PROPRIETARY INFORMATION – WITHHOLD UNDER 10 CFR 2.390

VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

10 CFR 50.55a

March 28, 2018

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No. 18-048
NAPS/RAP R0
Docket No. 50-339
License No. NPF-7

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION ENERGY VIRGINIA)
NORTH ANNA POWER STATION UNIT 2
ASME SECTION XI INSERVICE INSPECTION PROGRAM
REQUEST FOR PROPOSED ALTERNATIVE N2-I4-NDE-007

In accordance with 10 CFR 50.55a(z)(1), Virginia Electric and Power Company (Dominion Energy Virginia) requests Nuclear Regulatory Commission (NRC) approval of proposed in-service inspection (ISI) alternative N2-I4-NDE-007 for North Anna Power Station (NAPS) Unit 2. A baseline volumetric examination was performed on each of the three steam generator cold leg nozzle Alloy 82/182 welds during the spring 2013 refueling outage (N2R22). The requested extension would allow examination of the steam generator cold leg nozzle welds coincident with those of the steam generator hot leg nozzle welds, next due during the spring 2022 refueling outage (N2R28), resulting in personnel dose savings.

Information provided in the attachments to this letter is summarized below:

- Attachment 1 provides Relief Request N2-I4-NDE-007
- Attachment 2 provides the Crack Growth Analyses for NAPS Unit 2 Steam Generator Outlet Nozzles Calculation (Proprietary)
- Attachment 3 provides the Crack Growth Analyses for NAPS Unit 2 Steam Generator Outlet Nozzles Calculation (Non-proprietary)
- Attachment 4 provides an Affidavit on behalf of Westinghouse Electric Company, LLC (Westinghouse) for withholding proprietary information from public disclosure

Since Attachment 2 contains information proprietary to Westinghouse, it is supported by an affidavit signed by the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR 2.390.

Accordingly, it is respectfully requested that the proprietary information be withheld from public disclosure in accordance with 10 CFR 2.390.

The Facility Safety Review Committee has reviewed and approved this alternative request.

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NRR

Attachment 2 contains information that is being withheld from public disclosure under 10 CFR 2.390. Upon separation from Attachment 2, this letter is decontrolled.

Dominion requests approval of the proposed alternative by March 1, 2019 in support of the Unit 2 spring refueling outage. If you have any questions or require additional information regarding the information provided in the attachments, please contact Ms. Diane E. Aitken at (804) 273-2694.

Very truly yours,

M. D. Sartain
Vice President - Nuclear Engineering and Fleet Support

Attachments:

1. Relief Request N2-I4-NDE-007
2. Crack Growth Analyses for NAPS Unit 2 Steam Generator Outlet Nozzles Calculation (Proprietary)
3. Crack Growth Analyses for NAPS Unit 2 Steam Generator Outlet Nozzles Calculation (Non-proprietary)
4. Affidavit of Westinghouse Electric Company, LLC (Westinghouse)

This letter contains no NRC commitments.

cc: Regional Administrator
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Attachment 4

Affidavit of Westinghouse Electric Company, LLC (Westinghouse)

North Anna Power Station
Unit 2
Virginia Electric and Power Company
(Dominion Energy Virginia)

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CAW-18-4716

March 6, 2018

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: C-4520-00-03, Rev. 1, "Crack Growth Analyses for NAPS Unit 2 Steam Generator Outlet Nozzles," Dominion Engineering, Inc. (Proprietary)

The Application for Withholding Proprietary Information from Public Disclosure is submitted by Westinghouse Electric Company LLC ("Westinghouse"), pursuant to the provisions of paragraph (b)(1) of Section 2.390 of the Nuclear Regulatory Commission's ("Commission's") regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-18-4716 signed by the owner of the proprietary information, Westinghouse. The Affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.390 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Dominion Energy.

Correspondence with respect to the proprietary aspects of the Application for Withholding or the Westinghouse Affidavit should reference CAW-18-4716, and should be addressed to James A. Gresham, Manager, Regulatory Compliance, Westinghouse Electric Company, 1000 Westinghouse Drive, Building 2 Suite 259, Cranberry Township, Pennsylvania 16066.

