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February 22, 2017
L-17-070

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
Reply to Request for Additional Information Related to License Renewal Commitment No. 42 (CAC MF7626)

By letter dated April 21, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16112A079), FirstEnergy Nuclear Operating Company (FENOC) submitted a Fatigue Monitoring Program evaluation for Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS), to address License Renewal Commitment 42. By letter dated September 26, 2016 (ADAMS Accession No. ML16270A447), FENOC submitted a reply to a U.S. Nuclear Regulatory Commission (NRC) request for additional information regarding FENOC's April 21, 2016 letter.

By letter dated January 23, 2017 (ADAMS Accession No. ML16364A279), the NRC requested additional information to complete its review of FENOC's Fatigue Monitoring Program evaluation. Attachment 1 provides the FENOC reply to the NRC request for additional information. Attachment 2 provides a regulatory commitment to complete fatigue evaluations for nickel-based alloys (NBA) and low-alloy steel (LAS) components and submit the evaluations. These evaluations will be submitted on or before April 28, 2017.

If there are any questions or if additional information is required, please contact Mr. Patrick McCloskey, Manager – Regulatory Compliance, at (419) 321-7274.

Sincerely,

David Gudley for B.D. Boles

Brian D. Boles

A145
NRR

Attachments:
1. Reply to Request for Additional Information Related to Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS), License Renewal Commitment 42
2. Regulatory Commitment List

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

By letter dated January 23, 2017 (ADAMS Accession No. ML16364A279), the NRC requested additional information to complete its review of FirstEnergy Nuclear Operating Company's (FENOC's) Fatigue Monitoring Program evaluation. The requested information is provided below. The NRC staff request is shown in bold text, followed by the FENOC reply.

NRC STAFF RAI

Background

Section 2.C(11), "License Renewal Conditions," of Renewed Facility Operating License No. NPF-3 specifies that the Commitments in Appendix A of NUREG-2193, Supplement 1, "Safety Evaluation Report Related to the License Renewal of Davis-Besse Nuclear Power Station," published April 2016 (ADAMS Accession No. ML16104A350), are part of the DBNPS Updated Final Safety Analysis Report. License renewal Commitment No. 42 in Appendix A of NUREG 2193, Supplement 1, states 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[1]. This evaluation will include identification of the most limiting fatigue location exposed to reactor coolant for each material type (i.e., [carbon steel] CS, [low-alloy steel] LAS, [stainless steel] SS, and [nickel-based alloy] 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[2]. Submit the evaluation to the NRC 1 year prior to the period of extended operation.***

Enclosure B of the licensee's letter dated June 17, 2011 (ADAMS Accession No. ML11172A389), provides AREVA Report No. 51-9157140-001. Table 3-9 of the AREVA Report contains the environmentally-assisted fatigue (EAF) values for the NUREG/CR-6260 locations. Table 3-8 of the AREVA Report contains a summary of

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[1] NUREG/CR-6260, "Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components, dated February 1995, ADAMS Accession No. ML031480219.
[2] NUREG/CR-6909 "Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials," dated February 2007.

the reactor coolant system pressure boundary locations with environmentally-adjusted cumulative usage factor (CUF_{en}) values that exceed the limit of 1.0.

In its April 21, 2016, letter, the licensee submitted the results of its evaluations associated with Commitment No. 42. The letter stated that locations were screened in accordance with the methodology of Electric Power Research Institute (EPRI) Technical Report 1024995, "Environmentally Assisted Fatigue Screening[:] Process and Technical Basis for Identifying EAF Limiting Locations," dated 2012. The letter also identified the most limiting locations for each of the four material types (i.e., CS, LAS, SS, and NBA). The CUF_{en} values are provided for two of the four limiting locations. The CUF_{en} values are not provided for the LAS and NBA locations. The LAS and NBA locations reference EPRI Technical Report 1024995.

By email dated August 26, 2016 (ADAMS Accession No. ML 16242A008), the NRC staff requested additional information regarding the licensee's April 21, 2016, letter. The licensee responded to this request by letter dated September 26, 2016. However, this response did not fully address the staff's request.

