



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**

**REGION I
2100 RENAISSANCE BOULEVARD, SUITE 100
KING OF PRUSSIA, PENNSYLVANIA 19406-2713**

February 12, 2020

Mr. Bryan C. Hanson
Senior Vice President, Exelon Generation Company, LLC
President and Chief Nuclear Officer, Exelon Nuclear
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

**SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 – INTEGRATED
INSPECTION REPORT 05000352/2019004 AND 05000353/2019004**

Dear Mr. Hanson:

On December 31, 2019, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at Limerick Generating Station, Units 1 and 2. On January 17, 2020, the NRC inspectors discussed the results of this inspection with Mr. Frank Sturniolo 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.

A licensee-identified violation which was determined to be Severity Level IV is documented in this report. We are treating this violation as an NCV consistent with Section 2.3.2 of the Enforcement Policy.

If you contest the violations or the significance or severity of the violations 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, Units 1 and 2.

If you disagree with a cross-cutting aspect assignment in this report, you should provide a response within 30 days of the date of this inspection report, with the basis for your disagreement, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator, Region I; and the NRC Resident Inspector at Limerick Generating Station, Units 1 and 2.

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* 2.390, "Public Inspections, Exemptions, Requests for Withholding."

Sincerely,

 /RA/

Signed by: Jonathan E. Greives

Jonathan E. Greives, Chief
Reactor Projects Branch 4
Division of Reactor Projects

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

Enclosure:
As stated

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SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 – INTEGRATED
INSPECTION REPORT 05000352/2019004 AND 05000353/2019004 DATED
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U.S. NUCLEAR REGULATORY COMMISSION
Inspection Report

Docket Numbers: 05000352 and 05000353

License Numbers: NPF-39 and NPF-85

Report Numbers: 05000352/2019004 and 05000353/2019004

Enterprise Identifier: I-2019-004-0049

Licensee: Exelon Generation Company, LLC

Facility: Limerick Generating Station, Units 1 and 2

Location: Sanatoga, PA 19464

Inspection Dates: October 1, 2019 to December 31, 2019

Inspectors: J. Ambrosini, Senior Emergency Preparedness Inspector
H. Anagnostopoulos, Senior Health Physicist
D. Beacon, Resident Inspector
L. Casey, Senior Project Engineer
B. Fuller, Senior Operations Engineer
S. Haney, Resident Inspector
S. Rutenkroger, Senior Resident Inspector
T. Setzer, Senior Operations Engineer

Approved By: Jonathan E. Greives, Chief
Reactor Projects Branch 4
Division of Reactor Projects

Enclosure

SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) continued monitoring the licensee's performance by conducting an integrated inspection at Limerick Generating Station (LGS), Units 1 and 2, 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. A licensee-identified non-cited violation is documented in report section: 71111.11B.

List of Findings and Violations

Emergency Diesel Generator Lube Oil Pressure Sensing Line Shear Due to Inadequate Corrective Actions			
Cornerstone	Significance	Cross-Cutting Aspect	Report Section
Mitigating Systems	Green NCV 05000353/2019004-01 Open/Closed	[H.14] - Conservative Bias	71153
A self-revealing Green non-cited violation of 10 CFR Part 50, Appendix B, Criterion XVI, with a corresponding violation of LGS Unit 2 Technical Specification (TS) 3.8.1.1, was identified when Exelon failed to correct a degraded lube oil system instrumentation line on the 'D24' emergency diesel generator (EDG). The degraded instrumentation line threaded pipe connection for a lube oil pressure indicator subsequently sheared during a slow start monthly run on July 22, 2019.			

Additional Tracking Items

Type	Issue Number	Title	Report Section	Status
LER	05000353/2019-002-00	LER 2019-002-00 for Limerick Generating Station, Unit 2, Emergency Diesel Generator Lube Oil Pressure Sensing Line Leak Resulting in a Condition Prohibited by Technical Specifications	71153	Closed

PLANT STATUS

Unit 1 began the inspection period at rated thermal power. On November 15, 2019, the unit was down powered to 77 percent for a control rod pattern adjustment. The unit was returned to rated thermal power the following day.

