Constellation Energy
Nine Mile Point Nuclear Station

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July 2, 2004
NMP1L 1846

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

SUBJECT: Nine Mile Point Unit 1
Docket No. 50-220
License No. DPR-63

Response to NRC Staff Preliminary Questions Regarding Structural Flaw Evaluation Methodology Provided via Email dated April 8, 2004 (TAC MC0930)

Gentlemen:

By letter NMP1L 1776 dated September 19, 2003, Nine Mile Point Nuclear Station, LLC (NMPNS) submitted to the NRC a structural flaw evaluation for a subsurface flaw indication found in a Nine Mile Point Unit 1 (NMP1) reactor pressure vessel closure head meridional weld. By email on April 8, 2004, the staff forwarded a list of questions for discussion, directed at the treatment of cladding stress in the methodology supporting the submitted evaluation. The staff noted that the ASME XI, Appendix A methodology employed in the evaluation does not consider cladding stresses and gave NMPNS the option of demonstrating that these stresses are insignificant or, alternatively, answering a series of clarifying questions about evaluation methodology. A telephone conference call was held on May 6, 2004, during which the licensee provided the requested justification for not considering cladding stresses in the evaluation, stating that such an approach was conservative with respect to evaluation of the flaw in question. This submittal provides a written response consistent with the justification provided during the conference call.

NRC Question:

The flaw evaluation methodology in Appendix A of Section XI of the ASME Code does not consider cladding stresses. You have the option to (1) demonstrate that the impact due to cladding stresses on the acceptability of the detected reactor pressure vessel closure head flaw according to the Section XI requirements is insignificant, or (2) answer the following questions to support your modified flaw evaluation methodology....

Response to Option 1:

According to NRC approved BWRVIP-60-A, Section 6.1, cladding of the vessel results in tensile

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residual stresses in the clad material and compressive or near-zero stress in the vessel plate material beneath the clad. It is noted that such a distribution is needed to produce force equilibrium on the vessel wall cross section. This distribution can be seen in BWRVIP-60-A, Figures 6.1, 6.2 and 6.3. The BWRVIP-60-A figures show typical stress profiles consistent with that assumed for the subsurface flaw in question. Based on these figures and the location of the subsurface flaw, it is conservative to neglect the effects of cladding residual stresses for determining the allowable flaw size.

Additional qualitative basis for not including cladding stresses in the flaw evaluation is provided in the attached letter from Structural Integrity Associates, Inc. NMPNS has reviewed the attached letter and concurs with the conclusions presented.

On the basis of the above and attached evaluation, NMPNS concludes that the impact due to cladding stresses on the acceptability of the detected fabrication related subsurface flaw according to the ASME Section XI requirements is either beneficial or not significant. As such, the cladding stresses were neglected in the flaw evaluation.

Very truly yours,

William C. Holston
Manager, Engineering Services

WCH/JRH/jm

Attachment

cc: Mr. H. J. Miller, NRC Regional Administrator, Region I
Mr. G. K. Hunegs, NRC Senior Resident Inspector
Mr. P. S. Tam, Senior Project Manager, NRR (2 copies)

Structural Integrity Associates, Inc.

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May 24, 2004
AFD-04-018
SIR-04-060, Rev. 0

Mr. Roy Corieri
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Subject: Discussion of Effect of Cladding-Induced Stresses on Evaluation of Nine Mile Unit 1 Closure Head Flaw Evaluation

References:

1) Email from Peter Tam (NRC) to John J. Dosa and M. Steven Leonard, "Draft RAI on Your 9/19/03 Letter re. NMP1 RPV Flaw Evaluation (TAC MC0930)", April 8, 2004
2) SIR-03-036, "Nine Mile Point Unit 1 RPV Closure Head Flaw Evaluation," Structural Integrity Associates, July 22, 2003
3) ASME Code, Section XI, 1989 Edition
4) Rybicki, E. F., et al, "Experimental and Computational Residual Stress Evaluation of a Weld Clad Plate and Machined Test Specimens," *Journal of Engineering and Materials*, October 1988, Vol. 110, Page 297
5) Jones, D. P. et al, "Residual Stresses in Weld-Deposited Clad Pressure Vessels and Nozzles," *Journal of Pressure Vessels and Piping*, November 1999, Vol. 121, Page 423.

Dear Roy

The following provides an answer to the first issue identified in Reference 1. The issue identified the question "...flaw evaluation methodology of Appendix A of Section XI of the ASME Code does not consider cladding stresses. You have the option to (1) demonstrate that the impact due to cladding stresses on the acceptability of the detected reactor pressure vessel closure head flaw according to the Section XI requirements is insignificant, or (2) answer the following questions to support your modified flaw evaluation methodology."