James A. Gresham, Manager
Regulatory Compliance

CAW-18-4716

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

I, James A. Gresham, am authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse") and declare that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief.

Executed on: 3/6/18

James A. Gresham, Manager
Regulatory Compliance

(1) I am Manager, Regulatory Compliance, Westinghouse Electric Company LLC ("Westinghouse"), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 of the Nuclear Regulatory Commission's ("Commission's") regulations and in conjunction with the Westinghouse Application for Withholding Proprietary Information from Public Disclosure accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitute Westinghouse policy and provide the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of

Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage (e.g., by optimization or improved marketability).

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(iii) There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iv) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, is to be received in confidence by the Commission.

(v) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(vi) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in C-4520-00-03, Rev. 1, "Crack Growth Analyses for NAPS Unit 2 Steam Generator Outlet Nozzles," Dominion Engineering, Inc. (Proprietary), for submittal to the Commission, being transmitted by Dominion Energy letter. The proprietary information as submitted by Westinghouse is that associated with piping loads used as input to crack growth analysis, and may be used only for that purpose.

(a) This information is part of that which will enable Westinghouse to perform crack growth analysis, or other component structural analyses utilizing piping loads as input.

(b) Further, this information has substantial commercial value as follows:

(i) Westinghouse plans to sell the use of similar information to its customers for the purpose of crack growth analysis, or other component structural analyses utilizing piping loads as input.

(ii) Westinghouse can sell support and defense of industry guidelines and acceptance criteria for plant-specific applications.

(iii) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and non-proprietary versions of a document, furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The bracketed information includes the designation, *"Confidential Commercial Information."* The justification for claiming the information so designated as proprietary is based on items (a) and (c). These letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the Affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

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Attachment 1

Relief Request N2-I4-NDE-007

North Anna Power Station
Unit 2
Virginia Electric and Power Company
(Dominion Energy Virginia)

North Anna Power Station Unit 2
10 CFR 50.55a Request
Relief Request N2-I4-NDE-007

Proposed Alternative
in Accordance with 10 CFR 50.55a(z)(1)

--Alternative Provides Acceptable Level of Quality and Safety--

1. American Society of Mechanical Engineers (ASME) Code Components Affected

Components:	Steam Generator Cold Leg Nozzle To Safe End Dissimilar Metal Welds		
Code Class:	Class 1		
Examination Category:	B-F B5.70		
Weld Numbers:	**Description**	**Size**	**Materials**
A Cold Leg 31-RC-402 / N-SE31 IN	Steam Generator Cold Leg Nozzle to Safe End Weld	Nominal 27.5 inch ID	Low Alloy Steel Cold Leg Nozzle / Alloy 82-182 Weld / Stainless Steel Safe End
B Cold Leg 31-RC-405 / N-SE31 IN	Steam Generator Cold Leg Nozzle to Safe End Weld	Nominal 27.5 inch ID	Low Alloy Steel Cold Leg Nozzle / Alloy 82-182 Weld / Stainless Steel Safe End
C Cold Leg 31-RC-408 / N-SE31 IN	Steam Generator Cold Leg Nozzle to Safe End Weld	Nominal 27.5 inch ID	Low Alloy Steel Cold Leg Nozzle / Alloy 82-182 Weld / Stainless Steel Safe End

- Low Alloy Steel Nozzle-SA- 508, Class 3
- Stainless Steel Safe End-SA-336, Class F316LN
- ID = Inside Diameter

2. Applicable Code Edition and Addenda

The NAPS Unit 2 applicable Code for the fourth 10-year inservice inspection (ISI) interval and the ISI program is the 2004 Edition of ASME Section XI with no Addenda [1]. The NAPS Unit 2 fourth interval started December 14, 2010 and ends December 13, 2020. The NAPS Unit 2 fifth interval will start December 14, 2020 and ends December 13, 2030.

