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CALCULATION SUMMARY SHEET (CSS)

Document Identifier 32-9049828-000

Title North Anna Units 1 & 2 Weld Overlay - Piping Evaluation

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METHOD: ☑ DETAILED CHECK ☐ INDEPENDENT CALCULATION

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COST CENTER 41304 REF. PAGE(S) 7

TM STATEMENT: REVIEWER INDEPENDENCE

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PURPOSE AND SUMMARY OF RESULTS:

Purpose:
This document is a non-proprietary version of AREVA NP Document 32-9038670-001. The proprietary information removed from 32-9038670-001 is indicated by a pair of square brackets "[ ]".

The purpose of this document is to evaluate the impact of the Pressurizer Surge Nozzle, Spray Nozzle, Safety Nozzles and Relief Nozzle Weld Overlays on the attached piping. The Weld Overlays will be evaluated from the following aspects:

A. Increased stiffness at the joint due to increased thickness in the localized area

B. Increased weight due to the increased thickness in the localized area

C. Changes in loadings due to thermal contraction caused by the weld cooling process

Results:

The weld overlay process has no significant impact on loads in the Unit 1 and 2 surge lines, spray lines, safety lines or relief lines. In addition, the weld overlays have no significant impact on the seismic response of the pressurizer. Therefore, the weld overlays meet the requirements specified in ASME Code Case N-740-1 with respect to their impact on attached piping and supports.

THE FOLLOWING COMPUTER CODES HAVE BEEN USED IN THIS DOCUMENT:

CODE/VERSION/REV	CODE/VERSION/REV

THE DOCUMENT CONTAINS ASSUMPTIONS THAT MUST BE VERIFIED PRIOR TO USE ON SAFETY-RELATED WORK

☐ YES
☒ NO

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DESIGN VERIFICATION CHECKLIST

Document Identifier 32 - 9049828 - 000

Title North Anna Units 1 & 2 Weld Overlay - Piping Evaluation

1.	Were the inputs correctly selected and incorporated into design or analysis?	☒ Y	☐ N	☐ N/A
2.	Are assumptions necessary to perform the design or analysis activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	☐ Y	☐ N	☒ N/A
3.	Are the appropriate quality and quality assurance requirements specified? Or, for documents prepared per AREVA NP Inc. procedures, have the procedural requirements been met?	☒ Y	☐ N	☐ N/A
4.	If the design or analysis cites or is required to cite requirements or criteria based upon applicable codes, standards, specific regulatory requirements, including issue and addenda, are these properly identified, and are the requirements/criteria for design or analysis met?	☐ Y	☐ N	☒ N/A
5.	Have applicable construction and operating experience been considered?	☐ Y	☐ N	☒ N/A
6.	Have the design interface requirements been satisfied?	☐ Y	☐ N	☒ N/A
7.	Was an appropriate design or analytical method used?	☒ Y	☐ N	☐ N/A
8.	Is the output reasonable compared to inputs?	☒ Y	☐ N	☐ N/A
9.	Are the specified parts, equipment and processes suitable for the required application?	☐ Y	☐ N	☒ N/A
10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	☐ Y	☐ N	☒ N/A
11.	Have adequate maintenance features and requirements been specified?	☐ Y	☐ N	☒ N/A
12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	☐ Y	☐ N	☒ N/A
13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	☐ Y	☐ N	☒ N/A
14.	Has the design properly considered radiation exposure to the public and plant personnel?	☐ Y	☐ N	☒ N/A
15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	☐ Y	☐ N	☒ N/A
16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	☐ Y	☐ N	☒ N/A
17.	Are adequate handling, storage, cleaning and shipping requirements specified?	☐ Y	☐ N	☒ N/A
18.	Are adequate identification requirements specified?	☐ Y	☐ N	☒ N/A
19.	Is the document prepared and being released under the AREVA NP Inc. Quality Assurance Program? If not, are requirements for record preparation review, approval, retention, etc., adequately specified?	☒ Y	☐ N	☐ N/A

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DESIGN VERIFICATION CHECKLIST

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Comments:

Verified By:	JR Harrington		5-2-07
(First, MI, Last)	Printed / Typed Name	Signature	Date

Page : 3.