Unit 2 operated at or near rated thermal power for the entire 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 plant status activities described in IMC 2515, Appendix D, "Plant Status," and conducted routine reviews using IP 71152, "Problem Identification and Resolution." 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

71111.01 - Adverse Weather Protection

External Flooding Sample (IP Section 03.04) (1 Sample)

- (1) The inspectors evaluated readiness to cope with external flooding on December 4, 2019, through December 5, 2019

71111.04Q - Equipment Alignment

Partial Walkdown Sample (IP Section 03.01) (3 Samples)

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

- (1) Unit common '101' transformer and bus on October 16, 2019
- (2) Unit common 'B' control enclosure chiller on October 28, 2019
- (3) Unit 1 reactor core isolation cooling system on December 27, 2019

71111.04S - Equipment Alignment

Complete Walkdown Sample (IP Section 03.02) (1 Sample)

- (1) The inspectors evaluated system configurations during a complete walkdown of the Unit common emergency service water system on October 24, 2019, through November 13, 2019

71111.05Q - Fire Protection

Quarterly Inspection (IP Section 03.01) (5 Samples)

The inspectors evaluated fire protection program implementation in the following selected areas:

- (1) Fire area 24, Unit common control room and peripheral rooms on October 8, 2019
- (2) Fire areas 122 and 123, Unit common spray pond pump structure on November 13, 2019
- (3) Fire area 27, Unit common control structure fan room on December 30, 2019
- (4) Fire area 47, Unit 1 standby liquid control equipment area on December 30, 2019
- (5) Fire areas F-CWP-001 and F-P-001, Unit common motor driven fire pump area and diesel driven fire pump room on December 31, 2019

71111.07A - Heat Sink Performance

Annual Review (IP Section 02.01) (2 Samples)

The inspectors evaluated readiness and performance of:

- (1) Unit 1 'A' residual heat removal motor oil cooler (1A-E220) on October 29, 2019
- (2) Unit 2 'D23' EDG air cooler heat exchanger (2C-E586), lube oil heat exchanger (2C-E506) and jacketwater heat exchanger (2C-E507) on December 9, 2019

71111.11A - Licensed Operator Regualification Program and Licensed Operator Performance

Regualification Examination Results (IP Section 03.03) (1 Sample)

- (1) The inspectors reviewed and evaluated the licensed operator examination failure rates for the regualification annual operating exam administered on October 21, 2019, through October 25, 2019

71111.11B - Licensed Operator Regualification Program and Licensed Operator Performance

Licensed Operator Regualification Program (IP Section 03.04) (1 Sample)

- (1) Biennial Regualification Written Examinations

The inspectors evaluated the quality of the licensed operator biennial regualification written examination administered on October 24, 2019.

Annual Regualification Operating Tests

The inspectors evaluated the adequacy of the licensee's annual regualification operating test.

Administration of an Annual Requalification Operating Test

The inspectors evaluated the effectiveness of the licensee in administering requalification operating tests required by 10 CFR 55.59(a)(2) and that the licensee is effectively evaluating their licensed operators for mastery of training objectives.

Requalification Examination Security

The inspectors evaluated the ability of the licensee to safeguard examination material, such that the examination is not compromised.

Remedial Training and Re-examinations

The inspectors evaluated the effectiveness of remedial training conducted by the licensee, and reviewed the adequacy of re-examinations for licensed operators who did not pass a required requalification examination.

Operator License Conditions

The inspectors evaluated the licensee's program for ensuring that licensed operators meet the conditions of their licenses.

Control Room Simulator

The inspectors evaluated the adequacy of the licensee's control room simulator in modeling the actual plant, and for meeting the requirements contained in 10 CFR 55.46.

Problem Identification and Resolution

The inspectors evaluated the licensee's ability to identify and resolve problems associated with licensed operator performance.

