is replaced.

6.8 ***Conclusion*** – Although the structural integrity of the channel head cannot be demonstrated in accordance with a regulatory approved methodology, it is concluded the integrity and functional requirements of the channel head will be maintained. Thus the "B" SW header will continue to be capable of providing required cooling water flow to meet all required cooling loads including the "B" EDG heat exchanger. There will be no adverse impact on neighboring equipment due to either spray or flooding. DNC will implement the compensatory monitoring plan above to ensure if any growth in the flaw occurs, appropriate action can be taken. Upon replacement of the degraded channel head a thorough characterization of the old channel head cast material and the leaking area will be performed to determine any future action required.

7.0 DURATION OF PROPOSED ALTERNATIVE

Preliminary discussions with the channel head manufacturer indicated a lead time for a replacement channel head of approximately 6 months. Based on these preliminary discussions, a permanent Code replacement for the identified channel head eliminating the flaw will be completed no later than the end of the next refueling outage. It is assessed the degraded channel head could remain in service until refueling outage 2R19 occurs, which is currently scheduled for the fall 2009.

8.0 REFERENCES

8.1 ASME Code Section XI, Division 1, 1989 Edition with No Addenda

8.2 ASME Code Section XI, Division 1, 1998 Edition with No Addenda

8.3 NRC Generic Letter GL 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping," June 15, 1990

8.4 Code Case N-513-2, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping," Section XI, Division 1, February 20, 2004

8.5 ASME Code Section VIII, Division 1, 1992 Edition with No Addenda

8.6 TE M2-EV-08-0023 Revision 1, "Best Estimate Fluid Inventory Loss Assuming Structural Failure of Filet Weld Associated with FE 6397"

8.7 ERC 25203-ER-01-0068, "Evaluation of Flooding Consequences to EDG Rooms with Flood Door 205-14-01 Open"

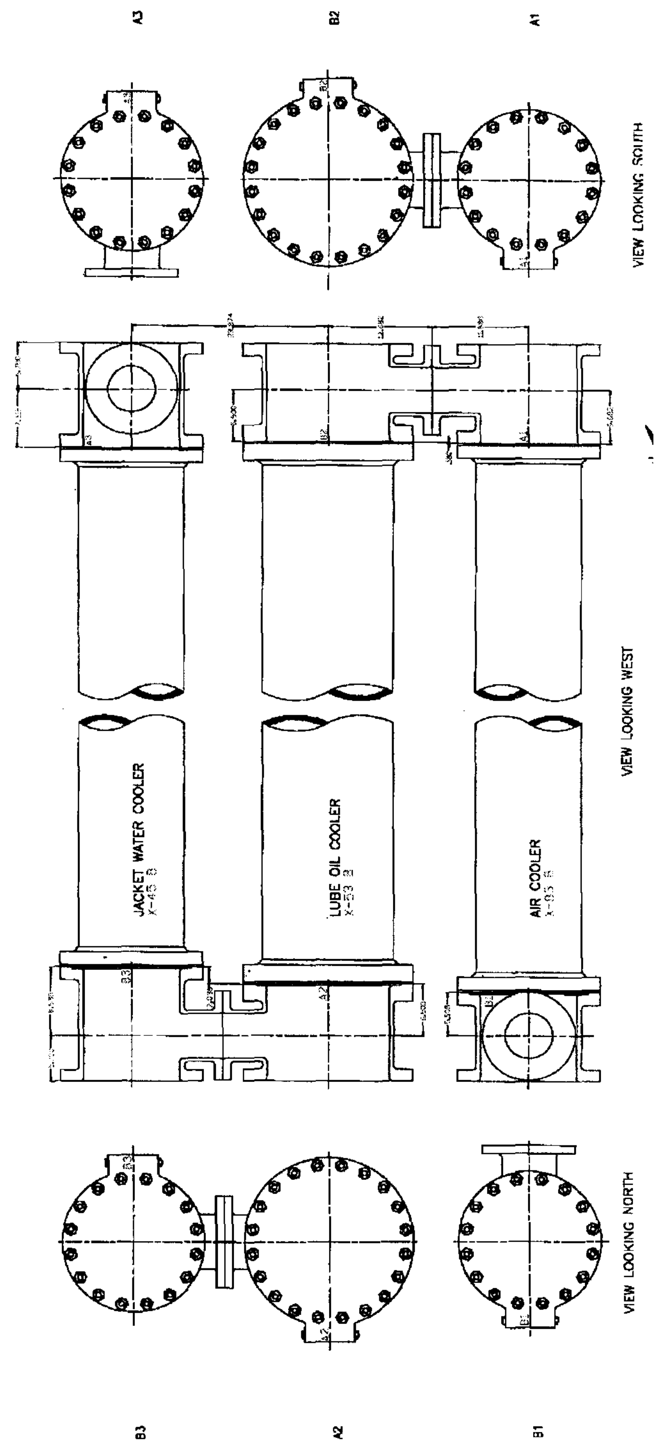
8.8 TE M2-EV-04-0021, "Evaluation of EDG Flood Door"

