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

Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-71 and DPR-62
Docket Nos. 50-325 and 50-324
Response to Request for Additional Information Regarding Request for Emergency License Amendment - Technical Specification 3.8.1, *AC Sources – Operating,* One-Time Extension of Emergency Diesel Generator Completion Times and Suspension of Surveillance Requirements

References:

1. Letter from William R. Gideon (Duke Energy) to the U.S. Nuclear Regulatory Commission Document Control Desk, *Request for Emergency License Amendment - Technical Specification 3.8.1, AC Sources – Operating, One-Time Extension of Emergency Diesel Generator Completion Times and Suspension of Surveillance Requirements*, dated November 22, 2017, ADAMS Accession Number ML17326B619

2. NRC E-mail Capture, *Brunswick Unit 1 and Unit 2 Request for Additional Information Related to Emergency Amendment Request for One-Time Extension of EDG Completions Time*, dated November 24, 2017

Ladies and Gentlemen:

By letter dated November 22, 2017 (i.e., Reference 1), Duke Energy Progress, LLC (Duke Energy), submitted an emergency license amendment request (LAR) for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. The proposed emergency license amendment would extend the current Completion Time of Technical Specification (TS) 3.8.1, Required Action D.5, in order to avoid an unnecessary shutdown of both Unit 1 and Unit 2. In addition, consistent with defense-in-depth philosophy, Duke Energy also requested to suspend monthly testing of Emergency Diesel Generators (EDGs) 1, 2, and 3 per Surveillance Requirement (SR) 3.8.1.2, SR 3.8.1.3, and SR 3.8.1.6 during the proposed extended Completion Times, if applicable.

On November 24, 2017, by electronic mail (i.e., Reference 2), the NRC provided a request for additional information (RAI) regarding the LAR. Duke Energy's response to the RAI is enclosed.

This document contains no new regulatory commitments.

I declare, under penalty of perjury, that the foregoing is true and correct. Executed on November 24, 2017.

Sincerely,

William R. Gideon

WRM/wrm

Enclosure: Response to Request for Additional Information

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**Response to Request for Additional Information**

By letter dated November 22, 2017, Duke Energy Progress, LLC (Duke Energy), submitted an emergency license amendment request for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. The proposed emergency license amendment (LAR) would extend the current Completion Time of Technical Specification (TS) 3.8.1, Required Action D.5, in order to avoid an unnecessary shutdown of both Unit 1 and Unit 2. In addition, consistent with defense-in-depth philosophy, Duke Energy also requested to suspend monthly testing of Emergency Diesel Generators (EDGs) 1, 2, and 3 per Surveillance Requirement (SR) 3.8.1.2, SR 3.8.1.3, and SR 3.8.1.6 during the proposed extended Completion Times, if applicable.

On November 24, 2017, by electronic mail, the NRC provided a request for additional information (RAI) regarding the LAR. Those questions, and Duke Energy's responses, are provided below.

**Electrical Engineering Branch (EEB) Question**

BTP 8-8 (mainly written for a single unit plant) does not require an accident to be considered during a AOT, but requires to consider a LOOP along with a single failure which could lead to an SBO. The plant should be able to achieve cold shutdown. In a dual unit plant, we need to evaluate LOOP in both units and a single failure in each unit.

To meet the intent of BTP 8-8 for a dual unit plant - please discuss the sequence of events, and the loadings of SUPP-DG and the remaining EDG, under the following scenarios, to achieve cold shutdown of both units:

> (1) LOOP in both units, EDG #4 (Unit 2) on maintenance, EDG #3 (Unit 2) fail - single failure in Unit 2; EDG #1 (Unit 1) fail – single failure in Unit 1 [Only SUPP-DG and EDG #2 available]
>
> (2) LOOP in both units, EDG #4 (Unit 2) on maintenance, EDG #3 (Unit 2) fail - single failure in Unit 2; EDG #2 (Unit 1) fail – single failure in Unit 1 [Only SUPP- DG and EDG #1 available]

**Response:**

**(1) LOOP in both units, EDG 4 (Unit 2) on maintenance, EDG 3 (Unit 2) fail - single failure in Unit 2; <u>EDG 1 (Unit 1) fail</u> – single failure in Unit 1 [Only SUPP-DG and EDG 2 available]**

