



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 30, 2017

Mr. Fadi Diya
Senior Vice President and
Chief Nuclear Officer
Union Electric Company
P.O. Box 620
Fulton, MO 65251

SUBJECT: CALLAWAY PLANT, UNIT NO. 1 – REVIEW OF SURVEILLANCE CAPSULE W
ANALYSIS FROM REACTOR PRESSURE VESSEL SURVEILLANCE
PROGRAM (CAC NO. MF9259)

Dear Mr. Diya:

By letter dated October 15, 2015, Union Electric Company (Ameren Missouri, the licensee) submitted an evaluation of the testing results of surveillance Capsule W from the Callaway Plant, Unit No. 1 (Callaway) reactor vessel titled WCAP-18001-NP, Revision 0, "Analysis of Capsule W from the Ameren Missouri Callaway Unit 1 Reactor Vessel Radiation Surveillance Program." The evaluation was submitted in accordance with the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements."

The reported reactor vessel capsule fluence values for Callaway were determined using the RAPTOR-M3G computer code, which has not been reviewed and approved by the U.S. Nuclear Regulatory Commission (NRC) staff. The NRC staff compared the RAPTOR-M3G fluence values for Capsule W to those that had been determined previously by use of NRC-approved Westinghouse fluence methods, and concluded the submittal does not present or imply a safety-significant issue. The NRC staff also concluded that the submittal met the reporting requirements pursuant to Appendix H to 10 CFR Part 50. Therefore, no further action from the NRC staff is warranted at this time.

The results of the NRC staff's review are provided in the enclosure to this letter, and should not be constructed as NRC approval for use of RAPTOR-M3G as a method for evaluation. The use of RAPTOR-M3G would require appropriate incorporation of the methodology into the Callaway licensing basis.

With the receipt of WCAP-18001-NP, Revision 0, the Callaway Pressure and Temperature Limits Report (PTLR) document will require revision. By letter dated March 9, 2017, the licensee submitted Revision 7 to the Callaway PTLR in accordance with Technical Specification 5.6.6.c.

F. Diya

- 2 -

If you have any questions, please contact me at 301-415-5136 or via e-mail at John.Klos@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "L. John Klos". The signature is written in a cursive, somewhat stylized font.

L. John Klos, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosure:
Review of Surveillance Capsule W
Analysis

cc w/encl: Distribution via Listserv



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF NUCLEAR REACTOR REGULATION

REVIEW OF SURVEILLANCE CAPSULE W ANALYSIS FROM

REACTOR PRESSURE VESSEL SURVEILLANCE PROGRAM

UNION ELECTRIC COMPANY

CALLAWAY PLANT, UNIT 1

DOCKET NO. 50-483

1.0 INTRODUCTION AND BACKGROUND

By letter dated October 15, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15288A518), Union Electric Company (Ameren Missouri, the licensee) submitted an evaluation of the testing results of surveillance Capsule W from the Callaway Plant, Unit No. 1 (Callaway) reactor vessel (RV) titled WCAP-18001-NP, Revision 0, "Analysis of Capsule W from the Ameren Missouri Callaway Unit 1 Reactor Vessel Radiation Surveillance Program." The evaluation was submitted in accordance with the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements."

The regulations in 10 CFR Part 50, Appendix H require that nuclear power plants install and, at certain intervals, remove and analyze the changes in fracture toughness of the RV materials contained in the surveillance capsules. Irradiation surveillance of the RV is necessary to assure that the vessel material will maintain its fracture toughness throughout the service life of the plant. The surveillance capsule contains both dosimeters as well as archival material samples to be irradiated to levels comparable to those expected to be accrued by the RV at the end of its licensed period. This is accomplished by mounting the surveillance capsule in a location closer to the core to accelerate its exposure rate. The metric used for material embrittlement is the reference temperature for nil-ductility transition temperature RT_{NDT} .