3. Applicable Code Requirement

Examination requirements for Class 1 piping and nozzle dissimilar-metal butt welds, as required by 10 CFR 50.55a(g)(6)(ii)(F) implementing the requirements of ASME Code Case N-770-2, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or

UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities, Section XI, Division 1" (ASME Approval Date: June 9, 2011), are as follows:

- ASME Code Case N-770-2, Inspection Item "B", Unmitigated Butt Weld at Cold Leg Operating Temperature (-2410) ≥ 525°F (274°C) and < 580°F (304°C) requires visual examination once per interval and volumetric examination every second inspection period not to exceed 7 years.

  Note: This relief request will apply to future versions of Code Case N-770 that may be incorporated in 10CFR50.55a(g)(6)(ii)(F)(1) provided the Item B maximum examination frequency continues to be less than 9 years.

4. Reason for Request

Dominion requests to extend the steam generator cold leg nozzle weld inspections two operating cycles (approximately 36 months) to the spring 2022 for Refueling Outage N2R28. The total requested interval from the time of the previous volumetric examination of these locations is six (6) nominal 18-month fuel cycles.

The requested extension would allow the next volumetric examination of the steam generator cold leg nozzle welds to be performed during the same refueling outage as the next required volumetric examination of the steam generator hot leg nozzle welds. Performance of the steam generator hot leg and cold leg nozzle welds in such a coordinated manner would result in personnel dose savings for the site, promoting As Low As Reasonably Achievable (ALARA) practices associated with this significant non-destructive examination (NDE) activity.

EPRI report MRP-349 [2] and a plant-specific crack growth evaluation for NAPS Unit 2 [3] (Attachment 2) provide the basis for extension of the current volumetric examination interval for the steam generator cold leg nozzle Alloy 82/182 dissimilar metal welds. This technical basis demonstrates that the reexamination interval can be extended to the requested interval length while maintaining an acceptable level of quality and safety. The Unit 2 steam generator primary loop nozzles are Alloy 82/182 butter welds with Alloy 52/152 weld inlays. Neither the MRP-349 technical basis nor the plant-specific crack growth evaluation credit the presence of the Alloy 52/152 weld inlays. Thus, the presence of the Alloy 52/152 inlays at the surface in contact with the reactor coolant provides additional assurance that an acceptable level of quality and safety will be maintained under the proposed alternative.

5. Proposed Alternative and Basis for Use

Pursuant to 10CFR 50.55a(z)(1), Dominion proposes as an alternative to the ASME Code requirements stated above a one-time extension to the requirements of ASME Code Case N-770-2, Table 1, Inspection Item B, volumetric examinations from an interval not to exceed 7 years to a one-time interval of six (6) nominal 18-month fuel cycles, i.e., approximately 9 years, for NAPS Unit 2. A baseline volumetric examination was performed for each of the three steam generator cold leg nozzle Alloy 82/182 welds during the spring 2013 refueling outage (N2R22). The requested extension would allow examination of the steam generator cold leg nozzle welds coincident with those of the

steam generator hot leg nozzle welds, next due in N2R28, during the spring of 2022, resulting in personnel dose savings.

Technical Basis

The basis used to demonstrate the acceptability of extending the inspection interval for Code Case N-770-2, Inspection Item B components is contained in MRP-349 and a site-specific flaw evaluation performed for NAPS Unit 2. In summary, the basis for extending the inspection is: (1) there has been no service experience with PWSCC cracking found in any main loop Alloy 82/182 Cold Leg DM welds in US or overseas PWRs, (2) crack growth rates in Alloy 82/182 Cold Leg DM welds are relatively slow, about a factor of 4 lower than comparative Hot Leg DM welds based on the temperature dependence of the PWSCC crack growth equation, (3) the likelihood of initial cracking, crack growth and a subsequent through-wall leak is very small in Steam Generator Cold Leg DM welds, particularly with the relatively thick (~4.8 inches) Unit 2 Cold Leg nozzle welds, and (4) the NAPS Unit 2 specific axial and circumferential flaw evaluation showing that any indication detected during the 2013 and 2014 RFO examinations, as well as any flaw size which could have been reasonably missed during the nozzle to safe end weld examinations would not grow to exceed the allowable size flaw specified by ASME Section XI rules over the timeframe of the requested inspection interval. This technical basis demonstrates that the re-examination interval can be extended while maintaining an acceptable level of quality and safety.