ENCLOSURE 1

TYPICAL SKETCHES OF MILLSTONE POWER STATION UNIT 2, EMERGENCY DIESEL GENERATOR AIR COOLER HEAT EXCHANGER X-83B AND CHANNEL HEAD FLAW AREA

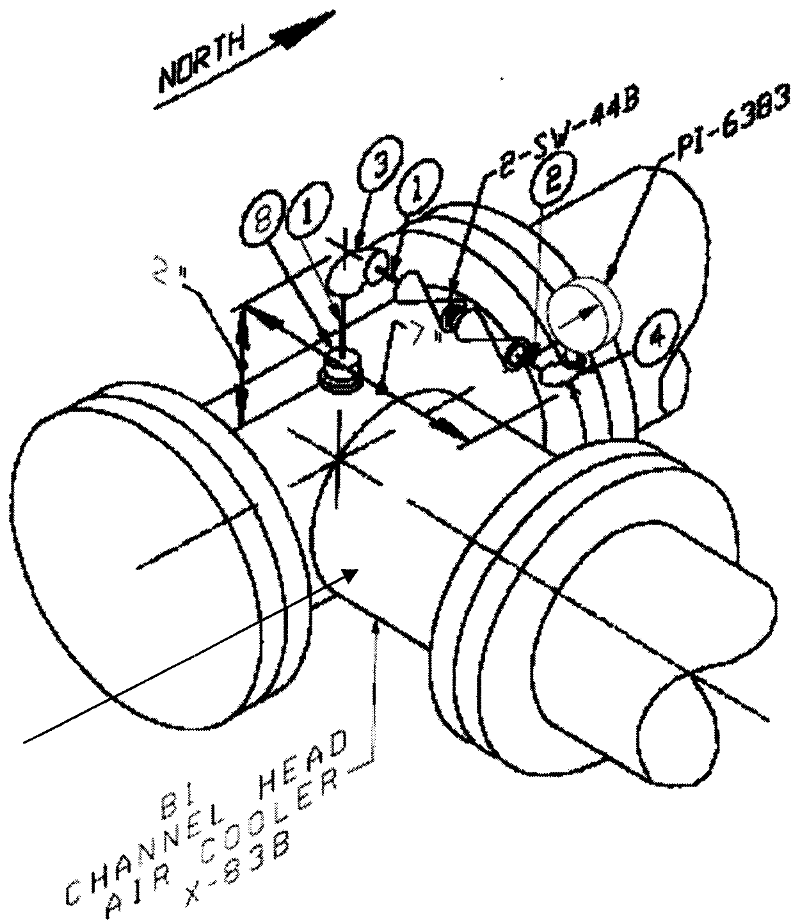
MILLSTONE POWER STATION UNIT 2
DOMINION NUCLEAR CONNECTICUT, INC.

SKETCH 1



Millstone Unit 2
'B' EDG Heat Exchanger Arrangement

SKETCH 2



Location
of Leak

Millstone Unit 2
'B' EDG Heat Exchanger Arrangement

ENCLOSURE 2

PRO FORMA CODE CASE EVALUATION OF STRUCTURAL INTEGRITY OF X-83B CHANNEL HEAD

MILLSTONE POWER STATION UNIT 2
DOMINION NUCLEAR CONNECTICUT, INC.