Record of Revisions

Revision	Description	Date
000	Original Issue	5/07

Table of Contents

1. Purpose

The purpose of this document is to evaluate the impact of the Pressurizer Surge Nozzle, Spray Nozzle, Safety Nozzles and Relief Nozzle Weld Overlays on the attached piping. The Weld Overlays will be evaluated from the following aspects:

A. Increased stiffness at the joint due to increased thickness in the localized area

B. Increased weight due to the increased thickness in the localized area

C. Changes in loadings due to thermal contraction caused by the weld cooling process

2. Assumptions

There are no "key assumptions" used in this evaluation that require verification.

3. References

1. Surge Line Drawings (See Note)
   A. Dominion Document 11715-FP-9A, Rev. 15, "Reactor Coolant Piping – Sheet 1 – North Anna Power Station Unit 1".
   B. Dominion Document 11715-FP-9B, Rev. 13, "Reactor Coolant Piping – Sheet 2 – North Anna Power Station Unit 1".
   C. Dominion Document 12050-FP-9A, Rev. 10, "Reactor Coolant Piping – Sheet 1 – North Anna Power Station Unit 2".
   D. Dominion Document 12050-FP-9B, Rev. 10, "Reactor Coolant Piping – Sheet 2 – North Anna Power Station Unit 2".

2. AREVA Document 02-8017167D-000, "North Anna Pressurizer Surge Nozzle Overlay Design".

3. AREVA Document 02-8017177D-001, "North Anna Pressurizer Safety Nozzle Overlay Design".

4. AREVA Document 02-8017175D-001, "North Anna Pressurizer Spray Nozzle Overlay Design".

5. AREVA Document 02-8017182D-001, "North Anna Pressurizer Relief Nozzle Overlay Design (1-PRZ-20)".

6. AREVA Document 51-9031151-002, "North Anna Units 1 and 2 Pressurizer Nozzle Weld Overlays – Technical Requirements".

7. AREVA Document 38-9042859-000, "ASME Code Case N-740-1 (2-1-2007 Draft), "Dissimilar Metal Weld Overlay for Repair of Class 1, 2 and 3 Items – Section XI, Division 1".

8. Safety Line Support Drawing (See Note)
   A. Dominion Document 12050-FV-69A, Rev. 6, "Pressurizer Safety Valve Restraints – North Anna Power Station Unit 2".

9. Surge Line Restraint Drawings (See Note)
   Unit 1:
   A. Dominion Document 11715-FV-83A, Rev. 2, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 1 – North Anna Power Station Unit 1".
   B. Dominion Document 11715-FV-83B, Rev. 2, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 2 – North Anna Power Station Unit 1".
   C. Dominion Document 11715-FV-83J, Rev. 1, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 9 – North Anna Power Station Unit 1".
   D. Dominion Document 11715-FV-83L, Rev. 2, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 11 – North Anna Power Station Unit 1".

Unit 2:

E. Dominion Document 12050-FV-83A, Rev. 4, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 1 – North Anna Power Station Unit 2".

F. Dominion Document 12050-FV-83M, Rev. 2, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 12 – North Anna Power Station Unit 2".

G. Dominion Document 12050-FV-83L, Rev. 3, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 11 – North Anna Power Station Unit 2".

H. Dominion Document 12050-FV-83E, Rev. 3, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 5 – North Anna Power Station Unit 2".

I. Dominion Document 12050-FV-83F, Rev. 3, "Pipe Break Restraints – Pressurizer Surge Line – Sheet 6 – North Anna Power Station Unit 2".

10. AREVA Document 38-9045875-000, "Change to Purchase Order for Load Due to Axial Shrinkage of Safety Nozzle Line".

Note: This reference is not available from the AREVA NP Inc document control system. This reference is available from the Dominion document control system. Therefore, this is a valid reference for this contract per AREVA NP Inc procedure 0402-01.

Project Manager

4. Design Input

1. Design dimensions for the weld overlays for the surge nozzle, spray nozzle, safety nozzles and relief nozzle are taken from references 2, 3, 4 and 5.