71111.11Q - Licensed Operator Requalification Program and Licensed Operator Performance

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

- (1) The inspectors observed and evaluated licensed operator requalification training on October 22, 2019

71111.12 - Maintenance Effectiveness

Routine Maintenance Effectiveness Inspection (IP Section 02.01) (2 Samples)

The inspectors evaluated the effectiveness of routine maintenance activities associated with the following equipment and/or safety significant functions:

- (1) Review of (a)(1) determinations for offgas system and 480 volt alternating current distribution system resulting from Unit 2 scram on June 4, 2019
- (2) Unit 1 'D12' and Unit 2 'D23' EDG 4 kV emergency bus undervoltage relays through December 13, 2019

71111.13 - Maintenance Risk Assessments and Emergent Work Control

Risk Assessment and Management Sample (IP Section 03.01) (5 Samples)

The inspectors evaluated the risk assessments for the following planned and emergent work activities:

- (1) Unit common '201' transformer and bus planned maintenance to restore normal alignment on October 16, 2019
- (2) Unit 2 'D24' EDG fast start surveillance testing and 4 kV bus undervoltage channel functional testing on October 22, 2019
- (3) Unit 1 high pressure coolant injection (HPCI) surveillance testing on October 23, 2019
- (4) Unit 1 'A' residual heat removal pump motor oil cooler flushing on October 29, 2019
- (5) Unit common 'B' control room fresh air system planned maintenance on December 16 and 17, 2019

71111.15 - Operability Determinations and Functionality Assessments

Operability Determination or Functionality Assessment (IP Section 02.02) (6 Samples)

The inspectors evaluated the following operability determinations and functionality assessments:

- (1) Unit common remote shutdown panel room main halon bottle weight below technical requirements manual minimum on October 3, 2019
- (2) Unit common 'D' residual heat removal service water pump vibration trend on October 9, 2019
- (3) Unit 2 HPCI flow controller drifting in manual on October 24, 2019
- (4) Unit 1 moisture carryover sample above 0.30 percent on November 20, 2019
- (5) Unit common 'A' control room emergency fresh air supply system damper 'HV-078-020A' did not stroke time within the required band on December 11, 2019
- (6) Unit 2 'D23' EDG jacket water pressure fluctuations on December 12, 2019

71111.19 - Post-Maintenance Testing

Post-Maintenance Test Sample (IP Section 03.01) (5 Samples)

The inspectors evaluated the following post maintenance tests:

- (1) Unit 1 'A' standby liquid control installation of new flow meters on October 4, 2019
- (2) Unit 1 HPCI discharge, test loop shutoff, and test line flush to suppression pool auto closure seal-in contact test and post-maintenance test on October 24, 2019
- (3) Unit 1 division 1 safeguard battery ground repairs on November 16, 2019
- (4) Unit 1 reactor core isolation cooling pump, valve and flow test following planned maintenance on November 18, 2019
- (5) Unit 2 'D23' EDG fast start surveillance following planned maintenance on December 16, 2019

71111.22 - Surveillance Testing

The inspectors evaluated the following surveillance tests:

Surveillance Tests (other) (IP Section 03.01) (3 Samples)

- (1) Unit 2 HPCI pump, valve and flow surveillance on October 25, 2019
- (2) Unit 2 'C' residual heat removal pump, valve, and flow surveillance on November 14, 2019
- (3) Unit 1 main turbine control valve 'CV-1' exercise on December 23, 2019

71114.06 - Drill Evaluation

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

- (1) The inspectors evaluated the conduct of a routine LGS emergency planning drill on October 1, 2019

Drill/Training Evolution Observation (IP Section 03.02) (1 Sample)

The inspectors evaluated:

- (1) The inspectors evaluated a simulator training evolution on November 12, 2019

RADIATION SAFETY

71124.06 - Radioactive Gaseous and Liquid Effluent Treatment

Walk Downs and Observations (IP Section 02.01) (1 Sample)

- (1) The inspectors walked down the gaseous and liquid radioactive effluent monitoring and filtered ventilation systems to assess the material condition and verify proper alignment according to plant design.

Calibration and Testing Program (Process & Effluent Monitors) (IP Section 02.02) (1 Sample)

- (1) The inspectors evaluated the gaseous and liquid effluent monitor instrument calibration and testing.

