UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
475 ALLENDALE RD, STE 102
KING OF PRUSSIA, PENNSYLVANIA 19406-1415

October 27, 2023

David P. Rhoades
Senior Vice President
Constellation Energy Generation, LLC
President and Chief Nuclear Officer (CNO)
Constellation Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: LIMERICK GENERATING STATION – INTEGRATED INSPECTION REPORT 05000352/2023003 AND 05000353/2023003 AND INDEPENDENT SPENT FUEL STORAGE INSTALLATION INSPECTION 07200065/2023001

Dear David Rhoades:

On September 30, 2023, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at Limerick Generating Station. On October 19, 2023, the NRC inspectors discussed the results of this inspection with Michael Gillin, Site Vice President, and other members of your staff. The results of this inspection are documented in the enclosed report.

One finding of very low safety significance (Green) is documented in this report. This finding involved a violation of NRC requirements. We are treating this violation as a non-cited violation (NCV) consistent with Section 2.3.2 of the Enforcement Policy.

If you contest the violation or the significance or severity of the violation documented in this inspection report, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator, Region I; the Director, Office of Enforcement; and the NRC Resident Inspector at Limerick Generating Station.

This letter, its enclosure, and your response (if any) will be made available for public inspection and copying at http://www.nrc.gov/reading-rm/adams.html and at the NRC Public Document Room in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 2.390, "Public Inspections, Exemptions, Requests for Withholding."

Sincerely,

Sarah H. Elkhiamy

Digitally signed by Sarah H. Elkhiamy
Date: 2023.10.27 10:28:24 -04'00'

Sarah H. Elkhiamy, Acting Chief
Projects Branch 4
Division of Operating Reactor Safety

Docket Nos. 05000352, 05000353
and 07200065
License Nos. NPF-39 and NPF-85

Enclosure:
As stated

cc w/ encl: Distribution via LISTSERV

SUBJECT: LIMERICK GENERATING STATION – INTEGRATED INSPECTION REPORT 05000352/2023003 AND 05000353/2023003 AND INDEPENDENT SPENT FUEL STORAGE INSTALLATION INSPECTION 07200065/2023001 DATED OCTOBER 27, 2023

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U.S. NUCLEAR REGULATORY COMMISSION
Inspection Report

Docket Numbers:	05000352, 05000353 and 07200065
License Numbers:	NPF-39 and NPF-85
Report Numbers:	05000352/2023003, 05000353/2023003 and 07200065/2023001
Enterprise Identifier:	I-2023-003-0039 and I-2023-001-0069
Licensee:	Constellation Energy Generation, LLC
Facility:	Limerick Generating Station
Location:	Sanatoga, PA 19464
Inspection Dates:	July 1, 2023 to September 30, 2023
Inspectors:	S. Haney, Senior Resident Inspector L. Grimes, Resident Inspector F. Arner, Senior Reactor Analyst C. Bickett, Senior Reactor Analyst C. Borman, Health Physicist L. Cline, Senior Reactor Inspector B. Edwards, Health Physicist M. Henrion, Senior Health Physicist J. Kulp, Senior Reactor Inspector A. Ziedonis, Team Leader
Approved By:	Sarah H. Elkhiamy, Acting Chief Projects Branch 4 Division of Operating Reactor Safety

Enclosure

SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) continued monitoring the licensee's performance by conducting an integrated inspection at Limerick Generating Station, in accordance with the Reactor Oversight Process. The Reactor Oversight Process is the NRC's program for overseeing the safe operation of commercial nuclear power reactors. Refer to https://www.nrc.gov/reactors/operating/oversight.html for more information.

List of Findings and Violations

Failure to Promptly Identify and Correct Conditions Adverse to Quality Results in D11 Emergency Diesel Generator (EDG) Inoperability and Unavailability			
Cornerstone	Significance	Cross-Cutting Aspect	Report Section
Mitigating Systems	Green NCV 05000352/2023003-01 Open/Closed	None (NPP)	71152A
The inspectors determined there was a self-revealing Green finding and associated non-cited violation (NCV) of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix B, Criterion XVI, "Corrective Action," and Technical Specification (TS) 3.8.1.1, action b, because Constellation did not promptly identify and correct conditions adverse to quality associated with the D11 EDG. Specifically, Constellation identified certain adverse conditions that caused or contributed to high cycle fatigue fracture of a lubricating oil system pressure instrument fitting on multiple EDGs between 2013 and 2019, but did not take adequate action to promptly identify and correct these adverse conditions on D11 prior to high cycle fatigue fracture of the same lubricating oil fitting on February 27, 2023, which resulted in unplanned inoperability and unavailability of D11.			