Service Experience

Ultrasonic examination of the Unit 2 Steam Generator Cold Leg Nozzle to Safe End Welds were last performed for the A and B Cold Legs during refueling outage N2R22 (spring 2013). The C Cold Leg was examined during refueling outage N2R22 with limitations, then reexamined during N2R23 (fall 2014) with full coverage. The technique for examination applied encoded phased array ultrasonic examination that met ASME Section XI, Appendix VIII requirements including an examination volume of essentially 100%.

No indications exhibiting characteristics indicative of Stress Corrosion Cracking (SCC) were noted during the evaluation of the recorded Ultrasonic Data for Cold Leg A. One axially oriented indication was recorded during the data analysis process. This indication did not exhibit characteristics of SCC, i.e. the indication:

- was only apparent with the 35 LW Focal Law Group
- exhibited no major through wall dimension
- was not apparent across multiple probe positions (scan lines) and skews

This type of indication response is indicative of small metallurgical indication from a shallow ID repair. Although the precise locations of shallow ID cladding repairs have not been documented, the weld fabrication records do indicate shallow ID Repairs were made around the circumference of the weld.

No indications exhibiting characteristics indicative of Stress Corrosion Cracking (SCC) were noted during the evaluation of the recorded Ultrasonic Data for Cold Leg B.

No indications exhibiting characteristics indicative of Stress Corrosion Cracking (SCC) were noted during the evaluation of the recorded Ultrasonic Data for Cold Leg C. Three (3) indications attributed to embedded fabrication discontinuities were noted throughout the circumference of the weld volume. The procedure used, meeting Section XI, Appendix VIII requirements, has not been demonstrated to detect or size embedded flaws. Embedded flaws are considered to be fabrication related and thus outside of the Appendix VIII qualification requirements. Geometric and metallurgical indications typical for this configuration were also noted during the evaluation of recorded ultrasonic data.

All recordable subsurface indications were acceptable per IWB-3514 of ASME Section X,I 2004 edition.

Third interval examination of Cold Leg A was performed during N2R15 (fall 2002) with 80% coverage identifying no reportable indications. Third interval examination of Cold Leg B was performed during N2R18 (spring 2007) with no reportable indications. Third interval examination of Cold Leg C was performed during N2R19 (fall 2008) identifying only geometric indications.

Plant-Specific Crack Growth Evaluation

Crack growth calculations were performed considering the specific geometry and loads applicable to the NAPS Unit 2 steam generator outlet nozzles, including the weld residual stress (WRS) analysis results documented in C-4520-00-01, Rev. 0 [5]. These calculations applied the common deterministic approach for unmitigated Alloy 82/182 piping butt welds in PWRs. The results of these crack growth calculations demonstrate the acceptability of the following alternative volumetric reexamination intervals for the NAPS Unit 2 steam generator outlet nozzles:

- *"Loop 1" and "Loop 3" nozzles:* Once per Section XI interval (nominally 10 years), as specified by ASME Code Cases N-770-3 and N-770-4 per Inspection Item B-2 for unmitigated cold-leg butt weld locations NPS 14 or larger (N-770-3 and N-770-4 are not currently approved by NRC)

- *"Loop 2" nozzle:* Six nominal 18-month fuel cycles (nominally 9 years)

The crack growth calculation results presented below demonstrate that these alternative volumetric examination frequencies are sufficient to provide reasonable assurance of the structural integrity of the cold-leg piping at NAPS Unit 2. Hence, these alternative frequencies provide an acceptable level of quality and safety.

The key results of the crack growth calculations are as follows:

- The crack growth rate for axial cracks was found to be greater than for circumferential cracks, due to the total (residual plus operating) hoop stresses being greater than the total axial stresses. Thus, the analysis cases for axial cracks are the limiting cases.

- The limiting case for the calculated time for a crack to grow from 10% through-wall to the maximum allowable depth is 9.1 years. The limiting case is for an axial crack growing to an allowable depth of 75% through-wall. In this limiting case, an additional 3.1 years is calculated for the axial crack to penetrate through the remaining 25% of the wall thickness. This limiting case is applicable only to the "Loop 2" nozzle, which includes a 55% through-wall localized weld repair. The 55% through-wall ID weld repair assumption was developed on the basis of a review of fabrication records for each nozzle, which exceeds the 50% through-wall repair assumption of MRP-287 [7].