Sampling and Analysis (IP Section 02.03) (1 Sample)

- (1) The inspectors reviewed:
 1. Radioactive effluent sampling activities
 2. Representative sampling requirements
 3. Compensatory measures taken during effluent discharges with inoperable effluent radiation monitoring instrumentation
 4. The use of compensatory radioactive effluent sampling
 5. The results of the inter-laboratory and intra-laboratory comparison program, including scaling of hard-to-detect isotopes

Instrumentation and Equipment (IP Section 02.04) (1 Sample)

- (1) The inspectors reviewed radioactive effluent discharge system surveillance test results and reviewed the methodology used to determine the radioactive effluent stack and vent flow rates based on Technical Specifications/Off Site Dose Calculation Manual acceptance criteria.

Dose Calculations (IP Section 02.05) (1 Sample)

- (1) The inspectors reviewed several liquid and gaseous discharge permits to evaluate public dose calculations (monthly, quarterly, and annual) and the annual radiological effluent release reports for 2017 and 2018.

OTHER ACTIVITIES – BASELINE

71151 - Performance Indicator Verification

The inspectors verified Exelon's performance indicator submittals listed below for the period October 1, 2018 through September 30, 2019 (8 samples):

MS10: Cooling Water Support Systems (IP Section 02.09) (2 Samples)

- (1) Unit 1 cooling water
- (2) Unit 2 cooling water

BI01: Reactor Coolant System (RCS) Specific Activity Sample (IP Section 02.10) (2 Samples)

- (1) Unit 1 reactor coolant system specific activity
- (2) Unit 2 reactor coolant system specific activity

BI02: RCS Leak Rate Sample (IP Section 02.11) (2 Samples)

- (1) Unit 1 reactor coolant system leak rate
- (2) Unit 2 reactor coolant system leak rate

OR01: Occupational Exposure Control Effectiveness Sample (IP Section 02.15) (1 Sample)

- (1) Occupational exposure control effectiveness

PR01: Radiological Effluent Technical Specifications/Offsite Dose Calculation Manual
Radiological Effluent Occurrences (RETS/ODCM) Radiological Effluent Occurrences Sample
(IP Section 02.16) (1 Sample)

- (1) Radiological effluent technical specifications/offsite dose calculation manual
radiological effluent

71152 - Problem Identification and Resolution

Semiannual Trend Review (IP Section 02.02) (1 Sample)

- (1) The inspectors reviewed the licensee's corrective action program for potential adverse trends that might be indicative of a more significant safety issue

Annual Follow-up of Selected Issues (IP Section 02.03) (2 Samples)

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

- (1) Multiple sirens indicated issues on the semi-annual full sound test, issue report (IR) 4199902
- (2) Reactor core isolation cooling flow, speed, and discharge pressure oscillations, IR 4173191

71153 - Followup of Events and Notices of Enforcement Discretion

Event Report (IP Section 03.02) (1 Sample)

The inspectors evaluated the following licensee event reports (LERs):

- (1) LER 2019-002-00 for Limerick Generating Station, Unit 2, Emergency Diesel Generator Lube Oil Pressure Sensing Line Leak Resulting in a Condition Prohibited by Technical Specifications

INSPECTION RESULTS

Licensee-Identified Non-Cited Violation	71111.11B
This violation of very low safety significance was identified by the licensee and has been entered into the licensee corrective action program and is being treated as a non-cited violation, consistent with Section 2.3.2 of the Enforcement Policy.	
Violation: Title 10 CFR 55.25 requires, in part, that if a licensed operator develops a permanent physical condition that causes the licensee to fail to meet the requirements of 10 CFR 55.21, the facility shall notify the Commission within 30 days of learning of the diagnosis. For conditions where a license condition is required, the facility licensee must provide medical certification on NRC Form 396, "Certification of Medical Examination by Facility Licensee." Contrary to the above, from March 16, 2017, to August 27, 2019, the licensee failed to notify the Commission, within 30 days of learning the diagnosis, of a change in medical condition of one licensed operator and one licensed senior operator that developed permanent physical conditions that could potentially cause them to fail to meet the requirements of 10 CFR 55.21. Specifically, in March 2017, a licensed operator reported to the licensee medical staff that he was no longer required by his physician to use any medications. In August 2019, the licensee notified the Commission to remove the medication condition from the individual's license. Additionally, in November 2018, a senior licensed operator was diagnosed with a potentially disqualifying medical condition that was in remission, and as such was reportable to the Commission. The licensee reported the diagnosis to the Commission on August 27, 2019.	

