FPL

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January 5, 2024

-VIA ELECTRONIC FILING -

Adam Teitzman
Commission Clerk
Florida Public Service Commission
2540 Shumard Oak Blvd.
Tallahassee, FL 32399-0850

Re: Docket No. 20240001-EI

Dear Mr. Teitzman:

Pursuant to Order No. PSC-2023-0207-PCO-EI, attached for electronic filing in the above docket are the prepared testimony and exhibits of FPL witnesses Daniel DeBoer and Joel Gebbie. This testimony relates to replacement power cost issues, which the Commission deferred from Docket 20230001-EI to this year's docket.

Please feel free to reach me at (561) 304-5795 with any questions regarding this filing.

Sincerely,

s/ Maria Jose Moncada
Maria Jose Moncada

:21800752

Attachments
cc: Counsel for Parties of Record (w/ attachments)

CERTIFICATE OF SERVICE
Docket No. 20240001-EI

I HEREBY CERTIFY that a true and correct copy of the foregoing has been furnished by electronic service on this 5th day of January 2024 to the following:

Suzanne Brownless
Ryan Sandy
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By: *s/ Maria Jose Moncada*
Maria Jose Moncada
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BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

FLORIDA POWER & LIGHT COMPANY

TESTIMONY OF DANIEL DeBOER

DOCKET NO. 20230001-EI

JANUARY 5, 2024

Q. Please state your name and business address.

A. My name is Daniel DeBoer. My work address is 15430 Endeavor Drive, Jupiter, Florida 33478.

Q. By whom are you employed and what is your position?

A. I am employed by Florida Power & Light Company (FPL or the Company) as the Vice President, Nuclear.

Q. Please describe your duties and responsibilities in that position.

A. I am responsible for the Nuclear fleet functional areas of engineering, training, performance improvement, regulatory affairs, security, quality assurance, online work management, outages and nuclear projects, which consists of major maintenance and modifications.

Q. Please describe your educational background and professional experience.

A. I hold a Bachelor of Science Degree in Chemical Engineering from the University of Notre Dame. I also earned a Senior Reactor Operator license from the Nuclear Regulatory Commission at the former Crystal River Nuclear Plant in Florida, and a Senior Reactor Operator Management Certification at the Browns Ferry Nuclear Station in Alabama. In addition, I completed the Institute of Nuclear Power Operations (INPO) Senior Plant Management Course.

I have spent over 35 years in the nuclear industry, beginning in the United States Navy Nuclear Submarine Force where I served as an officer for more than 24 years on active and reserve duty, retiring as a Commander. During this 35-year period, I have served in various management positions at six nuclear stations in the United States over the last 30 years and have been with FPL since 2010. While employed with FPL, I have held numerous positions of increasing responsibility including Senior Director of Fleet Outages for NextEra Energy corporate at Juno Beach, Operations Director at St. Lucie, Plant General Manager at NextEra Energy's Point Beach Nuclear Plant, and Site Vice President at St. Lucie. In 2022, I assumed my current position as the Vice President, Nuclear, where I am responsible for support and oversight of both of FPL's nuclear sites.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring Exhibit DD-1 – Excerpt from: FPL's Procedure 0-PME-049.0, Reactor Trip and Trip Bypass Breaker Inspection Maintenance.

Q. What is the purpose of your testimony?

A. My testimony discusses unplanned outages and down power events that occurred at the Turkey Point and St. Lucie nuclear power plants over the period from July 2020 through 2022.

Q. Aside from planned maintenance outages, does FPL project that its nuclear units will achieve 100% availability?

A. No, it does not. No nuclear plant in the industry projects 100% availability. Nuclear plants are complex industrial facilities that consist of dozens of interdependent systems, hundreds of major components, tens of thousands of sub-components, tens of thousands of tubes, miles of piping and many redundant safety features. FPL continuously improves the physical plant, procedures and processes to improve reliability and maintain nuclear safety. However, even when prudent actions are taken, FPL's nuclear units – like all nuclear units in the industry – experience equipment failures and unplanned outages and down power events. My testimony describes outages and down power events that warrant further explanation for the Florida Public Service Commission.

2020 Unplanned Outage and Down Power Events

Q. Please describe the unplanned outage and the down power event that occurred at FPL's nuclear plants in 2020 for which FPL wishes to provide further information.