- The limiting case applicable to the "Loop 1" and "Loop 3" nozzles results in a time of 10.3 years for an axial crack to grow from 10% through-wall to 75% through-wall. In this case, an additional 2.8 years is calculated for the axial crack to penetrate through the remaining 25% of the wall thickness.

- The relatively large thickness of the subject Alloy 82/182 weld (4.813 inches) compared to other Alloy 82/182 butt welds in U.S. PWRs is a major factor in these calculated crack growth times. As the wall thickness increases, the distance that the crack has to grow to exceed allowable depth increases.

These limiting axial crack growth calculation results reflect some key conservatisms that provide increased assurance of the structural integrity of the cold-leg piping at NAPS Unit 2:

- The limiting crack growth result is for axial flaws, which are not a credible concern for becoming unstable and causing rupture of the pressure boundary. This is because the critical flaw length of a through-wall axial flaw needed to cause unstable rupture in this case is much greater than the axial width of Alloy 82/182 weld metal susceptible to primary water stress corrosion cracking (PWSCC). For the limiting case, the calculated time for a flaw detectable via ultrasonic testing (UT), (i.e., initial depth of 10% through-wall), to grow though the weld thickness and cause leakage is 12.2 years.

- A universal weight function method was applied to accurately calculate the stress intensity factor resulting from the through-wall stress distribution. This approach does not fit a polynomial to approximate the stress profile, as is often the case when applying published solutions such as the method of influence coefficients. Fitting the stress profile to a polynomial can introduce a significant source of modeling uncertainty depending on the accuracy of the fit obtained. Conservatism results from assuming that the same through-wall weld residual stress (WRS) profile is present along the entire length of the modeled axial crack.

- For modeling axial cracks, the stress intensity factor calculation conservatively does not credit the effect of flaw total-length-to-depth aspect ratios ($2c/a$) below 1. Because of the lack of published solutions for this range of aspect ratios, a conservatism is introduced by assuming $2c/a = 1$ in the stress intensity factor calculations when $2c/a < 1$. This results in stress intensity factors at the deepest point on the crack somewhat greater than the true stress intensity factor corresponding to the true aspect ratio with identical crack loading. The end result is

a conservatism in the calculated crack growth time since the axial crack growth occurs with $2c/a < 1$ during most of the time.

Benefit of Alloy 52/152 Inlays

Based on existing fabrication records, the final inside diameter (ID) welding of the Steam Generator Cold Leg DM welds would have been completed using the Automated gas tungsten arc welding (GTAW) process with weld filler materials having a minimum chromium content of 28% (i.e, Alloy 52). The fabrication records also show that the Alloy 52 material would have filled the last 0.27" of the Safe-End DM weld groove. Documentation from Westinghouse engineering has confirmed it is conservative to assume a minimum of two weld layers were used in the application of the weld inlays, while maintaining the >24% chromium content of the weld surfaces that contact the primary water. After final machining, the Alloy 52 inlays have a nominal thickness of 0.13", and the Alloy 52 cladding tie-in to the nozzles have a nominal thickness of 0.22". Figure 1 illustrates the final configuration and filler materials used during the construction of the Nozzle-to-Safe-End DM welds. The completed DM welds received final visual, liquid penetrant, radiographic, and ultrasonic nondestructive examinations for ASME Section III and Section XI acceptance.

The inlays, applied prior to placing the equipment in service and exposing Alloy 82/182 weld material to primary water, provide expected benefit for both PWSCC initiation and growth. Even considering this benefit, the MRP-349 technical basis and the plant-specific crack growth evaluation do not credit the Alloy 52/152 inlays in any way. While the inlays provide additional assurance of quality and safety, this is not a request for these nozzle DM welds to be categorized as being mitigated per ASME Code Case N-770-2 and 10CFR50.55a.