Significance/Severity: Severity Level IV. The ROP's significance determination process does not specifically consider the regulatory process impact in its assessment of licensee performance. Therefore, it is necessary to address this violation which impedes the NRC's ability to regulate using traditional enforcement to adequately deter non-compliance. The inspectors determined the violation to be a Severity Level IV violation similar to Example 6.4.d.1.a in the NRC Enforcement Policy. Specifically, the licensee non-willfully failed to inform the NRC of a change in an operator's medical condition, which did not contribute to the NRC making an incorrect regulatory decision.

Corrective Action References: IR 04265550

Observation: December 2018 Siren Issues as Described in IR 4199902	71152
The inspectors reviewed the causal analysis and corrective actions for IR 4199902, which described the problems with the activation of 30 sirens during testing in December 2018. The inspectors determined Exelon appropriately engaged vendor and corporate expertise to perform a thorough causal analysis, which determined the failure mode to be motor brush corrosion. This failure mode was not expected due to the sealed design of the motor and the inspectors verified there was no mention of preventive maintenance in the vendor manual that could have prevented the siren failures. The inspectors reviewed the siren maintenance procedure to ensure Exelon incorporated the corrective actions to perform annual resistance checks and biennial physical inspections. Additionally, the inspectors assessed Exelon's efforts to communicate this previously unknown failure mode to the rest of the nuclear industry. The inspectors determined that this issue was not reasonably within Exelon's ability to foresee and correct, and therefore there is no performance deficiency associated with the December 2018 siren issues.	

Observation: Reactor Core Isolation Cooling System Flow, Speed, and Discharge Pressure Oscillations, IR 4173191	71152
The inspectors reviewed the causal analysis and corrective actions for IR 4173191, which described the failure of the LGS Unit 2 reactor core isolation cooling system's flow transmitter on September 14, 2018. Exelon sent the failed transmitter to the vendor for investigation. The vendor identified that fill oil had migrated to the outer diameter of the high side isolating diaphragm causing swelling of the concentric corrugations near the diaphragm's edge. This swelling interfered with the movement of oil required for proper operation of the transmitter. Exelon was not able to determine a definitive cause for the oil migration. The inspectors reviewed the performance history, preventive maintenance records, corrective actions, industry operating experience, and extent of condition checks. The inspectors determined that Exelon's evaluation, completed actions, and planned actions were reasonable and timely. In particular, Exelon inspected three other flow transmitters with a similar operating history, and all three had no indication of a similar condition. The inspectors determined that this issue was not reasonably within Exelon's ability to foresee and correct, and therefore there is no performance deficiency associated with the failed transmitter.	

Observation: 71152 Semiannual Trend Review	71152
The inspectors performed a semi-annual review of site issues to identify trends that might indicate the existence of more significant safety concerns. As part of this review, the inspectors included repetitive or closely-related issues documented by Exelon in the corrective action program database, trend reports, site performance indicators, major equipment problem lists, system health reports, maintenance rule assessments, and maintenance or corrective action program backlogs. The inspectors also reviewed how	

Exelon's corrective action program evaluated and responded to individual issues identified by the NRC inspectors during routine plant walkdowns and daily condition report reviews.

The inspectors reviewed and assessed an equipment failure trend identified by Exelon in condition report IR 4266423. The trend examples initially consisted, in part, of issues with EDG temperature switches which the inspectors previously identified as a trend, along with issues involving water makeup capacity to the cooling towers and hotwell level control. The inspectors reviewed Exelon's training and actions performed, which included an evaluation of long-standing issues to ensure proper handling within Exelon's tools. The applicable tools included Engage System Health, Risk Classification Manager, and the Plant Health Committee. Open issues included the diesel temperature switches, redundant reactivity control system circuit cards, control rod drive system, and radiation monitor reliability. The inspectors reviewed the classifications and open corrective actions and determined that Exelon was addressing the issues commensurate with the safety significance.

