August 14, 2007

Mr. David A. Christian
Senior Vice President and
Chief Nuclear Officer
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: KEWAUNEE POWER STATION - REACTOR VESSEL SURVEILLANCE CAPSULE TEST RESULTS FOR CAPSULE T (TAC NO. MD3700)

Dear Mr. Christian:

By letter dated November 14, 2006, Dominion Energy Kewaunee, Inc. (the licensee), submitted its irradiated reactor pressure vessel (RPV) capsule test results for Kewaunee Power Station (KPS) surveillance capsule T, which was removed from the KPS RPV in November 2004. The results were submitted to the Nuclear Regulatory Commission (NRC), pursuant to Appendix H, "Reactor Vessel Material Surveillance Program Requirements," to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR). In this regard, the licensee provided Westinghouse Reports WCAP-16641-NP, "Analysis of Capsule T from Dominion Energy Kewaunee Power Station Reactor Vessel Radiation Surveillance Program," and WCAP-16609-NP, "Master Curve Assessment of KNP RPV Weld Metal."

The NRC staff has performed its review of WCAP-16641-NP and WCAP-16609-NP and has confirmed that the reports include all of the data and test results that are required by Appendix H to 10 CFR Part 50 and American Society of Testing and Materials (ASTM) Standard Practice E-185-82. Based on its review as detailed in the enclosed safety evaluation, the NRC staff has not identified any immediate safety issues associated with the information provided in these reports. Therefore, the NRC staff intends to forward this report to the Pacific Northwest National Laboratory for the purpose of officially updating the surveillance data in the staff's Reactor Vessel Integrity Database.

Sincerely,

/RA/

Patrick D. Milano, Senior Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-305
Enclosure:
Safety Evaluation

cc w/encl: See next page

Mr. David A. Christian
Senior Vice President and
Chief Nuclear Officer
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: KEWAUNEE POWER STATION - REACTOR VESSEL SURVEILLANCE CAPSULE TEST RESULTS FOR CAPSULE T (TAC NO. MD3700)

Dear Mr. Christian:

By letter dated November 14, 2006, Dominion Energy Kewaunee, Inc. (the licensee), submitted its irradiated reactor pressure vessel (RPV) capsule test results for Kewaunee Power Station (KPS) surveillance capsule T, which was removed from the KPS RPV in November 2004. The results were submitted to the Nuclear Regulatory Commission (NRC), pursuant to Appendix H, "Reactor Vessel Material Surveillance Program Requirements," to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR). In this regard, the licensee provided Westinghouse Reports WCAP-16641-NP, "Analysis of Capsule T from Dominion Energy Kewaunee Power Station Reactor Vessel Radiation Surveillance Program," and WCAP-16609-NP, "Master Curve Assessment of KNP RPV Weld Metal."

The NRC staff has performed its review of WCAP-16641-NP and WCAP-16609-NP and has confirmed that the reports include all of the data and test results that are required by Appendix H to 10 CFR Part 50 and American Society of Testing and Materials (ASTM) Standard Practice E-185-82. Based on its review as detailed in the enclosed safety evaluation, the NRC staff has not identified any immediate safety issues associated with the information provided in these reports. Therefore, the NRC staff intends to forward this report to the Pacific Northwest National Laboratory for the purpose of officially updating the surveillance data in the staff's Reactor Vessel Integrity Database.

Sincerely,

/RA/

Patrick D. Milano, Senior Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-305
Enclosure:
Safety Evaluation
cc w/encl: See next page

DISTRIBUTION:

PUBLIC	RidsNrrDciCvib	RidsRgn3MailCenter	RidsOgcRp
LPL3-1 Reading File	RidsNrrPMPMilano	B. Parks	RidsAcrsAcnwMailCenter
RidsNrrDorlLpl3-1	RidsNrrLATHarris	N. Ray	
RidsNrrDssSrxb	RidsNrrDorlDpr		

ADAMS Accession Number: ML072110277

OFFICE	LPL3-2/PM	LPL3-1/PM	LPL3-1/LA	SRXB/BC	CVIB/BC	LPL3-1/(A)BC
NAME	RKuntz	PMilano	THarris	GCranston	MMitchell	TTate
DATE	07/30/07	08/13/07	08/ 14 /07	05/17/07	01/08/07	08/ 14 /07

OFFICIAL RECORD COPY

Kewaunee Power Station

cc:

Resident Inspectors Office
U.S. Nuclear Regulatory Commission
N490 Hwy 42
Kewaunee, WI 54216-9510