In this case, Unit 2 would be considered the blacked-out unit and procedure 2EOP-01-SBO, *Station Blackout*, would be entered. Electrical configuration in this case would require cross-tie of 4kV bus E2 to E4 (i.e., 0EOP-01-SBO-06, *4160V E-Bus Crosstie*) and cross-tie of bus 480V bus E7 to E8 (i.e., 0EOP-01-SBO-07, *480V E-Bus Crosstie*). The SUPP-DG would be aligned to E3 (i.e., 0EOP-01-SBO-08, *Supplemental DG Alignment*). 4kV bus E3 would then be cross-tied with E1 (i.e., 0EOP-01-SBO-06). FLEX DG2 would be available, if needed to power limited loads on E8 (i.e., battery chargers).

For coping strategy, the following alignment would be used:

The Unit 1 priority is maintaining reactor pressure vessel (RPV) pressure above 500 psig (i.e., 1EOP-01-SBO, *Station Blackout*).

Suppression Pool Cooling (i.e., 1EOP-01-SBO-11, *Unit 1 SBO Torus Cooling*) and Drywell Cooling (i.e., 1EOP-01-SBO-12, *Unit 1 SBO Drywell Cooling*) would be established for containment parameters.

The Unit 2 priority is cooling the RPV to 150 to 300 psig (i.e., 2EOP-01-SBO).

Suppression Pool Cooling (i.e., 2EOP-01-SBO-11, *Unit 2 SBO Torus Cooling*) and Drywell Cooling (i.e., 2EOP-01-SBO-12, *Unit 2 SBO Drywell Cooling*) would be established for containment parameters.

These coping strategies will maintain conditions outside of an extended loss of AC power (ELAP). In the event it is desirable to continue to cold shutdown conditions, suppression pool cooling would be replaced by Shutdown Cooling Mode of Residual Heat Removal (RHR). To achieve RPV pressure below the shutdown cooling suction interlock, an alternative level control method would need to be invoked, such as Control Rod Drive (CRD) injection with the loss of Reactor Core Isolation Cooling (RCIC) on low reactor pressure.

Loading Requirements:

On EDG 2 (E2):

1) 1100 kW for torus cooling
2) 600 kW for drywell cooling
3) 67 kW for control room ventilation
4) 12 kW for battery room ventilation

The total would be approximately 1800 kW on E2 from the above.

Battery loading would also be applicable. A very conservative loading would be 500 kW. This is based on the FLEX DGs being capable of carrying the battery chargers, and having a load limit of 500 kW. This would bring the total E2 load to a worst case of 2300 kW for coping strategies.

In the event it is desirable to continue to cold shutdown, the following additional loads are required:

1) 600 kW for an Residual Heat Removal Service Water (RHRSW) pump
2) 190 kW for a CRD pump.

This would bring the total E2 load to a worst case of 3090 kW for beyond coping strategy evolutions including inventory control and shutdown cooling.

On Supplemental DG (SUPP-DG) (E3):

1) 1100 kW for torus cooling
2) 600 kW for drywell cooling

3) 67 kW for control room ventilation
4) 12 kW for battery room ventilation

The total would be approximately 1800 kW on the Supplemental DG from the above.

Battery loading would also be applicable. A very conservative loading would be 500 kW. This is based on the FLEX DGs being capable of carrying the battery chargers, and having a load limit of 500 kW. This would bring the total Supplemental DG (E3) load to a worst case of 2300 kW.

In the event it is desirable to continue to cold shutdown, the following additional loads are required:

1) 600 kW for an RHRSW pump
2) 190 kW for a CRD pump.

This would bring the total Supplemental DG (E3) load to a worst case of 3090 kW for beyond coping strategy evolutions including inventory control and shutdown cooling.

**(2) LOOP in both units, EDG 4 (Unit 2) on maintenance, EDG 3 (Unit 2) fail - single failure in Unit 2; EDG 2 (Unit 1) fail – single failure in Unit 1 [Only SUPP- DG and EDG 1 available]**

In this case, Unit 2 would be considered the blacked-out unit and procedure 2EOP-01-SBO, *Station Blackout*, would be entered. Electrical configuration in this case would require cross-tie of 4kV bus E1 to E3 (i.e., 0EOP-01-SBO-06) and powering 480V bus E8 from FLEX DG2 per procedure 0EOP-01-FSG-04, *FLEX Diesel Generator Alignment*. SUPP-DG would be aligned to E4 (i.e., 0EOP-01-SBO-08). 4kV bus E2 would then be cross-tied with E4 (i.e., 0EOP-01-SBO-06). Coordinate transfer of E8 to SUPP-DG (E4) with Emergency Response Organization (ERO) team as additional loads are required on bus E8.