Conclusions

- There are significant ALARA / radiological benefits, as well as scaffolding, insulation and mobilization cost benefits, associated with aligning the SG cold leg nozzle examinations with the SG hot leg nozzle examinations. That currently means the cold leg nozzles required to be examined within 7 years are either examined with the hot legs at 4.5 years (with 18 month cycles), or there is remobilization for the cold leg nozzle exams on a different frequency of 6 years (with 18 month cycles). Both of these alternatives impact outage scheduling and increase dose and resource costs. Increasing the cold leg nozzle exams from 7 years to 9 years while providing an acceptable level of quality and safety allows alignment of the cold leg and hot leg examinations while maintaining radiological and resource efficiencies.
- Conclusions from MRP-349 technical basis include: 1) all known incidents of cracking in large bore Alloy 82/182 piping welds have occurred in locations operating at hot leg temperatures or higher; 2) no safety or structural integrity concern has resulted from cold leg butt weld PWSCC to date; 3) the flaw tolerance analyses performed to date have shown that the critical crack sizes in large-diameter butt welds operating at cold leg temperatures are very large, and those that initiate take very long to grow to critical size; 4) analyses performed to

calculate the probability of failure for Alloy 82/182 welds using both probabilistic fracture mechanics and statistical methods have shown that the likelihood of cracking or through-wall leaks in large diameter cold leg welds is very small. Sensitivity studies performed using probabilistic fracture mechanics have shown that even for the more limiting high temperature locations, more frequent inspections than required by Section XI, such as that in MRP-139 or Code Case N-770, has only a small benefit in terms of risk. While the increased inspection frequency from Code Case N-770 may be needed for the more susceptible hot leg locations, it is not necessary to maintain an acceptable level of safety and quality for cold legs.

- The plant-specific crack growth evaluation concluded that more than 9 years is required for growth from the standard detectability limit to the allowable size per the ASME Section XI IWB-3640 flaw evaluation procedure.
- The flaw evaluation procedure also concluded that the crack growth rate for axial cracks was greater than for circumferential cracks, and axial flaws are bounding with respect to the growth time and not a credible concern for causing pipe rupture.
- The Alloy 52/152 weld inlays installed with the new steam generators prior to exposure to primary water provide additional assurance that crack initiation will be prevented in the Alloy 82/182 weld material.

The reexamination interval can be extended from 7 years as required by Code Case N-770 to the requested interval length of 9 years while maintaining an acceptable level of quality and safety. For these reasons, it is requested that the NRC authorize this proposed alternative in accordance with 10 CFR 50.55a(z)(1).

6. Duration of Proposed Alternative

The provisions of this alternative are applicable to:

- the fourth ten-year in-service inspection interval for NAPS which commenced on December 14, 2010 and will end on December 13, 2020, and
- the fifth ten-year in-service inspection interval for NAPS which will commence on December 14, 2020 and end on December 13, 2030, until the welds are examined during refueling outage N2R28, spring 2022.

7. Precedents

Similar proposed alternatives for unmitigated Alloy 82/182 piping butt welds were previously approved by the NRC for the following licensees:

Plant	NRC ADAMS Accession No.		Approval Date
	Relief Request	NRC Safety Evaluation	
Comanche Peak Unit 1	ML15300A013	ML16074A001	03/14/2016
Farley Units 1 and 2	ML14084A203	ML14262A317	12/05/2014
Indian Point Unit 2	ML13064A299	ML13310A575	11/14/2013
Indian Point Unit 3	ML14017A054	ML14199A444	08/04/2014
McGuire Unit 1	ML15083A045	ML15232A543	08/27/2015
South Texas Project Unit 1	ML15133A130	ML15218A367	08/21/2015
South Texas Project Unit 2	ML16076A319	ML16174A091	06/30/2016

8. References

1. ASME Boiler and Pressure Vessel Code, Section XI, 2004 Edition.

2. *Materials Reliability Program: PWR Reactor Coolant System Cold-Loop Dissimilar Metal Butt Weld Reexamination Interval Extension (MRP-349): A Basis for Revision to the Requirements of MRP-139 and American Society of Mechanical Engineers Code Case N-770 for Large-Diameter Welds at Cold-Leg Temperatures*. EPRI, Palo Alto, CA: 2012. 1025852. [freely available at www.epri.com]

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4. Dominion Engineering, Inc., "Crack Growth Analysis for NAPS Unit 2 Steam Generator Outlet Nozzles," Calculation No. C-4520-00-03, Rev. 0, dated December 20, 2017.