In the August 26, 2016, email, the NRC staff asked for the following information in Request (1):

> ***Describe the plant-specific methodology and criteria used to rank locations and select the most limiting locations for EAF. Describe relevant factors for each step of the process, such as thermal zones, material types, transient complexity, temperature effects, and complexity of the systems (as applicable). Justify the use of different material types to bound locations. Justify that the process is appropriately conservative.***

In addition, the NRC staff asked for the following information in Request (4):

> ***State the locations being managed by the fatigue monitoring program to maintain the CUF_{en} values below the limit of 1.0 through the period of extended operation. Provide the CUF_{en} values for the locations being managed by the fatigue monitoring program.***

The licensee's response to Request (1) did not justify the use of different material types to bound locations and did not justify that the process is appropriately conservative. In Table 1 of the licensee's September 26, 2016, letter, the licensee provided information regarding the screening of initial sentinel locations. The NBA and LAS locations in Table 3-9 of AREVA Report No. 51-9157140-001 are not bounded by the locations provided in Table 1 of the September 26, 2016, letter.

The licensee's response to Request (4) states that Table 2 of the licensee's September 26, 2016, letter "lists the CUF_{en} value for the components evaluated." Table 2 appears to only include the non-NUREG/CR-6260 locations being tracked by the licensee's allowable operating transient cycle program to maintain the CUF_{en} values below the limit of 1.0 through the period of extended operation.

Request

The numbering is continued from the NRC staff's previous request for additional information issued by email dated August 26, 2016.

(5) a. Justify the use of different material types to bound locations.

b. Justify the elimination of NBA and LAS locations with CUF_{en} values that are more limiting than NBA and LAS locations considered in NUREG/CR-6260.

c. Justify that the process is appropriately conservative if the allowable operating transient cycle program is tracking NBA and LAS locations that do not have the highest CUF_{en} values and are not bounding for the respective material types.

d. Provide the list of EAF locations being tracked by the fatigue monitoring program, if it is revised.

(6) Provide both the NUREG/CR-6260 and non-NUREG/CR-6260 locations being managed by the fatigue monitoring program to maintain the CUF_{en} values below the limit of 1.0 through the period of extended operation. Provide the CUF_{en} value, American Society of Mechanical Engineers Code CUF value, material type, and environmental correction factor (F_{en}) for each EAF location being managed by the fatigue monitoring program.

(7) License renewal Commitment No. 23 states:

> **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.**

In its April 21, 2016, [letter,] the licensee stated that:

> **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.

By letter dated November 18, 2016 (ADAMS Accession No. ML 16327A066), the licensee stated that it had completed those activities noted in license renewal commitments applicable to DBNPS, which are part of the DBNPS Updated Final Safety Analysis Report.

Confirm that the elbows immediately upstream of the HPI nozzles impacted by the completion of Commitment No. 23 are bounded by the limiting EAF locations that are being tracked. Confirm that the plant-specific methodology and criteria used to rank locations and select the most limiting locations for EAF was consistently applied to these locations.

FENOC REPLY TO RAI

(5) a. Justify the use of different material types to bound locations.

b. Justify the elimination of NBA and LAS locations with CUF_{en} values that are more limiting than NBA and LAS locations considered in NUREG/CR-6260.

c. Justify that the process is appropriately conservative if the allowable operating transient cycle program is tracking NBA and LAS locations that do not have the highest CUF_{en} values and are not bounding for the respective material types.

d. Provide the list of EAF locations being tracked by the fatigue monitoring program, if it is revised.

RESPONSE RAI (5) a - d

In response to issues (5) a - c, in lieu of justifying the use of different materials to bound locations, FENOC will evaluate the limiting NBA and LAS for EAF for 60-year projected cycles. In addition, Davis-Besse plans to evaluate the remaining locations with EAF greater than 1.0 that were considered bounded by other locations. These locations were identified in FENOC Letter dated September 26, 2016 (ADAMS Accession No. ML16270A447), Table 1.

See Attachment 2 to this letter for the regulatory commitment.

In response to issue (5) d, as discussed in FENOC Letter dated September 26, 2016 (ADAMS Accession No. ML16270A447), response to Question 4, all locations are being tracked by the Fatigue Monitoring Program. See Table 1 at the end of this section for the current list of EAF locations being managed by the Fatigue Monitoring Program.

(6) Provide both the NUREG/CR-6260 and non-NUREG/CR-6260 locations being managed by the fatigue monitoring program to maintain the CUF_{en} values below the limit of 1.0 through the period of extended operation. Provide the CUF_{en} value, American Society of Mechanical Engineers Code CUF value, material type, and environmental correction factor (F_{en}) for each EAF location being managed by the fatigue monitoring program.