For coping strategy, the following alignment would be used:

The Unit 1 priority is maintaining RPV pressure above 500 psig (1EOP-01-SBO).

Suppression Pool Cooling (1EOP-01-SBO-11) and Drywell Cooling (1EOP-01-SBO-12) would be established for containment parameters.

The Unit 2 priority is cooling the RPV to 150 to 300 psig (2EOP-01-SBO).

Suppression Pool Cooling (2EOP-01-SBO-11) and Drywell Cooling (2EOP-01-SBO-12) would be established for containment parameters.

These coping strategies should maintain conditions outside of ELAP. In the event it is desirable to continue to cold shutdown conditions, Suppression Pool Cooling would be replaced by Shutdown Cooling Mode of RHR. To achieve RPV pressure below the shutdown cooling suction interlock, an alternative level control method would need to be invoked such as CRD injection with the loss of RCIC on low reactor pressure.

Loading Requirements

On EDG 1 (E1):

1) 1100 kW for torus cooling
2) 600 kW for drywell cooling
3) 67 kW for control room ventilation
4) 12 kW for battery room ventilation

The total would be approximately 1800 kW on E1 from the above.

Battery loading would also be applicable. A very conservative loading would be 500 kW. This is based on the FLEX DGs being capable of carrying the battery chargers, and having a load limit of 500 kW. This would bring the total E1 load to a worst case of 2300 kW for coping strategies.

In the event it is desirable to continue to cold shutdown, the following additional loads are required:

1) 600 kW for an RHRSW pump
2) 190 kW for a CRD pump.

This would bring the total E1 load to a worst case of 3090 kW for beyond coping strategy evolutions including inventory control and shutdown cooling.

On Supplemental DG (SUPP-DG) (E4):

1) 1100 kW for torus cooling
2) 600 kW for drywell cooling
3) 67 kW for control room ventilation
4) 12 kW for battery room ventilation

The total would be approximately 1800 kW on the Supplemental DG from the above.

Battery loading would also be applicable. A very conservative loading would be 500 kW. This is based on the FLEX DGs being capable of carrying the battery chargers, and having a load limit of 500 kW. This would bring the total Supplemental DG (E4) load to a worst case of 2300 kW.

In the event it is desirable to continue to cold shutdown, the following additional loadings are required:

1) 600 kW for an RHRSW pump
2) 190 kW for a CRD pump.

This would bring the total SUPP-DG (E4) load to a worst case of 3090 kW for beyond coping strategy evolutions including inventory control and shutdown cooling.

**Mechanical Engineering Branch (MEB) Question 1**

The licensee is requesting to suspend monthly testing of EDGs 1, 2, and 3 per Surveillance Requirement (SR) 3.8.1.2, SR 3.8.1.3, and SR 3.8.1.6 for EDGs 1, 2, and 3 during the proposed extended Completion Times. For each EDG, provide the last date the surveillances were performed, and when the next surveillances are scheduled.

**Response:**

The three SRs are performed concurrently.

For EDG 1, they were last performed on October 24, 2017, with the next scheduled performance scheduled on November 26, 2017.

For EDG 2, they were last performed on October 29, 2017, with the next scheduled performance scheduled on December 3, 2017.

For EDG 3, they were last performed on November 5, 2017, with the next scheduled performance scheduled on December 10, 2017.

**MEB Question 2:**

Provide the manufacturer and model number for the emergency diesel generators (EDGs).

**Response:**

The emergency diesel generator is manufactured by Nordberg, Model No. FS-1316-HSC.

**MEB Question 3:**

In Section 2.3 it is stated, "This crankshaft bow is believed to have occurred over several years of normal EDG operation, with low levels of bearing heating causing the bowed condition." Please expand on this statement and explain how low levels of bearing heating can cause a bowed crankshaft.