A. Beginning in July 2020, Turkey Point Unit 4 automatically shut down due to a main generator lockout followed by a turbine trip. In November 2020, Turkey Point Unit 3 reduced power to address a heater drain system. FPL's responses to the unplanned outage and down power event was prudent and efficient, and the units were returned to service safely. More details are provided below.

July 2020 Turkey Point Unit 4

Q. Please describe the circumstances related to the July 2020 outage.

A. In July 2020, Turkey Point Unit 4 automatically shut down due to a main generator lockout followed by a turbine trip. FPL conducted an investigation, which determined the permanent magnet generator (PMG) malfunctioned.

Q. What did the investigation of the PMG malfunction find?

A. FPL's investigation revealed that two factors, which individually would not result in a PMG stator winding malfunction, combined to cause the event. The malfunction of the Unit 4 PMG stator occurred due to an aged winding in combination with water intrusion. Neither an aged winding nor water intrusion occurring by itself would have resulted in failure of the stator.

Q. Was periodic maintenance performed on the Unit 4 PMG in accordance with manufacturer recommendations and industry standards?

A. Yes. FPL incorporates original equipment manufacturer (OEM) and industry operating experience into the PMG maintenance program. The PMG stator had been in service since 1986 without rewind. There was no requirement by the OEM or industry documents to perform a rewind on a specified frequency. Maintenance work on the exciter, including weather sealing, was performed by the OEM, Siemens, in accordance with its procedures. However, Siemens failed to install all the weather sealing during the last housing installation. The exciter housing vertical weather seals were missing, and gaskets were dislodged. The FPL site-specific procedure, procedure 0-GMM-090.1 'Exciter Removal, Inspection and Installation' contains the site-specific gasket and vertical weather seal guidance. However, Siemens procedure 3.2.2.1, which governs installation of the exciter housing, did not contain site-specific guidance.

Q. Describe generally the preventative maintenance work performed by Siemens.

A. Siemens is engaged to perform preventative maintenance on the exciter at least every seven and a half years during scheduled refueling outages. When the preventative maintenance is performed, the exciter housing is completely removed, cleaned, inspected, and the seals are replaced by Siemens in accordance with their proprietary procedure.

Q. Is Siemens an appropriate vendor to perform maintenance on the exciter?

A. Yes, Siemens is the OEM for this equipment and has the proprietary information including detailed design drawings, technical specifications, and specialty tooling to perform this work. In fact, Siemens's expertise applies to every part of the centerline equipment: the turbine, the generator and the exciter, all of which work together. Siemens therefore is engaged to perform maintenance work on the entire centerline, making FPL's engagement of Siemens for exciter work particularly appropriate.

Q. In addition to being the OEM with experience maintaining exciters, what else made Siemens a qualified vendor?

A. Siemens is one of the largest turbine generator manufacturers in the world, serving both nuclear and non-nuclear plants. This has included on-going maintenance and refurbishments, power uprates at FPL's nuclear units and new installations. Siemens also supports over 50% of the existing nuclear generation sites in the United States.

Q. Did FPL review the procedures that Siemens prepared for the exciter work?

A. Yes. Whenever FPL plans work at its nuclear site that is performed by any vendor, FPL reviews the procedures and processes that the vendor will use. The reviews are performed by qualified maintenance supervisors and engineers. The vendors use their procedures but are required to follow any FPL work control program that may apply.

Q. Please describe the exciter work that Siemens was required to perform.

A. During the work on the exciter, the housing was completely removed, cleaned, and inspected, and the seals were replaced by Siemens in accordance with its procedure. Siemens's proprietary procedure includes verification points designed to ensure the seals are properly prepared and installed. That verification step is performed by Siemens's technical director and is then further verified as part of Siemens's quality assurance review.

Q. Did these steps occur the last time Siemens performed exciter work before the July 5, 2020 event?

A. Yes. Prior to the July 5, 2020 event, the exciter housing for Unit 4 was removed in March 2019. During the inspection, Siemens noted that several seals were found to be hard or torn. All degraded seals were replaced. After the replacement was complete, Siemens inspected the work and noted that the final seals were acceptable for return to service. At that time, FPL verified that the inspection occurred.

Q. Did the procedures and inspections employed by Siemens satisfy the industry standard for exciter maintenance?

A. Yes. The procedures provided detailed guidance and satisfied industry standards for the exciter maintenance.

Q. In addition to the inspections performed by Siemens, please describe the oversight FPL provided during the exciter maintenance work.