Additional Tracking Items

Type	Issue Number	Title	Report Section	Status
LER	05000352/2023-001-00	Licensee Event Report (LER) 2023-001-00 for Limerick Generating Station, Unit 1, EDG Lube Oil Pressure Sensing Line Leak Resulting in a Condition Prohibited by TS	71153	Closed

PLANT STATUS

Unit 1 began the inspection period at rated thermal power (RTP). On September 2, 2023, operators lowered thermal power to approximately 79 percent for a control rod sequence exchange, channel distortion testing, and turbine valve testing. The unit was returned to full power on September 3, 2023. On September 15, 2023, operators lowered thermal power to approximately 88 percent for turbine valve testing. The unit was returned to full power on September 16, 2023, and remained at or near RTP for the remainder of the inspection period.

Unit 2 began the inspection period at RTP and remained at or near RTP during the inspection period.

INSPECTION SCOPES

Inspections were conducted using the appropriate portions of the inspection procedures (IPs) in effect at the beginning of the inspection unless otherwise noted. Currently approved IPs with their attached revision histories are located on the public website at http://www.nrc.gov/reading-rm/doc-collections/insp-manual/inspection-procedure/index.html. Samples were declared complete when the IP requirements most appropriate to the inspection activity were met consistent with Inspection Manual Chapter (IMC) 2515, "Light-Water Reactor Inspection Program - Operations Phase." The inspectors performed activities described in IMC 2515, Appendix D, "Plant Status," observed risk significant activities, and completed on-site portions of IPs. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel to assess licensee performance and compliance with Commission rules and regulations, license conditions, site procedures, and standards.

REACTOR SAFETY

71111.04 - Equipment Alignment

Partial Walkdown (IP Section 03.01) (3 Samples)

The inspectors evaluated system configurations during partial walkdowns of the following systems/trains:

(1) Unit 1 and Unit 2 Class 1E direct current power distribution on July 28, 2023
(2) Unit 1 'A' residual heat removal (RHR) system alignment following scheduled surveillance testing on September 11, 2023
(3) Unit 2 reactor core isolation cooling system (RCIC) during elevated risk window for planned testing on September 19, 2023

Complete Walkdown (IP Section 03.02) (1 Sample)

(1) The inspectors evaluated system configurations during a complete walkdown of the emergency service water (ESW) system during the week of September 25, 2023

71111.05 - Fire Protection

Fire Area Walkdown and Inspection (IP Section 03.01) (5 Samples)

The inspectors evaluated the implementation of the fire protection program by conducting a walkdown and performing a review to verify program compliance, equipment functionality, material condition, and operational readiness of the following fire areas:

(1) Unit 2 fire area 55, Unit 2 'B' and 'D' RHR heat exchanger and pump rooms on July 7, 2023
(2) Unit 2 fire area 64, reactor enclosure cooling water heat exchanger area on July 18, 2023
(3) Unit 1 fire area 33, Unit 1 RCIC pump room 109 on September 7, 2023
(4) Unit common fire areas 122 and 123, spray pond pump structure on September 14, 2023
(5) Unit common diverse and flexible coping strategies pump storage building on September 14, 2023

Fire Brigade Drill Performance (IP Section 03.02) (2 Samples)

(1) The inspectors evaluated the on-site fire brigade training and performance during an unannounced fire drill on August 9, 2023
(2) The inspectors evaluated the on-site fire brigade training and performance during an unannounced fire drill on August 17, 2023

71111.11Q - Licensed Operator Requalification Program and Licensed Operator Performance

Licensed Operator Performance in the Actual Plant/Main Control Room (IP Section 03.01) (1 Sample)

(1) The inspectors observed and evaluated licensed operator performance in the control room during Unit 1 downpower for main turbine valve testing on September 15 and 16, 2023

Licensed Operator Requalification Training/Examinations (IP Section 03.02) (1 Sample)

(1) The inspectors observed and evaluated licensed operator requalification training on August 7, 2023

71111.12 - Maintenance Effectiveness

Maintenance Effectiveness (IP Section 03.01) (1 Sample)

The inspectors evaluated the effectiveness of maintenance to ensure the following structures, systems, and components remain capable of performing their intended function:

(1) Unit 2 'B' adjustable speed drive cooling system maintenance following hardware fault on September 20, 2023

71111.13 - Maintenance Risk Assessments and Emergent Work Control

Risk Assessment and Management (IP Section 03.01) (4 Samples)

The inspectors evaluated the accuracy and completeness of risk assessments for the following planned and emergent work activities to ensure configuration changes and appropriate work controls were addressed:

(1) Unit 1 planned action green risk during high-pressure coolant injection (HPCI) system maintenance on July 10 and 11, 2023
(2) Unit 1 protected equipment walkdown for 'A' core spray low pressure trip instrumentation failure on August 1, 2023
(3) Unit common protected equipment walkdown for Unit 1 reactor enclosure differential pressure instrumentation failure on August 1, 2023
(4) Unit 1 main turbine control valve fast acting solenoid failure on September 12 and 13, 2023

71111.15 - Operability Determinations and Functionality Assessments

Operability Determination or Functionality Assessment (IP Section 03.01) (5 Samples)

The inspectors evaluated the licensee's justifications and actions associated with the following operability determinations and functionality assessments:

(1) Issue report (IR) 4690693, Unit 2 main steam line tunnel temperature instrument and logic operability
(2) IR 4691146, Unit 1 D-160 control blades exceed mechanical end of life limit (EC 639198)
(3) IR 4700273, Unit 1 hardened containment vent system following discovery of elevated pressure indication in argon purge header
(4) IR 4700217, Unit 1 main turbine control valve 2 fast acting solenoid failure
(5) IR 4697621, Unit 2 adverse trend in maximum fraction of limiting power distribution

71111.18 - Plant Modifications

Temporary Modifications and/or Permanent Modifications (IP Section 03.01 and/or 03.02) (1 Sample)

The inspectors evaluated the following permanent modification:

(1) Unit 2 D24 EDG governor replacement

71111.24 - Testing and Maintenance of Equipment Important to Risk

The inspectors evaluated the following testing and maintenance activities to verify system operability and/or functionality:

Post-Maintenance Testing (IP Section 03.01) (5 Samples)

(1) Unit 1 'B' RHR drywell spray valves 16B and 21B, following planned maintenance on July 12 and 13, 2023

(2) Unit 2 'A' RHR pump run following planned maintenance for motor oil cooler cleaning on July 20, 2023
(3) Unit 1 'A' core spray low pressure trip unit replacement on August 1, 2023
(4) Unit 1 reactor enclosure differential pressure transmitter replacement on August 1, 2023
(5) Unit common 'A' RHR service water pump following planned maintenance on September 14, 2023

Surveillance Testing (IP Section 03.01) (2 Samples)

(1) ST-6-051-235-2, Unit 2 'A' RHR pump comprehensive test on July 5 and 6, 2023
(2) ST-6-092-111-1, Unit 1 D11 EDG 24-hour endurance test on July 31, 2023

Inservice Testing (IP Section 03.01) (1 Sample)

(1) ST-6-011-231-0, Unit common 'A' loss of offsite power ESW pump valve and flow test on August 18, 2023

71114.06 - Drill Evaluation

Select Emergency Preparedness Drills and/or Training for Observation (IP Section 03.01) (1 Sample)

The inspectors evaluated:

(1) Hostile action based pre-exercise drill on August 22, 2023

RADIATION SAFETY

71124.05 - Radiation Monitoring Instrumentation

Walkdowns and Observations (IP Section 03.01) (8 Samples)

The inspectors evaluated the following radiation detection instrumentation during plant walkdowns:

(1) Continuous Air Monitor #0013539 outside instrument shop
(2) Personnel Contamination Monitor 12 #338000 at radiologically controlled area exit
(3) North Stack Area Radiation Monitor #00TB-RA60
(4) Unit 2 HPCI Area Radiation Monitor #20TB-RA02
(5) Radioactive Waste Building Area Radiation Monitor #00TB-RA42
(6) Unit 1 RCIC Area Radiation Monitor #10TB-RA01
(7) Auxiliary Panel Room which contained all the Unit 1, Unit 2, and common system Area Radiation Monitor instrument display panels
(8) Unit 1 Refuel Floor Area Radiation Monitor #10TB-RA02

Calibration and Testing Program (IP Section 03.02) (13 Samples)

The inspectors evaluated the calibration and testing of the following radiation detection instruments:

(1) Unit 2 Primary Drywell Post - Loss-of-Coolant Accident (LOCA) Radiation Monitor (RE-26-291D)
(2) Unit 2 Primary Drywell Post - LOCA Radiation Monitor (RE-26-291C)
(3) Small Article Monitor (SAM-11) #335001
(4) Ludlum-177 #0026524
(5) Eberline RO-20 Ion Chamber 0016173
(6) Canberra Accuscan-2 Whole Body Counter
(7) MGP Telepole #0011721
(8) MGP, DRM-1/2/2E *EXN Radiation Detector #0015089
(9) Eberline RO-20 Ion Chamber #0015811
(10) Eberline RO-20 Ion Chamber #0016166
(11) Ludlum 12-4/42-31H REM Ball #0016293
(12) Ludlum 12-4/42-31H REM Ball #0017294
(13) MGP AMP-100 Radiation Detection Device #079042

Effluent Monitoring Calibration and Testing Program (IP Section 03.03) (2 Samples)

The inspectors evaluated the calibration and maintenance of the following radioactive effluent monitoring and measurement instrumentation:

(1) Radioactive Waste Discharge to Discharge pipe radioactive effluent monitor #RISH-063-0K604
(2) Unit 2 Service Water return to cooling tower effluent monitor #RISH-010-2K605

OTHER ACTIVITIES – BASELINE

71151 - Performance Indicator Verification

The inspectors verified licensee performance indicators submittals listed below:

IE01: Unplanned Scrams per 7000 Critical Hours (IP Section 02.01) (2 Samples)

(1) Unit 1 for the period of July 1, 2022, through June 30, 2023
(2) Unit 2 for the period of July 1, 2022, through June 30, 2023

IE04: Unplanned Scrams with Complications (IP Section 02.03) (2 Samples)