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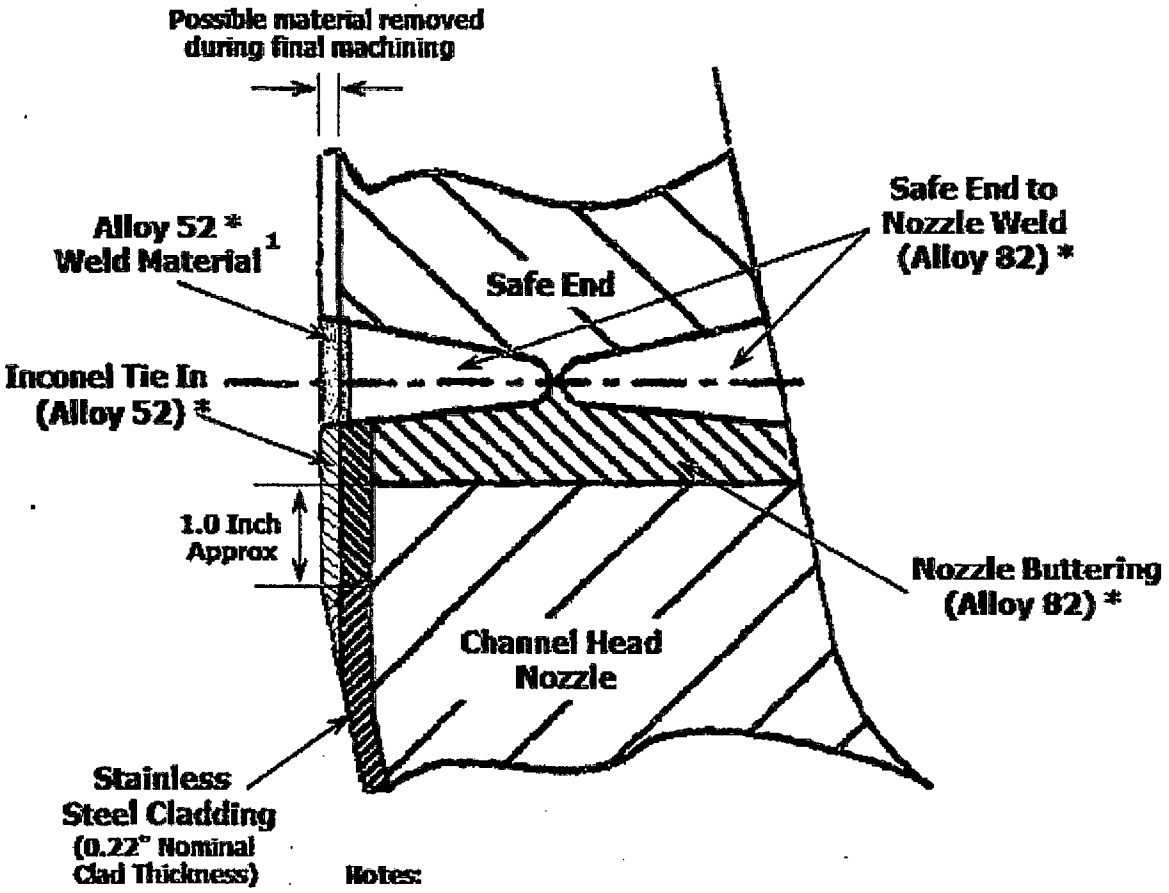
FIGURE 1



Notes:

1) 0.27" minimum deposited thickness of Alloy 52 prior to final machining of the Safe End and Nozzle Bore inside diameter.

Approx. 0.13" nominal Alloy 52 deposit thickness following final machining.

* Note: The above sketch details the weld classifications used during fabrication based on available records. The actual weld materials/classifications used may vary depending on the fabrication repair history for the individual Nozzle-to-Safe End Dissimilar Metal Welds.