2. Size and length of the surge line is taken from information in references 1A – 1B. Based on the drawings, the total lengths for the Unit 1 and Unit 2 surge lines are approximately [ ] and [ ], respectively. Therefore, the total length considered for the surge line is conservatively considered as [ ] to bound the evaluations for the two plants.

3. The maximum allowable axial weld shrinkage is specified in reference 6 (Section 3.16) as [ ]. This value is not used specifically in this analysis as this is a qualitative evaluation. However, if the axial weld shrinkage exceeded the allowable value significantly, additional evaluations or analysis may become necessary to determine the impact on supports.

4. Code Case N-740-1 (Ref. 7) provides requirements to be considered in evaluating the impact of axial weld shrinkage on attached piping and supports. These requirements are met by evaluating the impact of the weld overlay on stiffness, weight and thermal expansion loads.

5. Each of the three safety nozzle discharge lines are rigidly supported by an anchor in close proximity to the pressurizer safety nozzle. The support is shown in reference 8. In order to allow for the shrinkage in the safety nozzles after the weld overlay is installed, the piping between the nozzle and the anchor, just downstream of the nozzles, will be cut and rewelded, as discussed in reference 10.

5. Evaluation

In this section, evaluations of the impact of the Weld Overlays on the loads in the piping are evaluated for three aspects: 1) increased stiffness, 2) increased weight and, 3) thermal contraction.

5.1. Increased Stiffness

1. Surge Nozzles

The weld overlay increases the thickness of the Unit 1 and 2 surge nozzles from [ ] to approximately [ ]. The ID of the surge line is [ ].

The flexural moment of inertia of a pipe cross section is calculated as follows:

$$I = \frac{\pi}{4}(Ro^4 - Ri^4)$$

This gives the following values based on the dimensions above:

[ ]
[ ]

The moment of inertia at the location of the weld overlay increases by [ ]. However, the loads in a pipe are more a function of the average moment of inertia of the entire line because stiffness of a continuous beam is an integral over the entire length. In addition, the change in stiffness is near the analytical anchor for the pipe (nozzle), which would cause the change in stiffness to be even less of an impact to the piping loads.

Therefore, considering a conservatively low total length of [ ] (Section 4.2), the average moment of inertia is calculated as follows:

[ ]

This gives an increase of [ ], which is negligible.

As shown above, the change in the average moment of inertia is negligible. Therefore, there is a negligible impact on loads in the surge line due to the increased stiffness of the weld overlay. In addition, the overlay is mostly covering the thicker portions of the nozzle, which were already reinforced. Typically, these areas are considered in the piping analyses as fixities, because they are significantly stiffer than the rest of the pipe.

2. Spray Nozzles/Safety Nozzles/Relief Nozzles

As shown above for the surge nozzles, even significant changes in thickness over short lengths have an insignificant impact on loads in the pipe. The weld overlays for the spray nozzle, safety nozzles and relief nozzle have a similar geometry except that the diameters are significantly smaller. In addition, in each case, the overlay is mostly covering the thicker portions of the nozzle, which were already reinforced. Typically, these areas are considered in the piping analyses as fixities, because they are significantly stiffer than the rest of the pipe.

Therefore, there is no significant impact on loads in the spray lines, safety lines or relief lines due to the increased stiffness of the weld overlays.

5.2. Increased Weight

The increased weights of the weld overlays are insignificant relative to the weights of the attached piping. In each case, the additional weight is at the nozzle, which would be considered a fixity in the analysis. Therefore, the impact on seismic loads would be negligible because the seismic accelerations would be the zero period acceleration (ZPA) at the location, which are [ ].

An additional consideration is the impact of the additional weight on the seismic response of the pressurizer. As discussed above, in terms of the impact on attached piping, the weight of the weld overlays are insignificant relative to the weight of the pressurizer, which typically has a total operating weight of greater than [ ], whereas the additional weight due to the weld overlays will be less than [ ]. Using these values gives a ratio of overlay weight to component weight of [ ], which is considered negligible.

Therefore, the additional weight on the surge nozzles, spray nozzles, safety nozzles and relief nozzles has no significant impact on the deadweight and seismic loads at the nozzle, on the attached piping or on the pressurizer.

