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L-16-148

10 CFR 50

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT:
Davis-Besse Nuclear Power Station, Unit No. 1
Docket No. 50-346, License Number NPF-3
Fatigue Monitoring Program Evaluation of Reactor Coolant Pressure Boundary Components for Effects of the Reactor Coolant Environment on Fatigue Usage (i.e., Environmentally-Assisted Fatigue)

By letter dated August 27, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102450565), FirstEnergy Nuclear Operating Company (FENOC) submitted an application pursuant to Title 10 of the *Code of Federal Regulations*, Part 54 for renewal of Operating License NPF-3 for the Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse). Per NUREG-2193, *Safety Evaluation Report Related to the License Renewal of Davis-Besse Nuclear Power Station,* Supplement 1, published April 2016, Appendix A, "Davis-Besse Nuclear Power Station License Renewal Commitments," Commitment No. 42, FENOC committed to the following:

> *"Enhance the Fatigue Monitoring Program to:*
> - *Evaluate additional plant-specific component locations in the reactor coolant pressure boundary that may be more limiting than those considered in NUREG/CR-6260. This evaluation will include identification of the most limiting fatigue location exposed to reactor coolant for each material type (i.e., CS, LAS, SS, and NBA) and that each bounding material/location will be evaluated for the effects of the reactor coolant environment on fatigue usage. Nickel-based alloy items will be evaluated using NUREG/CR-6909. Submit the evaluation to the NRC 1 year prior to the period of extended operation."*

The Attachment provides the Fatigue Monitoring Program environmentally-assisted fatigue evaluation results of the non-NUREG/CR-6260 reactor coolant pressure boundary components.

There are no regulatory commitments contained in this submittal. If there are any questions or if additional information is required, please contact Mr. Patrick J. McCloskey, Manager – Regulatory Compliance, at (419) 321-7274.

Sincerely,

D.C. SALTZ FOR
Brian D. Boles

Attachment:
Fatigue Monitoring Program Environmentally-Assisted Fatigue Evaluation of the Reactor Coolant Pressure Boundary Components

cc: NRC Region III Administrator
NRR Project Manager
NRC Resident Inspector
Utility Radiological Safety Board

Attachment
L-16-148

Fatigue Monitoring Program
Environmentally-Assisted Fatigue Evaluation of the
Reactor Coolant Pressure Boundary Components

Per NUREG-2193, "Safety Evaluation Report Related to the License Renewal of Davis-Besse Nuclear Power Station," Supplement 1, dated April 2016, Appendix A, "Davis-Besse Nuclear Power Station License Renewal Commitments," Commitment No. 42, FirstEnergy Nuclear Operating Company (FENOC) committed to the following:

> *"Enhance the Fatigue Monitoring Program to:*
> - *Evaluate additional plant-specific component locations in the reactor coolant pressure boundary that may be more limiting than those considered in NUREG/CR-6260. This evaluation will include identification of the most limiting fatigue location exposed to reactor coolant for each material type (i.e., CS, LAS, SS, and NBA) and that each bounding material/location will be evaluated for the effects of the reactor coolant environment on fatigue usage. Nickel-based alloy items will be evaluated using NUREG/CR-6909. Submit the evaluation to the NRC 1 year prior to the period of extended operation."*

Evaluation Results:

An evaluation of the non-NUREG/CR-6260, "Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components," locations in the Reactor Coolant System was performed to determine the effects of the reactor coolant environment on fatigue usage through the period of extended operation (i.e., 60 years). These locations were screened in accordance with the methodology of EPRI Report 1024995, "Environmentally Assisted Fatigue Screening: Process and Technical Basis for Identifying EAF Limiting Locations," dated 2012.

The methodologies of:

- NUREG/CR-5704 (ANL-98/31), "Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels;"
- NUREG/CR-6583 (ANL-97/18), "Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low-Alloy Steels;" and
- NUREG/CR-6909 (ANL-06/08), "Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials," (for Ni-Cr-Fe),

were used to establish the fatigue life correction factors. Locations that screened-in were evaluated using the methodology of NUREG/CR-6260 to further refine the susceptible locations.

Three locations:

- Reactor Coolant Pump Bearing Cavity;
- Pressurizer Heater Bundle Diaphragm Plate; and
- Pressurizer Heater Bundle Diaphragm Plate Seal Weld,

required further analysis to reduce or remove conservatisms and establish their environmentally-assisted fatigue (EAF) usage factor (U_{en}). Detailed thermal and stress analyses by the finite element method (FEM) were performed on the Reactor Coolant Pump Bearing Cavity. Detailed elastic and elastic-plastic analyses were performed on the Pressurizer Heater Bundle diaphragm plate and seal weld. In each case, the maximum CUF considering EAF for 60 years was less than 1.0, as follows:

- Reactor Coolant Pump Bearing Cavity $U_{en} = 0.49$
- Pressurizer Heater Bundle Diaphragm Plate $U_{en} = 0.92$
- Pressurizer Heater Bundle Diaphragm Plate Seal Weld $U_{en} = 0.75$

The following are the most limiting locations for each material type:

- Carbon Steel – Decay Heat Removal Nozzle, CS portion: EAF of 0.92
- Stainless Steel - Pressurizer Heater Bundle Diaphragm Plate; EAF of 0.92
- Low-Alloy Steel – Steam Generator Inlet Nozzle Head Juncture (Note 1)
- Nickel-Based Alloy – Reactor Vessel Vent Nozzle J-Groove Weld (Note 1)

Note 1: Per EPRI Report 1024995, these materials are bounded by other materials in the same thermal zone. The cumulative usage factor (CUF) and fatigue life correction factor (F_{en}) values for the bounding sentinel location are each higher than the CUF and F_{en} values for these locations, and the bounding U_{en} is more than twice that of these materials.

During the current refueling outage, FENOC is replacing all four High Pressure Injection (HPI) nozzle safe ends and associated Alloy 82/182 welds in accordance with NUREG-2193 Commitment No. 23. The text of this commitment is as follows:

> *"In association with the time-limited aging analysis for effects of environmentally assisted fatigue of the high-pressure injection (HPI) nozzle safe end including the associated Alloy 82/182 weld (weld that connects the safe end to the nozzle), replace the HPI nozzle safe end, including the associated Alloy 82/182 weld, for all four HPI nozzles prior to the period of extended operation. Apply the Fatigue Monitoring Program to*

evaluate the environmental effects and manage cumulative fatigue damage for the replacement HPI nozzle safe ends and associated welds."

Due to higher than expected dose rates, the elbows immediately upstream of the HPI nozzles were not replaced as originally planned. The evaluation performed for Commitment 42 assumed these elbows would be replaced prior to entry into the period of extended operation, and therefore would have no appreciable fatigue life. The Fatigue Monitoring Program will be applied to these elbows as part of Commitment 23 to evaluate the environmental effects and manage cumulative fatigue damage for the elbows along with the replacement HPI nozzle safe ends and associated welds. This evaluation will be complete prior to October 22, 2016, as currently documented in NUREG-2193.