RESPONSE RAI (6)

See Table 1 at the end of this section for the current list of Reactor Coolant System (RCS) pressure boundary components in contact with the RCS Environment being managed for EAF by the Fatigue Monitoring Program.

(7) License renewal Commitment No. 23 states:

> **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.**

In its April 21, 2016, [letter,] the licensee stated that:

> **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.**

By letter dated November 18, 2016 (ADAMS Accession No. ML 16327A066), the licensee stated that it had completed those activities noted in license renewal commitments applicable to DBNPS, which are part of the DBNPS Updated Final Safety Analysis Report.

Confirm that the elbows immediately upstream of the HPI nozzles impacted by the completion of Commitment No. 23 are bounded by the limiting EAF locations that are being tracked. Confirm that the plant-specific methodology and criteria used to rank locations and select the most limiting locations for EAF was consistently applied to these locations.

RESPONSE RAI (7)

An EAF evaluation was performed for the High Pressure Injection (HPI) Piping and elbowlet connection in accordance with NUREG/CR-5704, "Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels." The results of the evaluation are included in Table 1, below.

Table 1: Reactor Coolant System (RCS) Components Managed by the Fatigue Monitoring Program

Component	Location	Material Type	CUF	CUFadj	Fen	CUFen	Notes
Reactor Vessel	RV Closure, Head	LAS	0.03		2.45	0.07	
	RV Closure, Vessel	LAS	0.02		2.45	0.05	
	CRDM Housing, Adapter	SS	0.014		15.35	0.21	
	CRDM Housing, Body	Ni-Cr-Fe	0.08		4.78	0.38	
	CRDM Housing, Blind Flanges	SS	0.0024		15.35	0.04	
	CRDM Housing, Motor Tube Flanges	SS	0.00		15.35	0	
	Inlet Nozzle	LAS	0.829	0.146	2.45	0.358	NUREG/CR-6260 Location
	Outlet Nozzle	LAS	0.768	0.335	2.45	0.821	NUREG/CR-6260 Location
	Core Flood Nozzle to Safe End	SS	0.064		15.34	0.982	
	Core Flood Nozzle	LAS	0.504		2.45	0.123	NUREG/CR-6260 Location
	Incore Instrument Nozzles	Ni-Cr-Fe	0.770	0.206	4.16	0.857	NUREG/CR-6260 Location
	Segmented Skirt, Head to Skirt Structure	CS	0.254		1.74	0.44	
	RV Shell, Nozzle Belt	LAS	0.024		2.45	0.059	
	RV Shell, Lower Head	LAS	0.024		2.45	0.059	NUREG/CR-6260 Location
	Continuous Vent Nozzle, Reducer to Pipe Weld	SS	0.001		15.35	0.02	
	Continuous Vent Nozzle, J-Groove Weld	Ni-Cr-Fe	0.9		4.78	4.31	See Note 10
Reactor Coolant Pumps	RC pump cover, cooling hole ligament	SS	0.56		N/A	N/A	See Note 1
	RC pump cover, bearing cavity	SS	0.964	0.032	15.35	0.49	

Table 1: Reactor Coolant System (RCS) Components Managed by the Fatigue Monitoring Program, cont.