During the reviews, the inspectors identified a potential trend regarding the halon fire system that was not previously identified by Exelon. The inspectors noted three annual surveillance failures within the past three months whereas the monthly surveillances had not identified potential issues or trends. Of potential concern, the remote shutdown panel halon system main bottle was found significantly underweight on September 9, 2019, and the reserve bottle was found below its required temperature-corrected pressure on December 9, 2019. The inspectors shared an observation that a minor halon leak may exist, that the monthly checks did not identify or trend the condition, and actions may be required to ensure continued functionality until the next annual surveillances. Exelon initiated IR 4303755 in response to the observation.

Overall, the inspectors determined Exelon's actions were proactive and appropriate. The inspectors did not identify an adverse trend that might indicate the existence of a more significant safety concern during this semi-annual period.

Emergency Diesel Generator Lube Oil Pressure Sensing Line Shear Due to Inadequate Corrective Actions			
Cornerstone	Significance	Cross-Cutting Aspect	Report Section
Mitigating Systems	Green NCV 05000353/2019004-01 Open/Closed	[H.14] - Conservative Bias	71153
A self-revealing Green non-cited violation of 10 CFR Part 50, Appendix B, Criterion XVI, with a corresponding violation of LGS Unit 2 Technical Specification (TS) 3.8.1.1, was identified when Exelon failed to correct a degraded lube oil system instrumentation line on the 'D24' emergency diesel generator (EDG). The degraded instrumentation line threaded pipe connection for a lube oil pressure indicator subsequently sheared during a slow start monthly run on July 22, 2019.			
<u>Description:</u> The EDG systems are safety-related standby emergency power systems for LGS Units 1 and 2 consisting of four diesel generator sets per unit. Each diesel generator has a lube oil system for maintaining lubrication of the engine. On July 22, 2019, an instrumentation line threaded pipe connection for a lube oil pressure indicator was found sheared on the 'D24' EDG during a slow start monthly run. The sheared pipe caused a substantial spraying leak of lube oil requiring immediate shutdown of the diesel engine to			

prevent engine damage from loss of lubrication in significantly less than 24 hours of operation.

The one-quarter inch instrumentation line threaded connection tees off the four-inch main lube oil piping near the discharge of the engine driven lube oil pump. Operators identified the lube oil leak caused by the sheared pipe after about one hour of the engine running. Exelon performed a root cause evaluation in which the past failure history of this connection was reviewed. The connection previously failed on April 27, 2013, and January 21, 2019. Prior to the January 2019 failure, Exelon had replaced the threaded connection on May 23, 2018.

After each failure, Exelon replaced the threaded pipe and determined that the failure was due to high-cyclic fatigue. After the January 2019 failure, Exelon initiated additional actions to install a clamp to increase support of the one-quarter inch instrument line and to modify the instrument line design to reduce the vibration at the threaded connection. On March 19, 2019, Exelon identified a broken U-bolt restraint on the four-inch main header in a location near the threaded connection. Exelon determined that the U-bolt had likely been failed for some time since the failed connection was not readily observable. Exelon replaced the U-bolt following the completion of the 24-hour endurance run.

On April 25, 2019, Exelon installed a clamp from the four-inch main header to the one-quarter inch instrument line. The running vibration data showed a reduction in magnitude following completion of adjustments. However, while significant vibrations were measured during the clamp installation and adjustment process, Exelon did not replace the threaded connection to reset fatigue that had accumulated since replacement in January 2019. In addition, although the new support was installed, the threaded connection was still experiencing notable vibration, albeit at a reduced level, and the engineering change to modify the instrument line design was assigned a due date of August 30, 2019. Therefore, accumulated high-cyclic fatigue remained and fatigue continued to progress with additional engine start and operation. Exelon started and ran the 'D24' EDG on April 27, 2019, May 12, 2019, May 24, 2019, June 18, 2019, and July 22, 2019, with the threaded connection failing on July 22, 2019. Exelon determined the 'D24' EDG was inoperable from the last run on June 18, 2019, to the failure on July 22, 2019.