5.3. Thermal Contraction Loading

A well-known impact of welding is weld shrinkage. When a weld overlay in a pipe is made, the weld metal will shrink as it cools, compressing the pipe radially and longitudinally. According to reference 6, the average axial weld shrinkage should be limited to [ ]. Even this small amount of shrinkage may have an impact on loads in the attached pipe. This process, and the loading involved, is very similar to that which would be experienced during original construction in the final weld of the pipe. This weld shrinkage is not commonly considered in the stress analysis of the pipe because it is a one time event that does not impact fatigue usage of the line. In addition, it is not considered a primary stress because it can be relieved with relaxation in the pipe.

Therefore, although the weld overlay may have some impact on the stresses in the pipe at cold and hot conditions, there is no impact on the stress and fatigue calculations that have been performed for the line.

The spray and relief lines attached to the top of the pressurizer (spray, relief) are designed to withstand vertical thermal growth of the pressurizer of [ ]. Therefore, the supports for these lines must be designed to allow large displacements without binding. The vertical supports are typically constructed with snubbers and constant load spring cans, which can withstand large thermal displacements. The overlay weld shrinkage will not change the thermal anchor motion of the pipe. However, the location of the pipe at cold locations may differ slightly. This may require the supports to be adjusted after the overlays are installed, but will not impact loads in the piping or supports.

The safety line is designed such that the anchor, which is in close proximity to the nozzle, moves along with the thermal growth of the pressurizer. This allows for the vertical growth without applying a significant load to the support or the piping. However, since the anchor is in close proximity to the nozzle, there is not sufficient flexibility in the pipe to allow axial shrinkage without significant loads in the piping, nozzles and support. Therefore, the piping between the nozzles and the anchors will be cut and rewelded to account for the shrinkage, as stated in Section 4.5. This will alleviate any loads due to shrinkage.

The surge line is the only line not attached to the top of the pressurizer that will have a weld overlay installed. Because the anchor point for this line is very near the anchor point for the pressurizer (skirt flange), it does not see a significant level of thermal anchor motions. However, the surge line is very long and flexible, as demonstrated in Section 5.1.1 and, therefore, the [ ] axial shrinkage should not significantly impact any supports in the system.

Each of the Unit 1 and Unit 2 surge lines have rupture restraints at various locations. As there are several different designs and gaps, each will be considered separately.

Unit 1 Surge Line Rupture Restraints:

Reference 9A provides the overall layout for the rupture restraints on the North Anna Unit 1 surge line. Of the 10 restraints depicted on the drawing, only 4 are vertical restraints (1-RC-PRR-163, 1-RC-PRR-69, 1-RC-PRR-164, 1-RC-PRR-60) that could be impacted by the axial shrinkage, which will be in the vertical direction.

1-RC-PRR-163 (Ref. 9C) – [

]

1-RC-PRR-69 (Ref. 9A) – [

]

1-RC-PRR-164 (Ref. 9D) – [

]

1-RC-PRR-60 (Ref. 9B) – [

]

Unit 2 Surge Line Rupture Restraints:

Reference 9E provides the overall layout for the rupture restraints on the North Anna Unit 2 surge line. Of the 6 restraints depicted on the drawing, only 4 are vertical restraints (2-RC-PRR-163, 2-RC-PRR-164, 2-RC-PRR-56, 2-RC-PRR-59) that could be impacted by the axial shrinkage, which will be in the vertical direction.

2-RC-PRR-163 (Ref. 9F) – [

]

2-RC-PRR-164 (Ref 9G) – [

]

2-RC-PRR-56 (Ref 9H) – [

]

2-RC-PRR-59 (Ref 9I) – [

]

5.4. Computer Output to Laser Disk (COLD) Listing

Not applicable as there is no computer output associated with this evaluation.

6. Conclusion

As discussed in Section 5 of this document, the weld overlay process has no significant impact on loads in the Unit 1 and 2 surge lines, spray lines, safety lines or relief lines. In addition, the weld overlays have no significant impact on the seismic response of the pressurizer. Therefore, the weld overlays meet the requirements specified in ASME Code Case N-740-1 with respect to their impact on attached piping and supports.