Component	Location	Material Type	CUF	CUFadj	Fen	CUFen	Notes
Pressurizer	Spray Nozzle, Nozzle	CS	0.01		1.74	0.02	
	Spray Nozzle, Safe End	Ni-Cr-Fe	0.01		4.78	0.05	
	Spray Nozzle, Nozzle / Head Juncture	CS	0.01		1.74	0.02	
	Spray Nozzle, Weld Overlay	Ni-Cr-Fe	0.01		4.78	0.05	
	Surge Nozzle, Inside Radius	CS	0.182		1.74	0.317	NUREG/CR-6260 Location
	Surge Nozzle, Safe End	SS	0.108	0.0581	15.35	0.892	NUREG/CR-6260 Location
	Surge Nozzle, Piping to Safe End Weld	SS	0.619		1.49	0.922	NUREG/CR-6260 Location
	Vessel Support Lugs, Support	CS	0.01		1.74	0.02	
	Vessel Support Lugs, Shell	CS	0.01		1.74	0.02	
	Heater Bundle Closure, Cover Plate	LAS	0.05		2.45	0.123	
	Heater Bundle Closure, Diaphragm Plate	SS	0.41	*	*	0.92	*See Note 3
	Heater Bundle Closure, Seal Weld	SS	0.66	*	*	0.75	*See Note 3
	Shell, Heater Belt Transition	CS	0.13		1.74	0.23	
	3" Pressurizer Relief Nozzle, Nozzle	CS	Exempt				See Note 4
	3" Pressurizer Relief Nozzle, Safe End	SS	Exempt				See Note 4
	3" Pressurizer Relief Nozzle, Upper Head	CS	Exempt				See Note 4
	Other Openings, Vent Nozzle	Ni-Cr-Fe	Exempt				See Note 5
	Other Openings, Level Sensing Nozzle (Upper)	Ni-Cr-Fe	Exempt				See Note 5
	Other Openings, Level Sensing Nozzle (Lower)	Ni-Cr-Fe	Exempt				See Note 5
	Other Openings, Level Sensing Nozzle (Lower) Opening	Ni-Cr-Fe	0.166		4.78	0.793	
	Other Openings, Thermowell Nozzle	Ni-Cr-Fe	Exempt				See Note 5
	Other Openings, Thermowell Nozzle Opening	Ni-Cr-Fe	0.166		4.78	0.793	
	Other Openings, Sampling Nozzle	Ni-Cr-Fe	Exempt				See Note 5
	Other Openings, Sampling Nozzle Opening	Ni-Cr-Fe	0.166		4.78	0.793	
	Other Openings, Manway	CS	Exempt				See Note 5

Table 1: Reactor Coolant System (RCS) Components Managed by the Fatigue Monitoring Program, cont.

Component	Location	Material Type	CUF	CUFadj	Fen	CUFen	Notes
Steam Generators (See Note 7)	Primary Manways	LAS	0.34		2.45	0.83	
	Primary Manway Diaphragm Seal Welds						See Note 6
	Primary Handhole Cover	LAS	0.37		2.45	0.91	
	Primary Handhole Diaphragm Seal Weld						See Note 6
	Inlet Nozzle / Primary Head Juncture	LAS	0.79		2.45	1.94	See Note 10
	Primary Outlet Nozzles	LAS	0.14		2.45	0.34	
	Outlet Nozzle / Primary Head Junctures	LAS	0.25		2.45	0.61	
	Lower Primary Head away from Outlet Nozzles	LAS	0.11		2.45	0.27	
	Upper Primary Head / Tubesheet Knuckle including Vent / Level Sensing and Acoustic Sensor	LAS	0.28		2.45	0.69	
	Lower Primary Head / Tubesheet Knuckle	LAS	0.08		2.45	0.20	
	Perforated Tubesheets, Postulated Thin Ligament (Primary Side)	LAS	0.39		2.45	0.96	
	Lower Spherical / Flat Head Juncture	LAS	0.33		2.45	0.81	
	Lower Flat Head	LAS	0.10		2.45	0.25	
	Tubes	Ni-Cr-Fe	0.36		4.78	1.72	See Note 10
	Tube Seal Welds	Ni-Cr-Fe	0.42		4.78	2.01	See Note 10
	Tube Plug Seal Welds	Ni-Cr-Fe	0.23		4.78	1.10	See Note 10

Table 1: Reactor Coolant System (RCS) Components Managed by the Fatigue Monitoring Program, cont.

Component	Location	Material Type	CUF	CUFadj	Fen	CUFen	Notes
Reactor Coolant System (RCS) Piping	Hot Leg Piping	CS	0.827		1.74	1.44	See Note 10
	Upper Cold Leg Piping	CS	0.59		1.74	0.10	
	Lower Cold Leg	CS	0.183		1.74	0.32	
	Pressurizer Surge Line, Hot Leg Surge Nozzle Inside Radius	CS	0.445		1.74	0.774	NUREG/CR-6260 Location
	Pressurizer Surge Line, Piping Adjacent to Outboard End of Hot Leg Surge Nozzle (End of Hot Leg Weld Overlay)	SS	0.179	0.0385	9.05	0.348	NUREG/CR-6260 Location
	Pressurizer Surge Line, Piping Elbows	SS	0.6463	0.0833	11.13	0.927	NUREG/CR-6260 Location
	Pressurizer Surge Line, Piping Straights	SS	0.7658	0.0953	9.85	0.939	NUREG/CR-6260 Location
	Reactor Coolant Pump Discharge Nozzle	SS	0.0007		15.35	0.01	
	Reactor Coolant Pump Suction Nozzle	SS	0.0004		15.35	0.01	
	Spray Line Piping (Node 73)	SS	0.486		9.013	4.38	See Note 10
	Spray Line Piping (Node 81)	SS	0.454		9.013	4.09	See Note 10
	Decay Heat Nozzle	CS	0.89	0.5269	1.74	0.92	

Table 1: Reactor Coolant System (RCS) Components Managed by the Fatigue Monitoring Program, cont.

