September 20, 2012

MEMORANDUM TO: Thomas A. Bergman, Director
Division of Engineering
Office of New Reactors

FROM: Michael J. Case, Director ***/RA/***
Division of Engineering
Office of Nuclear Regulatory Research

SUBJECT: WELD RESIDUAL STRESS ANALYSIS OF NARROW GAP WELD WITH REPAIR

In June, 2012, NRO/DE/CIB requested technical assistance from RES/DE/CIB in assessing the magnitude and distribution of weld residual stresses (WRS) in a narrow gap dissimilar metal (DM) Alloy 52/152 weld, and evaluating the change in WRS caused by grind-out and re-weld repair from the weld inner diameter. The attached PowerPoint file provides details of the analysis completed by RES/DE/CIB. This information has been discussed with members of your staff and Region II.

The stress analysis was completed using finite element based techniques developed by NRC staff, its contractors, and industry, and refined through an NRC sponsored validation program completed cooperatively with the Electric Power Research Institute under an Addendum to the Memorandum of Understanding. The results indicate that WRS are compressive near the weld inner diameter following initial deposition of the narrow gap weld, but become highly tensile in the same region following the weld repair. The change in stress state due to the repair for the narrow gap weld is consistent with the validation program findings.

The analysis demonstrates that weld repairs can have a detrimental effect on DM weld integrity, in that susceptibility to primary water stress corrosion cracking (PWSCC) may be increased. The analysis evaluates the stresses that exist in the weld following attachment of the stainless steel safe end to the carbon steel nozzle. To assess the DM WRS state that would exist while the plant is operating, two additional steps would need to be performed:

1. Simulate attachment of the stainless steel safe end to stainless steel piping
2. Apply operating temperature and pressure to the nozzle/weld/pipe configuration

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Each of these components can effect WRS in DM welds, and subsequent PWSCC susceptibility. Further, design basis loads, including deadweight, thermal expansion, and seismic will effect overall stress state within the weld.

If there are any questions regarding this analysis, please feel free to contact Howard J. Rathbun of my staff at 301-251-7647 and David Rudland @ 301-251-7627.

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