Code Case N-513-2 3.0(e) Branch Reinforcement Evaluation (pro forma) of X-83B

$psig := psi \quad ksi := 1000 \cdot psi$

$P_d := 150 \cdot psig$ design pressure

$P_{max} := 100 \cdot psig$ conservative to normal operating pressure of less than approximately 25 psig

$S_{tbl} := 18.7 \cdot ksi$ ASME II 1992 Ed Table 1B for ASTM B-148 Alloy C95400 @ 250F

$QF := 0.8$ Casting quality factor per UG-24 (neglects benefit of radiographic NDE)

$S_{all} := QF \cdot S_{tbl} \quad S_{all} = 14.96 ksi$

$D_o := 6.625 \cdot in$ Nozzle diameter

Minimum Wall

$$t_{min} := \frac{P_{max} \cdot D_o}{2(S_{all} + .4 \cdot P_{max})}$$ N-513-2 eq. (4)

$t_{min} = 0.022 in$

Flaw characterization

Per radiographic and UT examination, the X-83B flaw has the following characterization:

Maximum size $L_{X83B} := 0.50 \cdot in$

Minimum thick $t_{adjX83B} := 0.42 \cdot in$

Based on the available radiographic, ultrasonic and surface appearance, the defect has characteristics that are structurally equivalent to through-wall pitting; i.e., there is no cracking or general area corrosion near the through-wall defect. For conservatism, the following are chosen for analysis, bounding the assumed equivalent flaw size of a 1/4" hole used for evaluation of system leakage and function.

$d_{adj} := 1.0 \cdot in \quad > \quad L_{X83B} = 0.50 in \qquad t_{adj} := .42 \cdot in \quad > \quad t_{min} = 0.022 in$

ND-3643.3 reinforcement requirements , as invoked by N-513-2 3.0(e)

$A_{reqd} = 1.07 \cdot t_{mh} \cdot d_1$

$t_{mh} := t_{min}$

$d_1 := d_{adj}$

$A_{reqd} := 1.07 \cdot t_{mh} \cdot d_1$

$A_{reqd} = 0.0236 in^2$

$A_{reinf} = (2 \cdot d_2 - d_1) \cdot (T_h - t_{tol} - t_{mh})$

$T_h := t_{adj} - 0.002 \cdot in$ reduction accounts for minor corrosion over one year from time of measurement

$t_{tol} := 0.0 \cdot in$ analysis based on actual thickness, so mill tolerance not required

$d_2 := \max\left(d_1, T_h + \frac{d_1}{2}\right)$

$A_{reinf} := (2 \cdot d_2 - d_1) \cdot (T_h - t_{tol} - t_{mh})$

$A_{reinf} = 0.396 in^2$

$A_{reinf} = 0.396 in^2$ >> $A_{reqd} = 0.024 in^2$ **acceptable, reinforcement meets ND-3643.3 requirements**

Summary :

$\frac{A_{reinf}}{A_{reqd}} = 16.76$

$\frac{t_{adj}}{t_{min}} = 19.02$

As shown, margins on required reinforcement area and Code minimum wall thickness are large, and compensate for any uncertainties in material condition.

Construction Code Stress Limits

N-513-2 3.0(e) requires satisfaction of primary stress limits of the Construction Code. ASME VIII Division 1 does not provide explicit primary stress limits for operating loads but does say that they must be considered. The Design Specification does require seismic qualification of the component. The existing seismic analysis determines that the maximum stress for the channel head under pressure, deadweight plus seismic loads is 10443 psi as compared to the allowable of 16063 psi. The analysis assumes a limiting piping nozzle load of 175,953 in-lb moment. However the inlet and outlet nozzles have expansion joints between the piping and nozzle, without tie rods, so the imposed nozzle bending moment is essentially zero. The small reduction in nozzle cross section represented by the assumed 1" hole is very small in comparison to the remaining margin between the calculated vs. allowable stress mentioned above. Therefore the seismic qualification remains valid and the Construction Code primary stress limits are satisfied.