Following the July 2019 failure, Exelon performed additional investigation of the main header piping and identified that the main header pipe coupling was misaligned such that the main header piping was rigid, transferring vibratory energy to the piping appendages. Previous vibration analysis had concluded that the threaded pipe connection failure was caused by a resonance condition that had been resolved by installing a clamp and reinstalling the broken U-bolt. However, Exelon personnel failed to recognize that the running energy of the threaded connection and valve configuration did not change following the maintenance performed.

The inspectors reviewed the evaluation and past events pertaining to the threaded connection. The inspectors determined that Exelon was reasonably able to incorporate the past operating and failure history of the threaded connection into the timeline for planned corrective actions to include the start and operation of the engine. Specifically, between May 2018 when the coupling was replaced and January 2019 when the coupling failed, the engine experienced twelve starts and about 31 hours of operation. From the coupling replacement in January 2019 to the failure in July 2019 the engine experienced twelve starts and about 47 hours of operation. In addition, Exelon was reasonably able to replace the threaded connection to reset accumulated fatigue after the U-bolt repair in March 2019 and clamp installation in April 2019. Finally, the misalignment of the main header pipe coupling was

identified following additional investigation which was performed in September 2019 via work orders that were initiated following the failure in January 2019. Exelon procedure PI-AA-125, "Corrective Action Program (CAP) Procedure," specifies that correction action due dates should be established based on the risk associated with the condition, but should typically be done within 90 calendar days of issue identification. Exelon procedure PI-AA-120, "Issue Identification and Screening Process," specifies that interim corrective actions are taken to make an event less likely to recur during the period when the condition is being evaluated and until final corrective actions are completed.

Corrective Actions: Exelon implemented a temporary configuration change that removed the threaded pipe and valve, plugged the lube oil piping hole, and capped off the small diameter copper instrumentation tubing. This temporary change eliminated the threaded pipe failure vulnerability in this location. Exelon restored the 'D24' EDG to an operable status on July 25, 2019. Exelon also initiated a longer-term action to change the configuration of the connection between the four-inch main header and the one-quarter inch instrument line in order to restore the non-safety related function of the associated lube oil pressure gauge.

Corrective Action References: IR 4266201

Performance Assessment:

Performance Deficiency: The failure to adequately correct the degraded lube oil system instrumentation line on the 'D24' EDG before its failure on July 22, 2019, was reasonably within Exelon's ability to foresee and correct and should have been prevented and therefore was a performance deficiency.

Screening: The inspectors determined the performance deficiency was more than minor because it was associated with the Equipment Performance attribute of the Mitigating Systems cornerstone and adversely affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Specifically, the finding was associated with the equipment performance of the 'D24' EDG and the availability of the generator was adversely affected.

Significance: The inspectors assessed the significance of the finding using Appendix A, "The Significance Determination Process (SDP) for Findings At-Power." The inspectors screened the significance of the finding using IMC 0609, Appendix A, Exhibit 2, and determined that this finding required a detailed risk evaluation since the inoperability exceeded the TS allowed outage time of 30 days. The senior reactor analyst (SRA) used the Systems Analysis Programs for Hands-On Evaluation (SAPHIRE), Revision 8.2.0, Standardized Plant Analysis Risk (SPAR) Model, version 8.50 to perform the detailed risk evaluation. The SRA used the guidance in the risk assessment standardization project (RASP) handbook Volume I, revision 2.02, section 2.5, to determine an exposure time of a nominal 127 days. This was based on proven run time for the 'D24' EDG which completed a 24-hour endurance run on March 19, 2019. The SRA noted this is a bounding assumption given there is uncertainty with when this failure may have impacted the ability of the machine to perform its 24 hour mission time. The condition was modeled as a failure of the 'D24' to run. The SRA used a SPAR-H calculation to determine a failure probability for operator action to cross tie power from the Unit 1 and 2 EDGs. Additionally, the SRA ensured the logic and power dependencies for the low-pressure injection motor operated valves reflected the as-built configuration of the plant.