The modified flaw evaluation methodology referred to in option (2) of the NRC Staff's question was that documented in Reference 2 that addresses the approach used for evaluating stress intensity factors for surface connected flaws. Thus, it had no bearing on the evaluation of the 0.15-inch depth (a) by 7-inch long (l) sub-surface flaw with distance between the clad-to-base metal surface and the nearest crack tip of 0.2 inches. This flaw is completely contained in the top head base metal. As such, the following discussion only pertains to option (1) of the Staff's question:

In the fabrication of reactor pressure vessels, the cladding is applied by welding while the base metal is cold. Thus, there is a tendency for the cladding to develop high tensile stresses as the molten weld metal cools. For force equilibrium across the vessel wall, this tends to produce compressive stresses in the underlying base material. In addition, the relative values of the coefficients of thermal expansion tend to produce reduced stresses in the cladding and base metal as the vessel heats up.

For evaluation of subsurface flaws, the stress distribution in the metal across the surface of the flaw is the driving force important in determining the stress intensity factor. The stresses in the material beyond the crack tip have no bearing on the stress intensity factor developed at the crack tips. This is reflected in the ASME Code Section XI Appendix A [Reference 3] for subsurface flaws (Figure A-3200-1 (b)) that requires that the stresses at the crack tips of the flaw be used in the linearization to determine the membrane and bending components of the stresses used to evaluate the flaw.

There is a large body of data on the residual stresses in welded clad plate as a result of the application of stainless steel cladding. References 4 and 5 are typical. Figure 1 (from Reference 4) shows the envelope of the residual stresses due to cladding in plate material with a thickness comparable to the NMP top head. This figure demonstrates the discussion in both References 4 and 5 and shows that the room temperature stresses in the cladding are tensile, while the stresses in the base metal are very near zero or compressive. For the NMP flaw that extended from about 10.6 mm to 18.2 mm from the clad ID surface, this figure would indicate that the cladding induced stresses would be compressive at the point nearest the clad-to-base metal interface, and either near zero or compressive at the point nearest the center of the plate. Other figures in References 4 and 5 show that stresses in the entire region are compressive.

One other point is that the membrane stress correction factors for subsurface flaws at Point 1, which is the location that is nearest the surface of the plate, are relatively greater than those deeper into the vessel wall, as demonstrated in the graphs of Figures A-3300-2 and A-3300-4 of Section XI, Appendix A [Reference 3]. Since the stresses are compressive in the region of Point 1 of the NMP flaw, the above-referenced figures clearly demonstrate that the stress intensity factors would be more negative in the regions very near the clad-to-base metal interface. Thus, the effect of the cladding-induced stress is to produce a net small reduction in stress intensity factor for the NMP subsurface flaw.

Thus, it is concluded that the impact due to neglecting cladding stresses on the acceptability of the detected reactor pressure vessel closure head flaw according to the Section XI requirements is either beneficial or not significant.

Prepared by:	Reviewed by:	Approved by:
A. F. Deardorff, P.E.	N. G. Cofie, PhD	G. L. Stevens, P.E.

ml
cc: NMP-12Q-402

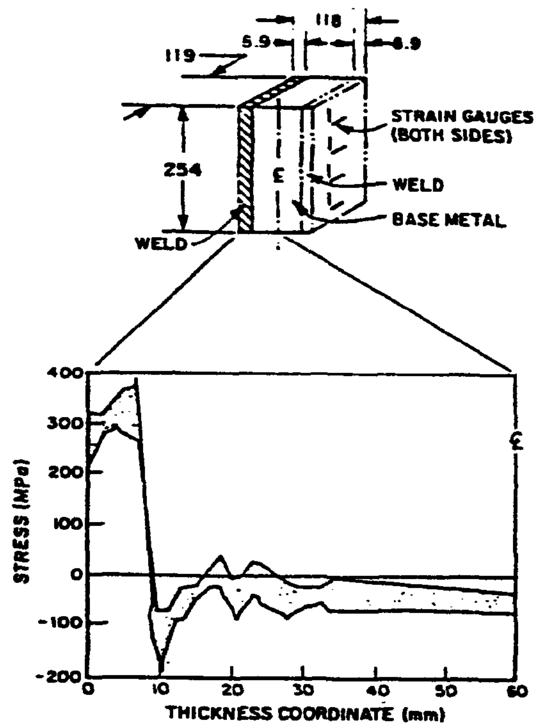

Fig. 3(a) Envelope of longitudinal and transverse distributions at four locations

Figure 1. Typical Stress Distribution in a Clad Plate [from Reference 4]