In a letter dated October 15, 2015, the licensee reported that RAPTOR-M3G, a Westinghouse proprietary computer code, was used to analyze the fluence of surveillance Capsule W. The Callaway Technical Specification (TS) 5.6.6.b states that the methodology described in WCAP-14040-NP-A, "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS [Reactor Coolant System] Heatup and Cooldown Limit Curves," dated May 2004 (ADAMS Accession No. ML050120209) is to be used for generating RCS pressure-limit (P-T) curves in the Callaway Pressure and Temperature Limits Report (PLTR) document. WCAP-14040-NP-A, Revision 4, specifies that the Discrete Ordinates Radial Transport code package (DORT/TORT), developed by the Oak Ridge National Laboratory, is to be used in reactor dosimetry calculations, such as those performed as part of the surveillance capsule report. The RAPTOR-M3G code has neither been reviewed nor approved by the U.S. Nuclear Regulatory Commission (NRC) staff.

Enclosure

There are six surveillance capsules in Callaway RV material surveillance program, designated U, Y, V, X, Z and W, that were inserted before reactor startup between the neutron shielding pads and the vessel wall, at various azimuthal locations. Capsules U, Y, V, X, and Z have been removed and analyzed. This review addresses Capsule W, mounted at an azimuthal angle of 121.5 degrees with a lead factor of 4.02, and is limited to the requirements in Section IV, "Report of Test Results" of 10 CFR Part 50, Appendix H. Capsule W was removed at 25.75 effective full-power years (EFPYs) of operation, having received a neutron fluence of 5.98×10^{19} n/cm² (E > 1.0 MeV).

2.0 REGULATORY REQUIREMENTS

The RV surveillance program for Callaway, was established in accordance with 10 CFR Part 50, Appendix H, which requires licensees to monitor changes in the fracture toughness properties of ferritic materials in the RV beltline region of light-water nuclear power reactors. Appendix H states that the design of the RV surveillance program must meet the requirements of the edition of the American Society for Testing and Materials (ASTM) Standard E185, "Standard Practice for Conducting Surveillance Test for Light-Water Cooled Nuclear Power Reactor Vessels," that was current on the issue date of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code to which the RV was purchased; however, the licensee may choose to use later editions through 1982 of the ASTM standard. The requirements for the reporting of test results are described in Section IV of Appendix H to 10 CFR Part 50.

3.0 TECHNICAL EVALUATION

3.1 Review of RAPTOR-M3G

By letter dated October 15, 2015, the licensee transmitted WCAP-18001-NP, Revision 0, which provides the results of the testing of surveillance Capsule W from the Unit 1 RV. In WCAP-18001-NP, Revision 0, the licensee stated that all of the transport calculations supporting the analysis of the fluence of surveillance Capsule W were carried out using the RAPTOR-M3G computer code. Yet, RAPTOR-M3G has neither been reviewed nor approved by the NRC staff. WCAP-16083-NP, Revision 1, "Benchmark Testing of the FERRET Code for Least Squares Evaluation of Light Water Reactor Dosimetry," dated April 2013 (ADAMS Accession No. ML14353A028), compares RAPTOR-M3G against the TORT computer code in an effort to demonstrate the methodological equivalence between the two computer codes. However, the document has not been reviewed and approved by NRC staff.

Appendix A, "Validation of the Radiation Transport Models Based on Neutron Dosimetry Measurements," of WCAP-18001-NP, Revision 0 compares RAPTOR-M3G and least-squares adjusted values to measured dosimetry results for all surveillance capsules withdrawn to date in an effort to justify the use of RAPTOR-M3G. WCAP-18001-NP, Revision 0, also references the benchmarks provided in Appendix A of WCAP-16083-NP, Revision 1.

While the licensee used an unapproved computer code to analyze the fluence of surveillance Capsule W, the licensee does not identify a change to the Callaway licensing basis in the submittal dated October 15, 2015. As a result, the NRC has found that no-safety significant issue is presented or implied by the results of the capsule surveillance report.

3.2 Review of 10 CFR 50, Appendix H Reporting Requirements

Paragraph IV.A of Appendix H to 10 CFR Part 50 specifies that a summary technical report for each capsule withdrawal and the associated test results must be submitted within 1 year of the date of capsule withdrawal, unless an extension is granted by the Director, Office of Nuclear Reactor Regulation. Capsule W was removed during Refuel 20 (November 2014) at 25.75 EFPY, with a neutron fluence exposure equal to the projected peak vessel neutron fluence at approximately 115.4 EFPY. Based on the submittal of WCAP-18001-NP, Revision 0, by letter dated October 15, 2015, the NRC staff finds the licensee has fulfilled the reporting requirements of paragraph IV.A of 10 CFR Part 50, Appendix H.