The increase in core damage frequency (CDF) for the conditional failure to run of the 'D24' was calculated to be $2.62\text{E-}8/\text{yr}$ for the internal event risk contribution. The dominant core

damage sequences consisted of weather, switchyard, and grid related loss-of-offsite power events, with a common cause failure of the unit's EDGs to run, failure to crosstie power from available buses, with failure to recover an EDG or offsite power within five hours. The SRA also noted the result was conservative because these sequences did not credit the use of the FLEX (Mitigation Strategies for Beyond Design Basis External Events) strategy which would be invoked through procedures. Consistent with IMC 0609, Appendix A, "The Significance Determination Process (SDP) For Findings At-Power," a detailed evaluation of external risk contribution is not required for increases in internal events CDF below the 1E-7/yr threshold. Notwithstanding this, the SRA noted that Exelon staff had run this failure on their fire risk model, and for the bounding and conservative timeframe of 127 days had determined the CDF increase due to the 'D24' failure was in the E-7/yr range or of very low safety significance. The SRA independently evaluated the fire risk contribution to CDF using the SPAR model and confirmed this conclusion. The SRA noted that the impact on the increase to large early release frequency would not change the conclusion of a very low safety significance issue (Green) for the increase in CDF/yr due to the 'D24' failure.

Cross-Cutting Aspect: H.14 - Conservative Bias: Individuals use decision making-practices that emphasize prudent choices over those that are simply allowable. A proposed action is determined to be safe in order to proceed, rather than unsafe in order to stop. Specifically, while knowledge of the vibratory conditions and cause of the failure were not fully understood, Exelon assumed that conditions were sufficiently resolved after reducing resonant vibrations. A conservative approach to decision making was not taken to identify interim mitigating measures and establish the timeliness of actions given evolving and incomplete information.

Enforcement:

Violation: 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," requires, in part, that measures shall be established to assure that conditions adverse to quality, such as deficiencies, defective material, and non-conformances are promptly identified and corrected. In addition, LGS Unit 2 TS 3.8.1.1 requires that an inoperable diesel generator be restored to an operable status within 30 days or the unit be in at least hot shutdown within the next 12 hours and in cold shutdown within the following 24 hours. Contrary to the above, Exelon did not correct the degraded conditions in the 'D24' EDG lube oil system from January 21, 2019, to July 25, 2019, and the instrumentation line threaded pipe connection for a lube oil pressure indicator failed on July 22, 2019. This caused the 'D24' EDG to be inoperable from at least June 18, 2019, to July 25, 2019, and the action to restore the diesel within 30 days or the unit be in at least hot shutdown within the next 12 hours and in cold shutdown within the following 24 hours was not met.

Enforcement Action: This violation is being treated as a non-cited violation, consistent with Section 2.3.2 of the Enforcement Policy.

EXIT MEETINGS AND DEBRIEFS

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

- On January 17, 2020, the inspectors presented the integrated inspection results to Mr. Frank Sturniolo and other members of the licensee staff.

DOCUMENTS REVIEWED

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
71111.01	Corrective Action Documents Resulting from Inspection	IR 04391999		
71111.04Q	Corrective Action Documents	IR 4291708		
71111.13	Procedures	ST-6-055-200-1	HPCI Valve Test	Revision 67
71111.15	Corrective Action Documents	IR 4303810		
71111.19	Procedures	ST-4-055-304-1	HPCI Pump Discharge, Test Loop Shutoff, and Test Line Flush to Supp. Pool Auto Closure Seal-In Contact Test for HV-055-1F006, HV-055-1F008, and HV-055-1F071	Revision 9
71151	Miscellaneous	LG-MSPI-001	Reactor Oversight Program MSPI Basis Document Limerick Generating Station	Revision 6
71152	Corrective Action Documents	IR 4173191		
		IR 4266423		
		IR 4278009		
		IR 4300194		
		IR 4302498		
		IR 4303755		
71153	Corrective Action Documents	IR 1439284		
		IR 1507365		
		IR 3951889		
		IR 4047881		
		IR 4212649		
		IR 4230964		
		IR 4266201		
	Miscellaneous	EC 628867	D24 Lube Oil Instrumentation Line to PI-GA-202D	Revision 0
	Procedures	PI-AA-120	Issue Identification and Screening Process	Revision 9
		PI-AA-125	Corrective Action Program (CAP) Procedure	Revision 7
	Work Orders	WO 4709424		

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
		WO 4878960		
		WO 4879829		
		WO 4899669		