

July 30, 2015

MEMORANDUM TO: Lawrence J. Burkhart, Chief
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Division of New Reactor Licensing
Office of New Reactors

FROM: Chandu P. Patel, Senior Project Manager */RA/*
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SUBJECT: SUMMARY OF VOGTLE ELECTRIC GENERATING PLANT UNITS 3
AND 4, AND VIRGIL C. SUMMER UNITS 2 AND 3, COMBINED
LICENSES, AUDIT RELATED TO USE OF AWS D1.1-2000 CRITERIA
FOR STRUCTURAL WELDS (LAR 15-009R)

The U.S. Nuclear Regulatory Commission staff conducted an audit of documents related to the Vogtle Electric Generating Plant Units 3 and 4, and Virgil C. Summer Units 2 and 3, combined licenses, specifically documents related to proposed license amendment request (LAR) 15-009 and LAR 15-09 respectively. The audit was conducted and completed on July 8, 2015. A summary of the audit is enclosed.

Docket Nos.: 52-025 and 52-026
52-027 and 52-028

Enclosure:
As stated

July 30, 2015

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License Amendment Request (LAR) 15-009, Vogtle Units 3 and 4, and
LAR 15-09 for Virgil C. Summer Units 2 and 3.
Use of AWS D1.1-2000 Criteria for Structural Welds Design Detail Review Audit Report

Nuclear Regulatory Commission's (NRC) Audit Team:

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1.0 SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) staff conducted an audit at the Westinghouse Electric Company's (Westinghouse) Rockville Office located in Rockville, Maryland on July 8, 2015, in accordance with the NRC's Office of New Reactors (NRO) Office Instruction NRO-REG-108, "Regulatory Audits." The audit plan for the Licensing Amendment Request (LAR) can be found in the Agencywide Documents Access and Management System (ADAMS) under Accession Number ML15188A426. The following Westinghouse proprietary document was made available to the NRC staff:

- APP-CA00-S3C-005, Rev. 1, "FEA of Circular Fillet Weld Subject to Out-of-Plane Loading."

2.0 PURPOSE

The purpose of the audit was to review design reports and calculations associated with LAR 15-009 for the use of American Welding Society, AWS D1.1-2000, criteria for structural weld design.

3.0 BACKGROUND

In June 2015, Southern Nuclear Company, and South Carolina Electric and Gas Company submitted LAR 15-009, Rev. 2, related to proposed Updated Final Safety Analysis Report (UFSAR) changes to use AWS D1.1-2000. This code includes provisions for the application of directionality to linear fillet weld groups concentrically loaded in plane and perpendicular to the axis of weld. The licensees' submittal extends this provision to rectangular and circular fillet weld groups concentrically loaded out of plane. During review of the LAR, the staff observed that the changes involved fillet weld design details supported by finite element analysis (FEA). The detailed Westinghouse proprietary calculation supporting the fillet weld design FEA is referenced in the LAR. For the purpose of confirming the staff's understanding of the requested design changes, staff performed an audit of the aforementioned supporting calculation. The main focus of the audit was to understand the licensees' approach for performing detailed linear and non-linear analyses and benchmark study of the fillet weld design.

Enclosure

4.0 OBSERVATIONS AND RESULTS RELATED TO FILLET WELD DESIGN

During the audit, staff performed a review of the supporting calculation and engaged in discussions with the licensees and Westinghouse technical staff regarding the design and analysis assumptions made in the design report.

Staff review of the report found that the overall design and analysis approach was consistent with codes and standards referenced in the UFSAR (i.e., ACI 349-01 and ANSI/AISC N690-1994). In particular, the staff reviewed the three step FEA process to verify that the analyses predict a similar result as the testing report by Gomez et al. referenced in the LAR. Below are the three steps in the FEA calculation report:

1. **Linear elastic analysis:** The FEA (ANSYS) with linear material properties of three fillet weld configurations, a) linear, b) rectangular, and 3) circular. The analysis focuses on the behavior of the fillet welds instead of capacities. The analyses confirmed the shift of potential weld failure plane for all of the fillet weld configurations.
2. **Nonlinear Benchmarking:** A quarter cruciform geometry FE model with nonlinear material properties is developed to validate test results in the Gomez report. In particular, the calculated fillet weld capacity agrees well with the test data.
3. **Nonlinear parametric study:** A “slice” of FE models with nonlinear material properties is developed to investigate the effects of fillet weld shape, size, length, and the weld connections in four groups.

The pressure loading is applied concentrically in all of the steps. The staff also reviewed one of the ANSYS input files to confirm the loading and boundary conditions of the FE models which are fixed at the bottom face of the FE models opposite to the pressure loading. For “slice” FE models, symmetry boundary conditions are also applied, as the geometries and boundary conditions are symmetric in the direction of loading.

The analyses demonstrated the angle shift of the failure plane when the weld is subject to loading transverse to the weld axis. The shape of the welds (i.e., line, rectangular or circle) is insignificant to the failure plane shift. The stresses in circular welds are comparable with linear welds with equivalent length. The shape of the welded part, either a solid bar or a tube, does not have a significant effect on the circular weld stresses.

Based on comparing the FEA analysis and the Gomez report testing results, the staff finds that extending directionality provisions of AWS D1.1-2000 using an increased factor of 1.5 is appropriate for the linear fillet welds and circular fillet welds when subject to concentrically loading out of plane.

5.0 CONCLUSION

At the audit exit meeting, NRC staff informed the licensees that the audit was productive and that support by the licensees and contractors led to quick resolution of technical questions. The audit tasks identified in the audit plan were all accomplished.

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(Revised 07/22/2015)

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