Paragraph IV.B of Appendix H to 10 CFR Part 50 specifies that the report must include the data required by ASTM E185, as specified in paragraph III.B.1 of this appendix, and the results of all fracture toughness tests conducted on the beltline materials in the irradiated and unirradiated conditions. The base metal in the Callaway RV material surveillance program is Lower Shell Plate R2708-1 and the weld metal is Weld Metal (Heat # 90077). Based on its review of ASTM 185-82 and the licensee's report, the NRC staff confirmed that the report includes all of the data and test results that are required by paragraph IV.B of 10 CFR Part 50, Appendix H and ASTM E185-82.

Paragraph IV.C of Appendix H to 10 CFR Part 50 specifies if a change in the technical specifications is required, either in the P-T limits or in the operating procedures required to meet the limits, the expected date for submittal of the revised TSs must be provided with the report. By letter dated October 15, 2015, the licensee stated that the PTLR is anticipated to be ready for transmittal to the NRC, in accordance with TS 5.6.6.c, during the first quarter of 2016. The licensee subsequently indicated that the expected date of transmittal of the PTLR in the first quarter of 2016 was a typographic error and the expected transmittal date is the first quarter of 2017. By letter dated March 9, 2017 (ADAMS Accession No. ML17068A381), the licensee submitted Revision 7 to the Callaway PTLR in accordance with Technical Specification 5.6.6.c. Therefore, the NRC staff finds the licensee has fulfilled the reporting requirements of paragraph IV.C of 10 CFR Part 50, Appendix H.

NRC staff note that all Callaway, Unit 1 surveillance capsules have now been removed from the RV, and that ex-vessel dosimetry has been installed for future measurement of RV neutron fluence.

4.0 CONCLUSION

The NRC staff has completed its review of the submittal and concludes that the reported reactor vessel capsule fluence values for Callaway were determined using the RAPTOR-M3G code, which has not been reviewed and approved by the NRC staff. The NRC staff examined the RAPTOR-M3G fluence values for Capsule W to those that had been determined previously by use of NRC-approved Westinghouse fluence methods, and concluded the submittal does not present or imply a safety-significant issue. The NRC staff also concluded that the submittal met the reporting requirements pursuant to Appendix H to 10 CFR Part 50 and noted that as a result of the Capsule W test results for Callaway, a revised PTLR was submitted on March 9, 2017. Therefore, no further action from the NRC staff is warranted at this time.

This letter does not represent approval for use of RAPTOR-M3G as part of licensing calculations or for the generation of the P-T limit curves as part of WCAP-14040-NP-A

methodology. The use of RAPTOR-M3G for such calculations would require appropriate incorporation of the methodology into the Callaway licensing basis.

Principal Contributors: Daniel Beacon, NRR
Carolyn Fairbanks, NRR

Date: May 30, 2017

SUBJECT: CALLAWAY PLANT, UNIT NO. 1 – REVIEW OF SURVEILLANCE CAPSULE W
ANALYSIS FROM REACTOR PRESSURE VESSEL SURVEILLANCE
PROGRAM (CAC NO. MF9259) DATED MAY 30, 2017

DISTRIBUTION:

PUBLIC

LPL4 Reading

RidsACRS_MailCTR Resource

RidsNrrDorlLpl4 Resource

RidsNrrPMCallaway Resource

RidsNrrLAPBlechman Resource

RidsRgn4MailCenter Resource

RidsNrrDssSnpb Resource

RidsNrrDeEvib Resource

DBeacon, NRR

CFairbanks, NRR

MWatford, NRR

ADAMS Accession No. ML17142A351***via e-mail**

OFFICE	NRR/DORL/LPL4/PM	NRR/DORL/LPL4/LA	NRR/DSS/SNPB/BC*
NAME	JKlos (MWatford for)	PBlechman	RLukes
DATE	5/24/17	5/23/17	4/26/17
OFFICE	NRR/DE/EVIB/BC*	NRR/DORL/LPL4/BC	NRR/DORL/LPL4/PM
NAME	DRudland	RPascarelli	JKlos (MWatford for)
DATE	5/1/17	5/30/17	5/30/17

OFFICIAL RECORD COPY