Regional Administrator, Region III
U.S. Nuclear Regulatory Commission
Suite 210
2443 Warrenville Road
Lisle, IL 60532-4351

Ms. Leslie N. Hartz
Dominion Energy Kewaunee, Inc.
Kewaunee Power Station
N 490 Highway 42
Kewaunee, WI 54216

Mr. Chris L. Funderburk
Director, Nuclear Licensing and
Operations Support
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

Mr. Thomas L. Breene
Dominon Energy Kewaunee, Inc.
Kewaunee Power Station
N490 Highway 42
Kewaunee, WI 54216

Ms. Lillian M. Cuoco, Esq.
Senior Counsel
Dominion Resources Services, Inc.
Millstone Power Station
Building 475, 5th Floor
Rope Ferry Road
Waterford, CT 06385

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING IRRADIATED REACTOR VESSEL SURVEILLANCE CAPSULE

TEST RESULTS FOR CAPSULE T

KEWAUNEE POWER STATION

DOMINION ENERGY KEWAUNEE

FACILITY OPERATING LICENSE NO. DPR-43

DOCKET NO. 50-305

1.0 INTRODUCTION

In a letter dated November 14, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML063250414), Dominion Energy Kewaunee, Inc. (the licensee), submitted, pursuant to Appendix H, "Reactor Vessel Material Surveillance Program Requirements," to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR), its irradiated reactor pressure vessel (RPV) capsule test results for Kewaunee Power Station (KPS) surveillance capsule T, which was removed from the KPS RPV in November 2004. In this regard, the licensee provided Westinghouse Reports WCAP-16641-NP, "Analysis of Capsule T from Dominion Energy Kewaunee Power Station Reactor Vessel Radiation Surveillance Program," and WCAP-16609-NP, "Master Curve Assessment of KNP RPV Weld Metal." These reports provides the applicable fracture toughness test data for surveillance capsule T.

By letter dated June 7, 1999, as supplemented on February 4, September 26, and December 18, 2000, and March 12, 2001 (ADAMS Accession Nos. 9906140196, ML003684252, ML003756569, ML003781203, and ML010800019, respectively), the former licensee requested exemptions to allow the use of an alternative methodology to evaluate RPV welds to meet the requirements of 10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events," and Appendix G, "Fracture Toughness Requirements," to 10 CFR Part 50, and to modify the basis for the KPS RPV surveillance program, as required by Appendix H to 10 CFR Part 50, to incorporate the acquisition of fracture toughness data. In response to Nuclear Regulatory Commission (NRC) letter dated February 21, 2001 (ADAMS Accession No. ML010540156), the former licensee for KPS agreed to (a) use the methodology as revised by the NRC, (b) incorporate information obtained as part of KPS surveillance capsule program into the evaluation of the RPV, using the revised methodology, and (c) obtain certain information regarding the next RPV radiation surveillance capsule. The former licensee further committed to obtain the following information regarding the next reactor vessel radiation surveillance capsule: (a) a valid measurement of the fracture toughness-based T_o parameter for the KPS RPV surveillance weld, (b) an estimate of the Charpy V-notch 30 ft-lb transition temperature shift for the surveillance weld, and (c) an

estimate of the upper shelf energy drop for the surveillance weld. By letter dated May 1, 2001 (ADAMS Accession No. ML011210180), NRC staff granted these exemptions.

2.0 REGULATORY EVALUATION

The NRC has promulgated regulations that ensure the structural integrity of the RPVs for light-water-cooled power reactors. Specific fracture toughness requirements for normal operation and for anticipated operational occurrences for power reactors are set forth in Appendix G to 10 CFR Part 50. The requirements of Appendix G are imposed by 10 CFR 50.60, "Acceptance criteria for fracture prevention measures for lightwater nuclear power reactors for normal operation." Additionally, in response to concerns over pressurized thermal shock events in pressurized-water reactors, the NRC issued 10 CFR 50.61. To satisfy the requirements of both Appendix G and 10 CFR 50.61, methods for determining fast neutron fluence are necessary to estimate the fracture toughness of the pressure vessel materials. Appendix H to 10 CFR Part 50, requires the installation of surveillance capsules, including material test specimens and flux dosimeters, to provide data for material damage correlations as a function of fluence.