**Response:**

In June 2009, BSEP took Hot Web Deflection measurements which confirmed crankshaft straightness. Subsequent to that inspection, two events occurred in September 2009 that put a higher than normal stress on the rotating mass of EDG 4. During the governor tuning evolution on or about September 21, 2009, EDG 4 was operated up to the overspeed trip, which actuated as designed to protect the machine, on four occasions. The overspeed trip setpoint is approximately 12 percent above nominal run speed. On September 24, 2009, EDG 4 was operated above the 2000-hour rating of 3850 kW for a total of 8 seconds over the course of four minutes. The peak loading was 4154.2 kW (i.e., approximately 19 percent of continuous rated load). It is surmised that these two events, taken together, constitute the initiator leading to the condition discovered in November 2017. Discussion supporting this conclusion follows.

Additionally, in November 2009, lead was first detected in an oil sample and this was confirmed during the next sample taken in February 2010. In both samples, the levels detected were well below the trigger value for further action and continued to be so in subsequent samples to the present day. Aluminum first increased above the lower limit of detectability in the first quarter of 2013 and a trend of increasing aluminum was identified by Strategic Engineering in 2017, driving the original inspection scope of our currently planned EDG maintenance window.

A planned maintenance outage commenced on November 13, 2017, to investigate the lube oil trend. During the planned maintenance window, main bearings 7 and 8 were found degraded. A total of five main bearings were replaced to correct the condition of the bearings. The investigation also identified that the EDG 4 crankshaft has a bow, as indicated by a total indicated runout of 0.010 inches on main bearing 7.

The two 2009 events are believed to have caused initial bearing damage which created a heat input into the crankshaft eventually resulting in a bow. This crankshaft bow is believed to have increased over several years of normal EDG operation post-2009, and, in a self-propagating cycle, increased bearing degradation and the shaft runout. Replacement of the main bearings (i.e., tightening clearances) during the planned maintenance window revealed the need to also correct the crankshaft bow. The EDG 4 crankshaft has been evaluated, and the shaft is acceptable for continued operation, pending correction of the excessive runout. The shaft hardness is within specifications, and there are no indications of cracking or excessive shaft heating as determined by magnetic particle testing.

**MEB Question 4:**

State whether any connecting rods were examined, and if so, state the results of the inspections.

**Response:**

Connecting rods 6R, 7L, 7R, and 8L were removed from the engine and were examined. Each connecting rod was inspected for signs of damage or foreign material. Connecting rod 7L contained small particulate from the degraded main bearing in the oil channel leading to the wrist pin, which were removed via air flush. The connecting rods were deemed acceptable for reinstallation, as no damage was present.

**MEB Question 5:**

Provide the dates for the last measurements of crankshaft runout for each of the EDGs (for EDG 4, prior to the latest measurement of 0.010 inches), and provide the measurements. Also provide the manufacturer’s maximum allowable crankshaft runout.

**Response:**

EDG 1 – Crankshaft runout was last collected in October/November 1992. The latest crankshaft runout measurement was 0.002 inches. The manufacturer’s maximum allowable crankshaft runout is 0.002 inches.

EDG 2 – Crankshaft runout not collected at Brunswick.

EDG 3 – Crankshaft runout not collected at Brunswick.

EDG 4 – Crankshaft runout was not collected prior to latest measurement of 0.010 inches.

The manufacturer's recommended maintenance strategy to assess crankshaft health is to collect hot web deflections. These deflections were last collected on:

EDG 1 - October 30, 2012
EDG 2 - August 27, 2012
EDG 3 - October 12, 2015

The most recent hot web deflections on each of EDGs 1, 2 and 3 have shown satisfactory results.

**MEB Question 6:**

State whether EDGs 1, 2, and 3, have had an overspeed and overload condition in the past, similar to EDG 4.

**Response:**

EDG 2 had an overload condition in the past. During performance of 0OP-39 (i.e., *Diesel Generator Operating Procedure)* on June 14, 2014, the kW loading briefly exceeded the 3850 kW limit sporadically over a period of three minutes. The maximum load reached was 3923 kW. The event was due to operating the diesel near 3850 kW to test the Auto-Voltage Regulator (AVR) replacement. Because of the natural fluctuations in load during operation of the diesel, this resulted in some spikes that exceeded the 3850 kW limit.

EDG 3 had an overload condition in the past. During routine performance of 0PT-12.2C, *No. 3 Diesel Generator Monthly Load Test*, on November 5, 2017, EDG 3 was loaded, in error, to greater than the maximum load. Plant computer data indicates EDG 3 operated above 3850 kW for a total period of 19 seconds, with the maximum load of approximately 4100 kW.