(1) Unit 1 for the period of July 1, 2022, through June 30, 2023
(2) Unit 2 for the period of July 1, 2022, through June 30, 2023

MS09: Residual Heat Removal Systems (IP Section 02.08) (2 Samples)

(1) Unit 1 for the period of July 1, 2022, through June 30, 2023
(2) Unit 2 for the period of July 1, 2022, through June 30, 2023

71152A - Annual Follow-up Problem Identification and Resolution

Annual Follow-up of Selected Issues (Section 03.03) (2 Samples)

The inspectors reviewed the licensee's implementation of its corrective action program (CAP) related to the following issues:

(1) Evaluation and corrective actions associated with the Unit 1 D12 EDG Dynalco Speed Switch Failure on November 2, 2022 (IR 04534372)
(2) Evaluation and corrective actions associated with the Unit 1 D11 EDG lubricating oil leak on February 27, 2023 (IR 4557807)

71153 - Follow-up of Events and Notices of Enforcement Discretion

Event Report (IP Section 03.02) (1 Sample)

The inspectors evaluated the following LER:

(1) LER 05000352/2023-001-00, "EDG Lube Oil Pressure Sensing Line Leak Resulting in a Condition Prohibited by TS" (ADAMS Accession No. ML23177A232). The inspection conclusions associated with this LER are documented in this report under Inspection Results Section. This LER is Closed.

OTHER ACTIVITIES – TEMPORARY INSTRUCTIONS, INFREQUENT AND ABNORMAL

60855 - Operation of an ISFSI

Operation Of an ISFSI (1 Sample)

(1) The inspectors evaluated the licensee's independent spent fuel storage installation (ISFSI) cask loadings August 21 through 25, 2023. Specifically, the inspectors observed the following activities:

- Fuel loading and verification
- Welding and non-destructive examination of multipurpose canister lid and shell
- Draining and flushing of HI-TRAC transfer cask annulus
- Removal of mating device from HI-STORM overpack
- Installation of HI-STORM lid
- Inspection of ISFSI pad and existing casks
- Transportation of HI-STORM to ISFSI pad and positioning of HI-STORM to final pad location

INSPECTION RESULTS

<table>
<tr><td colspan="4">Failure to Promptly Identify and Correct Conditions Adverse to Quality Results in D11 EDG Inoperability and Unavailability</td></tr>
<tr><td>Cornerstone</td><td>Significance</td><td>Cross-Cutting Aspect</td><td>Report Section</td></tr>
<tr><td>Mitigating Systems</td><td>Green
NCV 05000352/2023003-01
Open/Closed</td><td>None (NPP)</td><td>71152A</td></tr>
<tr><td colspan="4">The inspectors determined there was a self-revealing Green finding and associated NCV of Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix B, Criterion XVI, “Corrective Action,” and TS 3.8.1.1, action b, because Constellation did not promptly identify and correct conditions adverse to quality associated with the D11 EDG. Specifically, Constellation identified certain adverse conditions that caused or contributed to high cycle fatigue fracture of a lubricating oil system pressure instrument fitting on multiple EDGs between 2013 and 2019, but did not take adequate action to promptly identify and correct these adverse conditions on D11 prior to high cycle fatigue fracture of the same lubricating oil fitting on February 27, 2023, which resulted in unplanned inoperability and unavailability of D11.</td></tr>
<tr><td colspan="4">Description: On February 27, 2023, approximately 10 hours into a 24-hour endurance run of the D11 EDG, operators emergently tripped the engine following discovery of an unquantified volume of spray from the lubricating oil pressure sensing instrument tubing. Upon securing the engine, operators noted a crack in between the threads of the 1/4-inch diameter fitting connection to the 4-inch diameter lubricating oil pipe header. During removal of the fitting for corrective maintenance, the fitting sheared along the crack and separated into two pieces. Constellation replaced the fitting on February 28, 2023, and restored the EDG to an operable condition.

In response to this issue, Constellation performed a corrective action program evaluation (CAPE) under IR 4557807, assignment 17, and concluded the cause of the cracked fitting was attributed to vibration-induced fatigue fracture at an unsupported cantilever tubing configuration directly upstream of an instrument root valve. The CAPE identified one contributing cause to the fitting failure was not recognizing that EDG lubricating oil instrument tubing vibration signatures could change over time. Specifically, vibration measurements were taken at this location on D11 in 2019, as part of an extent of condition action from Root Cause Report (RCR) 4266201-15, following a vibration-induced fatigue failure of the same fitting on D24 on July 23, 2019. The extent of condition action determined no resonance vibration conditions were present at the lubricating oil fitting location on any of the other seven EDGs, as was the case on D24 in 2019. Based on this assessment, D24 was determined to be a unique condition, and no further actions were taken on the other seven EDGs, which are all of the same design and vintage. However, when vibrations at the D11 fitting were measured following replacement in 2023, the data indicated the presence of a resonance vibration condition during D11 operation. Additionally in 2023, Constellation identified loose c-clamp support nuts on the 4-inch lubricating oil header piping of D11. Constellation subsequently determined that the lack of lock washers, wires, or other rotational restraints resulted in the vibration signature change on D11 between 2019 and 2023.