Appendix H provides the surveillance and testing requirements for ferritic components in the RPVs of light-water reactors. The rule requires licensees to install a number of surveillance capsules within the cavities of the RPVs and to remove capsules and test the capsule materials in accordance with the withdrawal schedule and testing requirements of American Society for Testing and Materials (ASTM) Standard Practice E185-82. Paragraph IV.A. of the rule requires the RPV material surveillance capsule test results to be the subject of a summary technical report that is required to be submitted to the NRC within 1 year of the capsule withdrawal date. Paragraph IV.B. of the rule specifies that these topical reports shall include all data required by ASTM Standard Practice E185 and the results of all fracture toughness tests conducted on the RPV beltline materials in both the unirradiated and irradiated condition.

The NRC staff also considered the requirements of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 in its review. Specifically, General Design Criteria (GDC) 14, 30, and 31 are applicable. GDC 14, "Reactor Coolant Pressure Boundary," requires the design, fabrication, erection, and testing of the reactor coolant pressure boundary so as to have an extremely low probability of abnormal leakage of rapidly propagating failure, and of gross rupture. GDC 30, "Quality of Reactor Coolant Pressure Boundary," requires, among other things, that components comprising the reactor coolant pressure boundary be designed, fabricated, erected, and tested to the highest quality standards practical. GDC 31, "Fracture Prevention of Reactor Coolant Pressure Boundary," pertains to the design of the reactor coolant pressure boundary, stating:

> The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions, (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating maintenance, testing and postulated accident conditions and the uncertainties in determining (1) material properties,

(2) the effects of irradiation on material properties, (3) residual, steady state and transient stresses, and (4) size of flaws.

NRC Regulatory Guide (RG) 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," describes methods and assumptions acceptable to the NRC staff for determining the RPV neutron fluence with respect to the regulatory requirements discussed above.

3.0 TECHNICAL EVALUATION

3.1 Neutron Fluence Determination

The guidance provided in RG 1.190 indicates that the following comprises an acceptable fluence calculation:

a. A fluence calculation performed using an acceptable methodology
b. Analytic uncertainty analysis identifying possible sources of uncertainty
c. Benchmark comparison to approved results of a test facility
d. Plant-specific qualification by comparison to measured fluence values

The fast neutron exposure parameters were determined for The licensee by Westinghouse, using the methodologies discussed in WCAP-14040-NP-A, "Methodology Used to Develop Cold Overpressure Mitigating Systems Setpoints and RCS Heatup and Cooldown Limit Curves," and WCAP-16083-NP-A, "Benchmark Testing of the FERRET Code for Least Squares Evaluation of Light Water Reactor Dosimetry, May 2006." As noted by safety evaluations dated February 27, 2004, and January 10, 2006 (ADAMS Accession Nos. ML040620297 and ML053550466), these reports describe a methodology that the staff found acceptable.

For the neutron transport calculations, The licensee is using the two-dimensional discrete ordinates code, DORT, with the BUGLE-96 cross section library, which was derived from the Evaluated Nuclear Data File (ENDF/B-VI). Approximations include a P5 Legendre expansion for anisotropic scattering and a S16 order of angular quadrature. These approximations are of a higher order than the P3 expansion and S8 quadrature suggested in RG 1.190. Space and energy dependent core power (neutron source) distributions and associated core parameters are treated on a fuel cycle specific basis. Three dimensional flux solutions are constructed using a synthesis of azimuthal, axial, and radial flux. Source distributions include cycle-dependent fuel assembly initial enrichments, burnups, and axial power distributions, which are used to develop spatial and energy dependent core source distributions that are averaged over each fuel cycle. This method accounts for source energy spectral effects by using an appropriate fission split for uranium and plutonium isotopes based on the initial enrichment and burnup history of each fuel assembly. The neutron transport calculations, as described above, are performed in a manner consistent with the guidance set forth in RG 1.190.

The licensee performed an analytic uncertainty analysis by combining the uncertainties associated with the individual components of the transport calculations in quadrature. The calculations were compared with the benchmark measurements from the Poolside Critical Assembly simulator at the Oak Ridge National Laboratory, and with surveillance capsule and reactor cavity measurements from the H.B. Robinson power reactor benchmark experiment. These constitute acceptable test facilities.

The licensee provided, and the staff reviewed, a direct comparison against the measured sensor reaction rates from capsule T. For all reactions, the measured-to-calculated (M/C) ratios were very close to unity; the average ratio was 0.99 with 5.2-percent standard deviation. The distribution of M/C ratios ranged from 0.93 to 1.07. Therefore, all reaction rates were calculated within 20-percent of measured values, as suggested in RG 1.190.

The NRC staff finds that the licensee's fluence determination methods employed in the analysis of surveillance capsule T followed the guidance presented in RG 1.190 and are, therefore, acceptable.