**MEB Question 7:**

Discuss the vibration data for EDG 4 for the past four years, and compare it to the vibration data for EDGs 1, 2 and 3 for the past four years.

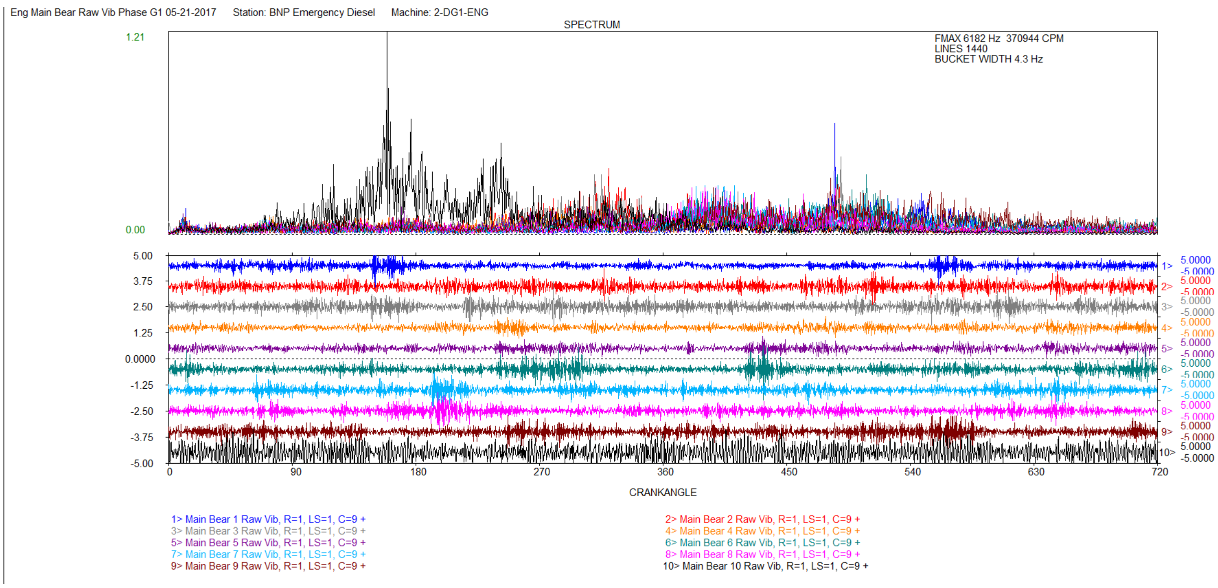
**Response:**

Latest collected vibration data (i.e., early 2017) for EDGs 1, 2, 3, and 4 are similar in magnitude. The latest data has been collected with a Windrock 6320/PA. The older data was collected with a RECIP-TRAP RT9260. Each used different sets of software, thus the different representations of data is due to the software capabilities.

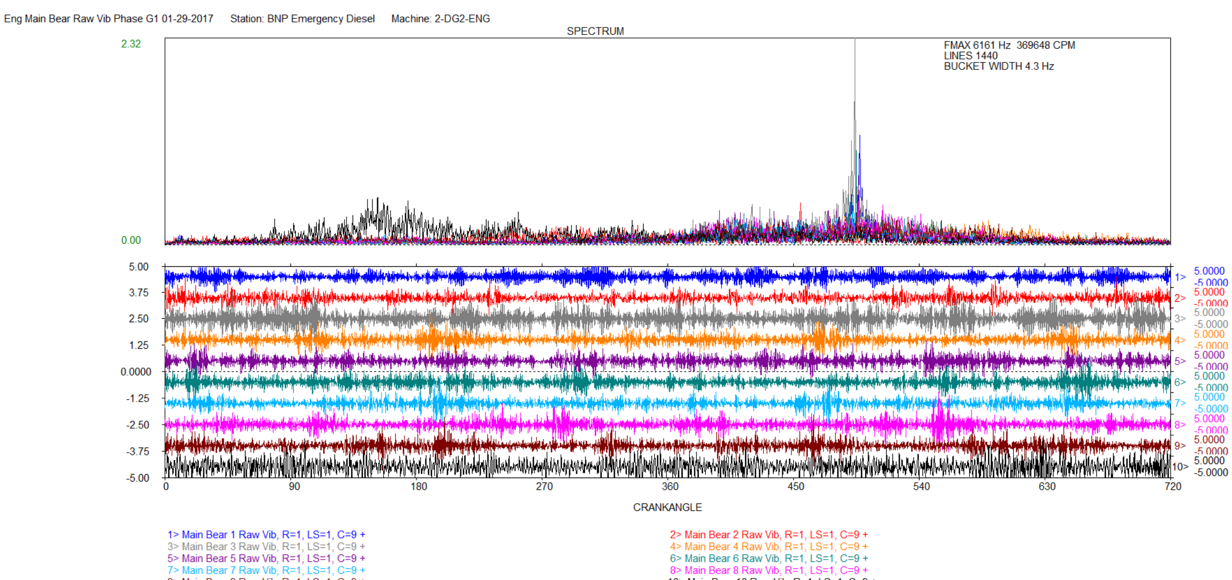
Each data point captures vibrations for each of 10 bearings on the EDGs. The data shows overall stable vibration data collections, and no bearing defects have been identified.