The inspectors performed a detailed CAP document review to understand the lubricating oil</td></tr>
</table>

piping and tubing performance history on all eight EDGs. The inspectors noted multiple historic high cycle fatigue fractures of the same lubricating oil fitting on several EDGs:

- April 27, 2013, on D24, evaluated under Equipment Apparent Cause Evaluation 1507365-08, and associated NCV 2013003-01 (ML13218B264)
- December 12, 2016, on D13, evaluated under Work Group Evaluation (WGE) 3951889
- August 31, 2017, on D11, when analyzed as an extent of condition investigation under assignment 5 of D13 WGE 3951889
- January 21, 2019, on D24, evaluated under Equipment Corrective Action Program Evaluation (ECAPE) 4212649-06
- July 22, 2019, on D24, under RCR 4266201-15 and associated NCV 2019004-01 (ML20043D441) and LER 05000-353-2019-002-00

Based on a detailed review of the above performance history, the inspectors noted three specific adverse conditions that were commonly determined by Constellation to cause or contribute to the high cycle fatigue cracks:

Loose or degraded supports:

- The 2019 D24 RCR described how broken and loose c-clamp supports were identified on the D24 lubricating oil pipe header on multiple occasions, but no actions were assigned to periodically inspect or tighten c-clamp supports on other EDGs, nor to evaluate installation of lock washers, wires, or rotational restraints, prior to the loose c-clamp determined to contribute to the D11 failure in 2023.
- The 2016 D13 WGE determined a missing tubing support contributed to the lubricating oil fitting failure at the same location on D13. Subsequently, an extent of condition action identified loose or missing supports on all seven EDGs, and a preventive maintenance task was created to inspect the lubricating oil tubing supports on all EDGs on a ten-year frequency. However, the preventive maintenance scope and frequency was not revisited after loose c-clamp supports were identified in the 2019 D24 RCR.
- On May 2, 2023, during engineering walkdowns to develop a modified connection for the lubricating oil pressure sensing instrumentation, as a corrective action from the 2023 D11 CAPE, engineers discovered a broken c-clamp on D13 EDG (IR 4674776). In response, operators declared D13 inoperable and unavailable. Later that same day, NRC inspectors walked down the remaining seven EDGs, and discovered a loose nut on the c-clamp support associated with D22 (IR 4674779). Inspectors noted that D22 had already been declared inoperable due to planned maintenance activities on an electrical bus associated with D22. The inspectors determined the continued identification of loose or broken lubricating oil piping c-clamps on multiple EDGs in 2023 provided further evidence that Constellation did not implement adequate actions to promptly identify and correct loose EDG lubricating oil piping and tubing supports, despite multiple previous examples noted above.

Resonance vibration conditions:

- The 2019 D24 RCR determined that corrective actions to adjust various lubricating oil piping supports (including the c-clamp noted above) changed the vibratory response to eliminate resonance conditions at the D24 lubricating oil fitting location. While the RCR created one-time actions to validate no resonance conditions existed at the lubricating oil fitting location on the seven other EDGs, the inspectors noted that no consideration was given to the potential for a resonance condition to be re-introduced

due to future loosening or degrading of the supports, despite having direct evidence that support adjustments changed the vibratory response. The inspectors determined this was not a reasonable assumption, given the multiple examples of lubricating oil piping and tubing support loosening and degrading as noted above.

- The 2019 D24 ECAPE assigned action 21 to create a preventive maintenance activity to periodically gather and analyze vibration data during existing EDG maintenance overhauls. However, this action was cancelled following the one-time vibration readings taken on all eight EDGs as discussed above (4266201-24). The inspectors determined this was a missed opportunity to identify changes in D11 lubricating oil tubing vibration conditions prior to the 2023 failure.

Unsupported cantilever-style fitting connection

- The 2019 D24 RCR determined that a contributing cause of the July 2019 D24 failure was the unsupported cantilever configuration of the lubricating oil fitting connection was "less than optimal." Specifically, a root valve is installed downstream of the 1/4-inch fitting connection to the 4-inch pipe header, followed by a 90-degree bend in the tubing without any supports at this location, thereby creating a moment arm which increases the forces at the fitting connection when the root valve and tubing vibrate during engine operation. The RCR assigned a corrective action to prevent recurrence to modify the cantilever connection on D24, and assigned action 37 to consider installing the modified connection on all other EDGs. However, assignment 37 was subsequently cancelled after one-time vibration measurements discussed in the bullet above did not identify the presence of resonance vibration conditions on other EDGs. The inspectors determined this was not a reasonable technical basis for cancelling a modification to the vulnerable cantilever configuration, given the multiple examples of lubricating oil piping and tubing supports loosening and degrading as discussed above, as well as the history of high cycle fatigue cracks at this location on multiple EDGs.