3.2 RPV Fracture Toughness

The NRC staff reviewed WCAP-16641-NP and has confirmed that the report includes all of the data and test results that are required by Paragraph IV.B of Appendix H to Part 50, and by ASTM Standard Practice E185-82.

On May 1, 2001, NRC granted the licensee specific exemptions to 10 CFR Part 50. As a condition of the exemptions, the licensee committed to use an NRC staff recommended methodology for the use of the Master Curve technology and to evaluate the impact of additional information from the next vessel radiation surveillance capsule. The licensee has evaluated the effects of capsule T on the previous Master Curve evaluation of the KPS RPV, and WCAP-16609-NP outlines the analysis of the fracture toughness data obtained from surveillance capsule T. WCAP-16609-NP surveillance capsule T has a neutron fluence slightly in excess of the 60-year fluence projection for the KPS RPV.

The NRC staff has performed its review of WCAP-16609-NP and has confirmed that the analysis was performed as recommended by the NRC staff.

4.0 CONCLUSION

In summary, the licensee has provided fluence calculations performed using an acceptable methodology, supported by analytic uncertainty analysis and comparison to approved test facilities, along with a plant-specific comparison of measured fluence values from surveillance capsule T. Based on these considerations, the NRC staff concludes that the licensee has followed the guidance in RG 1.190, and the neutron exposures reported in the licensee's submittal are, therefore, acceptable.

Based on its review, the NRC staff has not identified any immediate safety issues associated with the information provided in reports, WCAP-16641-NP and WCAP-16609-NP. Therefore, the staff intends to forward this report to the Pacific Northwest National Laboratory for the purpose of officially updating the surveillance data in the staff's Reactor Vessel Integrity Database.

The licensee will be expected to incorporate the updated surveillance data into the next revision of the plant's pressure-temperature limits, as required by 10 CFR Part 50, Appendix G.

5.0 REFERENCES

1. Dominion Energy Kewaunee letter, D. Christian to USNRC, “Irradiated Reactor Vessel Surveillance Capsule Test Results for Kewaunee Capsule T Per 10 CFR Part 50 Appendix H,” November 14, 2006. (ADAMS Accession No. ML063250414).

2. Nuclear Management Company (NMC) letter, K. Hoops to USNRC, “Request for Exemption from the Requirements of 10 CFR Part 50, Appendices G and H, and 10 CFR 50.61 (Master Curve),” March 12, 2001. (ADAMS Accession No. ML010800019).

3. *U.S. Code of Federal Regulations*, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Chapter I, Title 10, “Energy.”

4. Westinghouse Electric Company Report, “Analysis of Capsule T from Dominion Energy Kewaunee Power Station Reactor Vessel Radiation Surveillance Program,” WCAP-16641-NP, October 2006. (ADAMS Accession No. ML0632504152).

5. NRC Regulatory Guide 1.190, “Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence,” March 2001 (ADAMS Accession No. ML010890301).

6. Westinghouse Electric Company Report, “Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves,” WCAP14040-A, May 2004 (ADAMS Accession No. ML050120209).

7. Westinghouse Electric Company, “Benchmark Testing of the FERRET Code for Least Squares Evaluation of Light Water Reactor Dosimetry,” WCAP-16083-NP-A, May 2006. (ADAMS Accession No. ML061600256).

8. NRC letter, H. Berkow to G. Bischoff, Westinghouse Owners Group, “Final Safety Evaluation for Topical Report WCAP-14040, Revision 3, ‘Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves,’” February 27, 2004 (ADAMS Accession No. ML040620297).

9. NRC letter, R. Correia to G. Bischoff, Westinghouse Owners Group, “Final Safety Evaluation Report for Westinghouse Owners Group Topical Report WCAP-16083-NP, Revision 0, ‘Benchmark Testing of the FERRET Code for Least Squares Evaluation of Light Water Reactor Dosimetry,’” January 10, 2006. (ADAMS Accession No. ML053550466)

10. Radiation Safety Information Computational Center, “Two-Dimensional Discrete Ordinates Transport Code System (DORT),” August 1993.

11. McLane, V., et al., “ENDF/B-VI: Evaluated Nuclear Data Library for Nuclear Science and Technology,” December 1996.

12. Radiation Safety Information Computational Center, “Coupled 47 Neutron, 20 Gamma-Ray Group Cross Section Library Derived from ENDF/B-VI for LWR Shielding and Pressure Vessel Dosimetry Applications, (BUGLE-96)” March 1996.

Principal Contributors: B. Parks
N. Ray