A. Siemens is required to follow FPL's work control program. FPL confirms that appropriate verifications are included at key points in Siemens's procedures. These verification points are built into work orders which serve to confirm that all processes, including those applicable to exciter maintenance work, were completed.

Q. Did FPL verify the work performed by Siemens was completed in accordance with their procedures?

A. Yes. FPL verification of work performed by Siemens focused on review of documentation that evidenced the work performed by Siemens was in accordance with its procedures. FPL relied on Siemens's vast industry and site-specific experience regarding exciter related work including verifying that all weather seals were correctly installed.

Q. Was FPL able to inspect the seals after Siemens completed its work?

A. No. After the exciter housing is installed, the seals are between two surfaces and are not only inaccessible, they are not even visible. The exciter seals cannot be inspected while the unit is online because the exciter itself is rotating and energized at high voltage. In addition, there are no recommended OEM inspection requirements while the unit is online.

Q. Does this mean FPL performs no inspections of the exciter housing seals?

A. Not at all. FPL inspects the exciter housing seals during every refueling outage, which occur every 18 months. At that time, the seals and gasketed surfaces are inspected where accessible. FPL's inspections of the housing surfaces search for any evidence of water intrusion.

Q. What is your conclusion regarding FPL's inspection practices?

A. FPL inspects the exciter housing at reasonable intervals in a manner that is consistent with industry practice.

Q. What corrective actions were initiated to address this event?

A. After Siemens, the OEM, disassembled and inspected the PMG, Siemens replaced the PMG stator and rotating assembly due to collateral magnet damage in the PMG pole support caused by stator failure debris and heat-induced cracking.

FPL also initiated a time-based, rather than condition-based, PMG stator rewind in the preventative maintenance program. In addition, Siemens revised its procedure to require site-specific weather seals for exciter housing.

Q. Was an extent of condition performed on Turkey Point Unit 3 and St. Lucie Units 1 and 2?

A. Yes. FPL determined a similar risk exists for the other units. An action to replace exciter components with rewound spares was incorporated into the scope of work for upcoming planned refueling outages scope for each unit.

Q. How many days was Unit 4 out of service due to this event?

A. FPL moved quickly and prudently to restore the units to service safely and was able to keep the outage to approximately 15 days.

Q. What do you conclude regarding FPL's actions and decisions with respect to the work performed on the exciter prior to the July 5, 2020 event?

A. FPL engaged a highly qualified vendor to perform the maintenance and replacement work on the exciter housing pursuant to procedures that produced successful results at many sites over time. FPL acted prudently in its oversight and verification of the vendor's work on the exciter.

<u>November 2020 Turkey Point Unit 3</u>

Q. Please describe the circumstances related to the November 2020 down power event.

A. In November 2020, Unit 3 experienced a loss of control to several plant secondary valves due to performance anomalies from some plant secondary control system devices which resulted in a shut down of two heater drain pumps. The resulting conditions caused a 15% power reduction to the unit.

Q. What did the investigation of the performance anomalies from the affected secondary control system devices find?

A. FPL performed an investigation for this event but did not find the cause for the erratic performance of the secondary control system devices. An external forensic analysis evaluation of the affected removed components performed by a third party determined that a field control processor had faulty optocouplers.

Q. What corrective actions were initiated to address this event?

A. FPL replaced the affected components and tested them to ensure they were operating properly.

Q. How many days was Turkey Point Unit 3 at reduced power due to this event?

A. FPL moved quickly and prudently to restore the units to service safely and was able to keep the down power event to approximately 14 days.

2021 Unplanned Outage and Down Power Events

Q. Please describe the unplanned outages and down power events at FPL's nuclear plants in 2021 for which FPL wishes to provide further information.

A. Beginning in January 2021, St. Lucie Unit 2 shut down due to an unexpected deenergization of a Motor Control Center (MCC); in February 2021, Turkey Point Unit 3 reduced power due to increased sodium levels in the steam generator; in March 2021, Turkey Point Unit 3 shut down during Reactor Protection System Testing when a breaker cubicle cell failed to operate properly; in May 2021, St. Lucie Unit 1 experienced a delay in returning to service following the refueling outage associated with the Rod Control System upgrade; in August 2021, Turkey Point Unit 3 shut down to repair Turbine Control Valve No. 2; in November 2021, Turkey Point Unit 3 experienced a delay in returning to service from a refueling outage due to issues with the manipulator gripper, reactor coolant system (RCS), and an accumulation of boric acid in the core exit thermocouple (CET); and in December 2021, St. Lucie Unit 1 was manually shut down after a supply fuse blew resulting in a loss of high-pressure heater level control. FPL's responses to the unplanned outages and down power events were prudent and efficient, and the units were returned to service safely. More details are described below.