Latest maximum Fast Fourier Transform (FFT) magnitudes with individual bearing readings were collected for each EDG as follows:

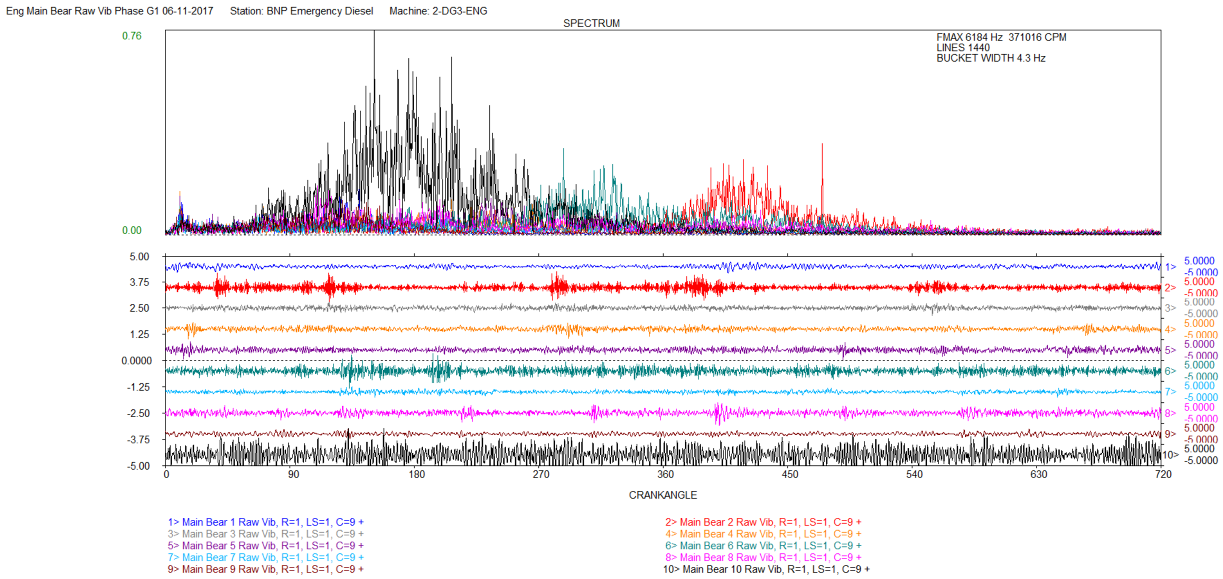
<u>EDG 1</u>



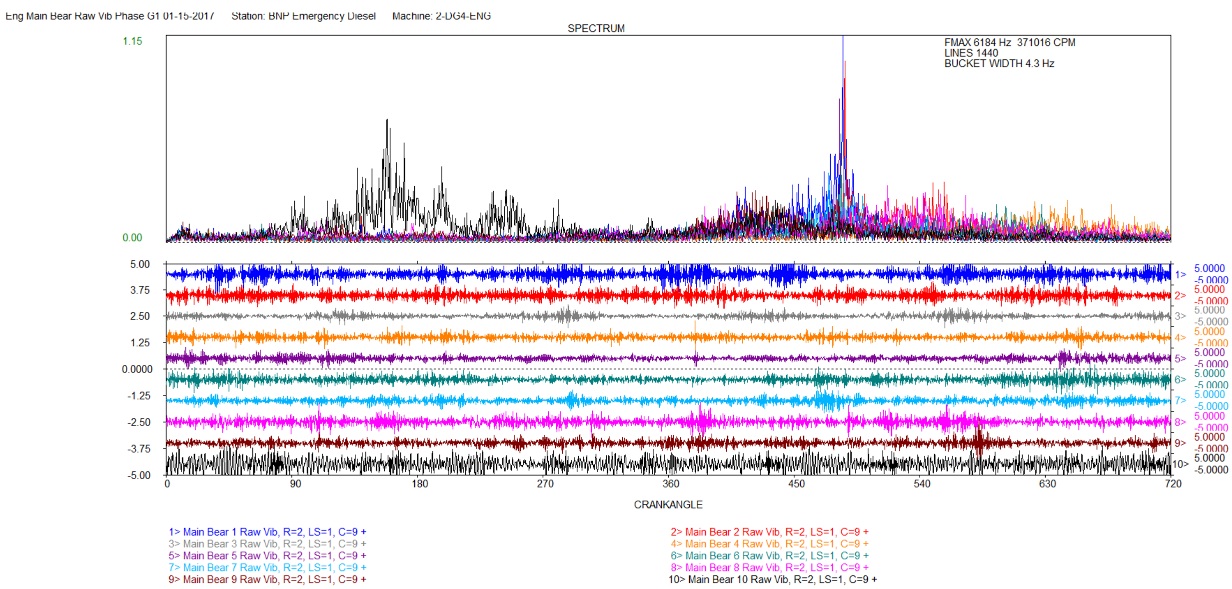

<u>EDG 2</u>



EDG 3




EDG 4




The vibration data shown in the response to MEB Question 7 is from the Windrock MD software. For each EDG, the raw vibration signals for each of the 10 main bearings are shown in the bottom portion of the plot. Each plot represents one mechanical cycle (i.e., 720 degrees of crankshaft revolution) of the engine, so the x-axis shows 0 to 720 degrees. The y-axis scale on the lower portion of the plots are the same for all four EDGs (i.e., -5 to +5 g's). The top portion of the plot shows the 10 overlaid Fast Fourier Transforms (FFTs) of the raw vibration signatures. The x-axis of the upper portion is frequency from 0 to approximately 6180 Hz. The y-axis is in g's, but the maximum y value shown is different for each of the four EDGs because it autoscales.

For example, the EDG 3 upper portion is scaled to a maximum of 0.76g, which is a smaller scale than the other three plots. The dominant vibration on EDG 3 is the main bearing 10, which is the generator inboard bearing (i.e., not one of the nine diesel engine bearings). All vibrations are in the normal range.

**MEB Question 8:**

Provide any similar operating experience, similar to EDG 4, for the same make and model EDGs in the non-nuclear industry.