Based on multiple examples of adverse EDG lubricating oil piping and tubing conditions noted above, the inspectors determined the onset of resonance vibration conditions on D11 due to a loose pipe support with an unsupported cantilever-style fitting connection, was reasonably within Constellation's ability to foresee and correct, and therefore the D11 lubricating oil fitting failure on February 27, 2023, should have been prevented.

Subsequently, based on the D11 failure analysis and reportability review, Constellation determined that D11 was inoperable since successful completion of its previous surveillance test on January 31, 2023. Therefore, during D13 planned maintenance between February 12 and 19, 2023, two EDGs were inoperable for greater than 72 hours in accordance with TS 3.8.1.1, Action b, which resulted in a condition prohibited by TS in accordance with 50.73(a)(2)(i)(B). Constellation subsequently submitted LER 2023-001-00 on June 26, 2023.

Corrective Actions: Constellation documented the lubricating oil pipe fitting failure on February 27, 2023, under IR 4557807, completed corrective maintenance on February 28, 2023, under work order (WO) 5340013 and restored the D11 EDG to an operable condition, performed CAPE 4557807-17 to determine the cause of the cracking, and has installed a modified lubricating oil pressure instrument connection on all eight EDGs.

Corrective Action References: IRs 4557807, 4668862, 4668863, 4668868, 4668880, 4668871, 4668872, 4668873, and 4668875; and WO 5340013

Performance Assessment:
Performance Deficiency: 10 CFR Part 50, Appendix B, Criterion XVI requires, in part, that conditions adverse to quality are promptly identified and corrected. Constellation procedure PI-AA-125, “CAP Procedure,” defines conditions adverse to quality as failures, malfunctions, deficiencies, defective items, and nonconformances, and requires a corrective action to restore a condition adverse to quality. The inspectors determined that the failure to promptly identify and correct conditions adverse to quality that caused or contributed to high cycle fatigue fracture of a lubricating oil system pressure instrument fitting on multiple EDGs was reasonably within Constellation’s ability to foresee and correct, and should have been prevented, and was therefore determined to be a performance deficiency.

Significance: The inspectors assessed the significance of the finding using IMC 0609 Appendix A, “The Significance Determination Process (SDP) for Findings At-Power.” The inspectors utilized IMC 0609, Appendix A, Exhibit 2, “Mitigating System Screening Questions,” and determined this finding required a detailed risk evaluation because the degraded condition represented a loss of the probabilistic risk assessment (PRA) function of one train of a multi-train TS system for greater than its TS allowed outage time. Region I senior reactor analysts (SRAs) performed the detailed risk assessment and estimated the increase in core damage frequency (CDF) associated with this performance deficiency to be 9.7E-7/yr, or of very low safety significance (Green).

Exposure Time
A key assumption for this evaluation was the exposure time for the degraded condition. On February 27, 2023, the D11 EDG ran successfully for about 10 hours prior to operators securing the machine due to lube oil leaking from a crack on an instrument fitting. Given that the degradation occurred while the D11 EDG was in operation, the SRAs used the methodology in Section 2.5 of the Risk Assessment of Operational Events Handbook, Volume 1, Revision 2.02, to calculate the exposure time. The SRAs used D11 EDG run history to determine the number of intervals necessary to accumulate 24 hours (PRA mission time) of D11 EDG runtime prior to the failure. Repair time is then added to the exposure time. The SRAs calculated an exposure time of 144 days for this issue, which includes a repair time of approximately 25 hours. This exposure time assumes the crack in the fitting would grow while the EDG was running, independent of EDG loading. The SRAs noted that there was a large amount of uncertainty as to when the crack would get to a point that the fitting would shear, similar to the D24 EDG lube oil failure in 2019. As such, given the availability of reserve lube oil in the EDG sump and lube oil make-up tank, it is possible that during an event, the D11 EDG may have run for longer than 10 hours, which increases the uncertainty with this exposure time assumption.

Standardized Plant Analysis Risk (SPAR) Model Information and Modifications
The SRAs developed the internal events risk estimate for the failure of the D11 EDG using System Analysis Program for Hands-On Integrated Reliability Evaluations (SAPHIRE) version 8.2.8 and a test and limited use (TLU) version of the Limerick Unit 1 SPAR model created by Idaho National Laboratories in August 2023 (TLU3). This TLU3 model included revisions to the Limerick Unit 1 SPAR model of record (version 8.81) and more closely reflected the as-built, as-operated plant. Key model changes included the following:

- The SRAs applied credit for post-Fukushima diverse and flexible coping strategies (FLEX) and updated FLEX unreliability parameters to those documented in PWROG-18042-NP, “FLEX Equipment Data Collection and Analysis,” Revision 1. The SRAs determined this data represents the best estimate for FLEX reliability.