Component	Location	Material Type	CUF	CUFadj	Fen	CUFen	Notes
Reactor Coolant System (RCS) Piping	HPI/MU Nozzle	CS	0.226	0.271	1.74	0.472	NUREG/CR-6260 Location
	HPI/MU Nozzle, Safe End including Weld	SS	0.141	0.064	*	0.434	NUREG/CR-6260 Location *See Note 8
	Letdown Piping	SS	0.604	0.04774	15.35	0.73	
	RC Drain Nozzles	SS	0.132	0.1184	*	0.8866	*See Note 9
	HPI Lines	SS	0.9115	0.008	15.35	0.123	
	HPI Lines, Elbowlet	SS	0.981	0.045	15.35	0.691	
	Core Flood Piping	SS	0.582	0.23967	2.55	0.61	
	Continuous Vent Line	SS	0.0318		15.35	0.49	
	Core Flood Tank Discharge Check Valves	SS	0.02839		15.35	0.44	
	Decay Heat Containment Isolation Valves	SS	0.14594	0.01268	15.35	0.19	
	Decay Heat Bypass Containment Isolation Valves	SS	0.02732		15.35	0.42	
	Low Pressure Injection Check Valves	SS	0.14099	0.00935	15.35	0.14	
	Low Pressure Injection Containment Isolation Valves	SS	0.18261	0.01294	15.35	0.20	
Decay Heat Piping	Decay Heat Class 1 Piping	SS	0.23303		2.55	0.595	NUREG/CR-6260 Location

Table 1: Reactor Coolant System (RCS) Components Managed by the Fatigue Monitoring Program, cont.

NOTES
(1) Location not exposed to RCS environment, therefore not subject to EAF.
(2) Not a RCS Pressure Boundary Component.
(3) Detailed elastic and elastic-plastic analyses completed to determine adjusted usage factors. For the elastic portion of the fatigue usage, the maximum Fen factor of 15.35 is conservatively applied. For the elastic-plastic portion, a detailed Fen calculation is performed.
(4) These nozzles are shown acceptable by satisfying requirements of paragraphs N-415.1 and N-450 of ASME Section III - 1968 Edition with Summer 1968 Addenda.
(5) These nozzles are shown acceptable by satisfying the requirements of paragraph N-415.1 of ASME Section III – 1968 Edition with Summer 1968 Addenda
(6) Covers are sealed using gaskets and seal welds were not used, therefore fatigue calculations not required.
(7) Only primary RCS Pressure Boundary locations with CUF greater than 0.052 are evaluated for EAF.
(8) EAF CUF using integrated strain rate Fen factors.
(9) CUFen determined using NUREG/CR-6909 rules. The strain amplitude is less than the strain amplitude threshold of 0.10% in all cases, Fen does not need to be applied.
(10) These locations were considered bounded by other locations. See response to Question 5.

Attachment 2
L-17-070

Regulatory Commitment List
Page 1 of 1

The following list identifies those actions committed to by FirstEnergy Nuclear Operating Company (FENOC) for the Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse) in this document. Any other actions discussed in the submittal represent intended or planned actions by FENOC. They are described only as information and are not Regulatory Commitments. Please notify Mr. Patrick McCloskey, Manager – Regulatory Compliance, at (419) 321-7274, of any questions regarding this document or associated Regulatory Commitments.

Regulatory Commitment	Due Date
1. FENOC will evaluate the limiting nickel-based alloy (NBA) and low-alloy steel (LAS) components for environmentally-assisted fatigue (EAF) for 60-year projected cycles. In addition, Davis-Besse plans to evaluate the remaining locations with EAF greater than 1.0 that were considered bounded by other locations. These locations were identified in FENOC Letter dated September 26, 2016 (ADAMS Accession No. ML16270A447), Table 1. FENOC will submit the results of the evaluations to the Nuclear Regulatory Commission.	April 28, 2017