**Response:**

Duke Energy has limited knowledge of bearing operating experience from the non-nuclear units. For information, other known non-nuclear Nordberg diesel generator installations have included:

Glomar Explorer, Model No. FS-1316-HSC
Sterling Kansas Installation, Model No. FS-1312-HSC
Carthage Missouri Installation, Model No. FS-1320-HSC
Russell Kansas Installation, Model No. FS-1316-HSC

**MEB Question 9:**

It is stated in Sections 2.1 and 3.3 that the SUPP-DG fuel oil tank has a capacity greater or equal to a 24-hour supply, and each of the two permanently installed FLEX diesels has an integral 526 gallon sub-base fuel tank. Discuss how the fuel oil supply for these diesels will be replenished if required during the requested Completion Time extension period.

**Response:**

Duke Energy contacted INNA Oil, the contracted fuel supplier for BSEP. They are a local supplier with a facility within 10 miles of the site. They are able to deliver a tanker of fuel oil to the site given a 12 hour notice.

The Supplemental DG has a 10,000 gallon storage tank with a minimum of 6,700 gallons (i.e., 24 hour supply) available. The FLEX diesels have a system to draw from the EDG 4-day tanks.

We also have approximately 5,000 gallons of additional diesel fuel on site and available to the site fuel truck to supply fuel to the Supplemental DG or permanently installed FLEX DGs, as needed.