- Given this performance deficiency and the number of EDG failure to run issues over the last four years at Limerick, the SRAs determined it was appropriate to increase the EDG fail-to-run probabilities in the SPAR model, which also increased the associated common cause failure probabilities. Considering these EDG failures, the SRAs determined a new failure rate (lambda) mean value of 1.5E-3/hr using a Bayesian-Poisson methodology, which resulted in a higher failure to run probability for the Limerick EDGs.
- Given that the dominant sequences for this evaluation included loss of offsite power and station blackout events, the SRAs reviewed the human error probability calculation for the operator action to crosstie 4KV buses. Constellation's calculation assumed that operators would need about one hour to complete the action and would have about 2.6 hours available. The SRAs compared this timeline to procedure E-1, "Loss of All AC Power (Station Blackout)," Revision 22, and determined that during a single unit station blackout event, operators have only one hour available to crosstie 4KV buses. The SRAs reviewed the two most recent validations to ensure that operators could complete the crosstie within one hour. Based on this review and considering the uncertainty of plant conditions at the time of the crosstie, the SRAs determined that Constellation's failure probability of 1.1E-3 for crosstie of 4KV buses was too low, specifically for a single unit station blackout event. The SRAs applied a new failure probability of 6E-2, calculated using SPAR-H, for the crosstie operator action for a single unit station blackout event.
- The offsite power non-recovery probabilities were adjusted in the SPAR model to provide credit for 10 hours of successful D11 EDG operation and associated decay heat reduction.
- The SRAs revised the initiating event probability for the grid-related loss of offsite power from 5.4E-3/yr to 1.31E-2/yr to reflect best available data provided in report INL/RPT-22-68809, "Analysis of Loss of Offsite Power Events – 2021 Update."
- Given that Limerick can crosstie power between units, and all eight EDGs are similar (Fairbanks-Morse), the TLU3 model incorporated an EDG common cause failure to run event across both units, which was not considered in the existing SPAR model of record. This aligns with Limerick's PRA model and was a notable risk contributor in this evaluation.

The SRAs determined the increase in CDF from internal events to be 5.7E-7/yr Dominant core damage sequences included loss of offsite power events with common cause failure (CCF) of either Unit 1 EDGs with failure to cross tie from Unit 2, or CCFs of Unit 1 and Unit 2 EDGs, operator failure to recover offsite power, operator failure to recover the EDGs, and failure of FLEX equipment.

<u>Contributions from External Events</u>
The SRAs evaluated risk from external events and determined that fire risk was initially the dominant contributor for this performance deficiency. The SRAs used Limerick's peer-reviewed fire PRA model as the best available information for estimating the increase in risk due to fire events.

As part of their evaluation of the D11 EDG failure, Constellation updated the Limerick fire PRA model with ignition frequency and non-suppression estimates included in NUREG-2262, "High Energy Arcing Fault Frequency and Consequence Modeling," issued in April 2023. Constellation's use of NUREG-2262 data in the Limerick fire PRA provided a significant decrease in fire risk because the original fire PRA model for the D11 EDG failure to run was

dominated by high energy arcing faults, especially in the switchgear rooms. As a comparison, prior to this evaluation, the Limerick fire PRA Birnbaum importance measure for failure of the D11 EDG to run was 7.33E-6/yr or 2.89E-6 for the 144-day exposure time. Following incorporation of the NUREG-2262 data, along with some other adjustments to the model, the increase in CDF due to fire events for this issue was 4E-7/yr. The dominant fire areas included the D14 switchgear room, switchyard area fires, and the Unit 1 reactor protection system static inverter compartment.

The SRAs evaluated this degraded condition for the impact to large early release frequency and determined it was bounded by the increase in CDF.

Cross-Cutting Aspect: Not Present Performance. No cross-cutting aspect was assigned to this finding because the inspectors determined the finding did not reflect present licensee performance.

Enforcement:

Violation: 10 CFR Part 50, Appendix B, Criterion XVI requires that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. Constellation procedure PI-AA-125, “CAP Procedure,” Revision 6, step 4.5.2, requires a corrective action to restore a condition adverse to quality, and defines conditions adverse to quality as failures, malfunctions, deficiencies, defective items, and nonconformances.

TS Limiting Condition for Operation 3.8.1.1, action b, specifies that with two EDGs inoperable, action must be taken to restore at least one inoperable EDG to operable with 72 hours, or be in at least hot shutdown within the next 12 hours and cold shutdown within the following 24 hours.

Contrary to this, from October 4, 2019, until February 28, 2023, Constellation did not assign actions to promptly identify and correct conditions adverse to quality associated with the D11 EDG. Specifically, Constellation did not take adequate action to promptly identify and correct adverse conditions that resulted in high cycle fatigue cracking on the D11 EDG lubricating oil system pressure instrument fitting, following the identification of adverse conditions that resulted in multiple high cycle fatigue cracks on several EDGs between 2013 and 2019. Consequently, D11 EDG was rendered inoperable and unavailable on February 27, 2023, when the lubricating oil pressure instrument fitting failed during surveillance testing. The inspectors determined that while completion of RCR 4266201-15 on October 4, 2019, represented the most reasonable opportunity to assign actions to identify and correct adverse conditions on the D11 lubricating oil piping and tubing, it did not represent any firm evidence that D11 was inoperable since 2019.