January 2021 St. Lucie Unit 2

Q. Please describe the circumstances related to the St. Lucie Unit 2 Motor Control Center malfunction in January 2021.

A. In January 2021, Unit 2 automatically shut down due to the Reactor Protection System trip as a result of a turbine trip. The turbine trip was caused by an unexpected deenergization of the 480V MCC. The plant equipment responded as designed. The loss of the MCC caused two of the four undervoltage (UV) relays in the Diverse Turbine Trip to deenergize to their failed condition which created a turbine trip. FPL investigated the root cause and determined the legacy drawings for the UV relay assemblies in the control element drive mechanism control system (CEDMCS) were changed in 1983 and did not conform to St. Lucie Unit 2 train and channel design conventions such that design details including power supply assignments were not clearly defined. This latent legacy defect resulted in inadvertently mis-assigning power to two of the four UV relays to the incorrect train of power when the rod control system was replaced 38 years later in 2019. There was no adequate basis upon which to reasonably expect that the latent channel misassignments should have been identified during the work performed in 2019.

Q. What corrective actions have been initiated to address this event?

A. FPL redesigned the UV relay power supplies such that the loss of a single power supply will not result in a turbine trip. FPL also revised the UV Relay Assembly drawing to show applicable train channel assignments to each UV Relay Assembly and revised the CEDMCS Power Supply drawing to show the UV Relay Assembly assignment to each power supply.

Q. How many days was St. Lucie Unit 2 out of service due to this event?

A. The Unit 2 outage due to MCC malfunction was approximately 3 days.

<u>February 2021 Turkey Point Unit 3</u>

Q. Please describe the circumstances related to the down power event that occurred in February 2021.

A. During plant operation, sodium levels in the steam generators had increased due to ingress of cooling water from the cooling canals through a leaking condenser tube. The increase in sodium levels had reached a level where actions were needed to lower the concentration of sodium in the steam generators. Mitigating actions (i.e., raising the rate of steam generator blowdown) did not immediately control the increasing sodium levels. As a result, plant power output was reduced by removing from service the two circulating water pumps which cool the condenser with the leaking tube to identify and repair the leak. The leaking tube was extracted in the Fall 2021 refueling outage and sent for further forensic analysis.

Q. What did the forensic analysis determine regarding the cause of the leak in the condenser tubes?

A. A forensic analysis performed by Structural Integrity Associates determined that the cause for the tube leak was mechanical damage induced by foreign material lodged in the hotwell side of the condenser tube bundle. FPL found that the condenser heater lagging (metal straps) cracked and loosened which in turn mechanically damaged the tubing. Testing analysis found that no cracking in the tubing had occurred.

Q. What corrective actions have been initiated to address this event?

A. FPL removed the affected tubes from service and plugged the tubes with a mechanical plug device.

Q. How many days was Turkey Point Unit 3 at reduced power due to this event?

A. Unit 3 was at reduced power for approximately 7 days.

<u>March 2021 Turkey Point Unit 3</u>

Q. Please describe the circumstances related to the Reactor Protection Testing that impacted Turkey Point Unit 3 in March 2021.

A. In March 2021, Turkey Point Unit 3 operators performed a planned test of the Reactor Protection System (RPS). The test restoration phase included closing the 3B reactor trip breaker (RTB) followed by opening the reactor bypass breaker (RBB). With the 3B RTB closed, after opening the 3B RBB, the unit experienced an automatic shut down. FPL was not able to determine the exact cause, but determined the most probable cause was hardened graphite grease on the cell switch that resulted in a condition whereby the contact was closed and providing a standing turbine trip signal that could not have been identified in advance. The reactor trip breakers and switchgear cubicles were inspected in accordance with FPL procedures which provide a methodical and proven approach to maintain the equipment.

Q. Did FPL follow the manufacturer recommendations for maintaining the cell switches?

A. Yes. Procedure 0-PME-049.01 was developed using Westinghouse vendor manual V000211, and Westinghouse Maintenance Program Manual (MPM) for the reactor trip breakers and associated switchgear. All criteria in the site procedure meet vendor recommendations with the exception of cell switch investigations which are conducted more frequently by FPL than the rate recommended by the manufacturer. FPL performs these inspections every 18 months which extends the life of the cell switches well beyond the service life recommended by the manufacturer. FPL performed an industry review and determined FPL's inspection protocol is consistent with industry maintenance practices.