In addition, because Constellation determined that D11 was inoperable since successful completion of its previous surveillance test on January 31, 2023, two EDGs were inoperable for greater than 72 hours during D13 planned maintenance between February 12 and 19, 2023, resulting in a violation of TS Limiting Condition for Operation 3.8.1.1. The disposition of this violation closes LER 05000352/2023-01-00, "Unit 1 EDG Lube Oil Pressure Sensing Line Leak Resulting in a Condition Prohibited by TSs."

Enforcement Action: This violation is being treated as an NCV, consistent with Section 2.3.2 of the Enforcement Policy.

Minor Performance Deficiency	71152A

MREQ Assignment Type Code Used to Track Unit 1 D12 EDG Dynalco Speed Switch Failure Extent of Condition Action Assignments (IR 04534372)

Minor Performance Deficiency: The licensee initiated IR 04534372 to track corrective actions for the EDG D12 Dynalco Speed Switch Failure. In accordance with PI-AA-120, "Issue Identification and Screening Process," Attachment 5, Guidance for Determining NCAP Issues (the non-Appendix B CAP, the licensee screened the IR to the Appendix B corrective action program (CAP)). The inspectors identified that PI-AA-125, "CAP," procedure (for the Appendix B CAP), Step 4.5.4 directs that CAP actions are created in the CAP computer program using the appropriate assignment type code per Attachment 3, Frequently Used Condition Report Assignment Types. Contrary to the procedure, several CAP assignments generated to address issues identified in the WGE for the D12 failure were tracked using the assignment type code MREQ. The MREQ code was not listed or defined in PI-AA-125, Attachment 3. The D12 failure CAP actions that the licensee coded as MREQs, included preventive maintenance task reviews, extent of condition investigations and a simple risk assessment. The inspectors determined, based on the descriptions included on PI-AA-125, Attachment 3, that the correct assignment code for these actions was Action Item (ACIT), items completed to improve performance or correct minor problems that do not represent conditions adverse to quality. The inspectors determined that the licensee normally used the MREQ code to track completion of NCAP actions.

Screening: The inspectors determined the performance deficiency was minor. The required corrective action for the condition adverse to quality, replacing the D12 failed speed switch, was performed in a timely manner and the other assigned actions were either completed or appropriately scheduled in accordance with the licensee's work planning process. The licensee issued IR 4707675 to document this performance deficiency.

Minor Performance Deficiency	71152A

Issue Report Generated to Track Extent of Condition Actions for Unit 1 D12 EDG Dynalco Speed Switch Failure screened to NCAP (IR 04550831)

Minor Performance Deficiency: Constellation initiated IR 4550831 to address the extent of condition for the failed D12 EDG speed switch (IR 04534372). The licensee identified the extent of condition to include all the Unit 1 and Unit 2 EDGs (D11 to D14 and D21 to D24). IR 4550831 directed installing upgraded speed switches during the next system outage window for each EDG. The station oversight committee screened this IR to the NCAP. The inspectors determined that because the IR directed speed switch replacements for the eight safety-related EDGs, it should have been classified as an Appendix B CAP IR in accordance with PI-AA-120, "Issue Identification and Screening Process," Attachment 5, Guidance for Determining NCAP Issues.

Screening: The inspectors determined the performance deficiency was minor. Each EDG speed switch was scheduled for timely replacement in accordance with the IR 4550831 directed action and the licensee's work planning process. The licensee issued IR 4707675 to document this performance deficiency.

Observation: Evaluation and Corrective Actions Associated with the Unit 1 D12 EDG Dynalco Speed Switch Failure on November 2, 2022	71152A
The inspectors reviewed the WGE), the Constellation power labs failure analysis, the simple issue risk assessment, and the licensee's identified corrective actions for IR 04534372. The review included a search for available operating experience for the failed switch and the licensee's evaluation of 10 CFR Part 21 reporting requirements. The sample was selected because the failure of the switch made the diesel inoperable and the extent of condition for the issue included all the Unit 1 and Unit 2 EDGs (D11 to D14 and D21 to D24). No findings were identified; however, two minor performance deficiencies were identified and documented above.	

EXIT MEETINGS AND DEBRIEFS

The inspectors verified no proprietary information was retained or documented in this report.

- On August 17, 2023, the inspectors presented the Exit Debrief for IP 71124.05 Radiation Monitoring Instrumentation inspection results to Matt Arnao, Maintenance Director, and other members of the licensee staff.
- On August 24, 2023, the inspectors presented the ISFSI inspection results to Michael Gillin, Site Vice President, and other members of the licensee staff.
- On October 19, 2023, the inspectors presented the integrated inspection results to Michael Gillin, Site Vice President, and other members of the licensee staff.

DOCUMENTS REVIEWED

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
71111.04	Corrective Action Documents Resulting from Inspection	IR 4704861		
71152A	Corrective Action Documents Resulting from Inspection	IR 4707675		