Q. Did FPL's decision to not follow the Westinghouse MPM contribute to the March 1, 2021 event?

A. No. The Westinghouse MPM recommendation that FPL did not follow at the time of the event – and still does not follow – is the replacement of the cell switches after 100 cycles. Because the cell switches are used only to validate the breaker position, they remain closed at all times except during testing which occurs quarterly, or four times a year. Following the Westinghouse MPM recommendation would mean that FPL would replace cell switches only once every 25 years. Therefore, implementing that practice would not have prevented the accumulation of lubricant around the cell switch.

Q. If FPL does not follow the Westinghouse MPM recommendation on cell switch life cycles, what process was in place to monitor proper function of the cell switch?

A. As previously stated, FPL tests and inspects the cell switches every 18 months. If the cell switch shows signs of deterioration, FPL would replace it at that time. This testing and inspection interval is more frequent than Westinghouse's MPM recommendation. FPL's maintenance program is more conservative than the 25-year interval for cell switch replacement recommended by Westinghouse. A review of the documentation of FPL's maintenance, provided as Exhibit DC-1, shows that the cell switches, including the one involved in the March 1, 2021 event, were reliable and had no failures.

Q. Has FPL determined why the cell switch failed on March 1, 2021?

A. As the root cause evaluation indicates, the cause remains undetermined. As part of the investigation, the RTB was sent to the OEM, Westinghouse, to conduct extensive inspections and testing to determine the root cause of the failure. However, the root cause was found to be undetermined. Overall, the RTB was found to be in excellent condition and cycled 50 times at Westinghouse without an issue. The RTB cubical cell switch was also thoroughly tested without an issue. Although all the inspection points for contacts and spring load were found satisfactory, during disassembly the cubical cell switch was found to have aged grease. The aged grease was the only anomaly identified. Therefore, it was considered a "*possible* cause of failure."

Q. What corrective actions have been initiated to address this event?

A. FPL replaced the 3B Reactor Trip Breaker and cell switch. Additionally, FPL revised the procedure to require time-based rather than condition-based cleaning and lubrication of cell switch contacts. In addition, a modification was implemented to detect a failed cell switch.

Q. How many days was Turkey Point Unit 3 out of service due to this event?

A. The Unit 3 outage due to reactor protection testing was approximately 3 days.

Q. What do you conclude regarding FPL's actions and decisions with respect to the work performed on the cell switch prior to the March 1, 2021 event?

A. FPL acted prudently with respect to the maintenance of the cell switch. FPL adhered to Westinghouse's recommended maintenance procedures and instituted even more conservative testing and inspection intervals. FPL's maintenance program was also aligned with industry standard.

<u>May 2021 St. Lucie Unit 1</u>

Q. Please describe the circumstances related to the May 2021 delay in returning St. Lucie Unit 1 back to service following the Unit's refueling outage.

A. In May 2021, while St. Lucie Unit 1 was in plant restart from a refueling outage, FPL determined the lower gripper coils for a group of Control Element Assemblies had malfunctioned. Troubleshooting revealed these coils were damaged by excessive current. While revising the firmware for the Rod Control System Coil Power Management Drawer (CPMD) for these coils, Westinghouse, the vendor who designed and installed the CPMD, inadvertently coded an unplanned software change. This removed the overcurrent protection for the impacted Control Element Assemblies.

Q. What corrective actions have been initiated to address these events?

A. The corrected software was programmed into all CPMDs. Westinghouse validated that all software was correct. In addition, Westinghouse enhanced its software development process to mandate a structured line code difference analysis.

Q. How many days was the St. Lucie Unit 1 refueling outage delayed due to these events?

A. Returning unit 1 to service was delayed by approximately 4 days.

<u>August 2021 Turkey Point Unit 3</u>

Q. Please describe the circumstances related to the No. 2 Turbine Control Valve that impacted Turkey Point Unit 3 in August 2021.

A. In August 2021, Turkey Point Unit 3 reduced power to investigate the unexpected closure of the No. 2 Turbine Control Valve (TCV). FPL performed on-line verification activities before determining the unit was required to shut down to complete troubleshooting and implement repairs.

Q. What caused the unexpected closure of the No. 2 TCV?

A. FPL disassembled and inspected the TCV and found the actuator stem (rod) was found sheared right inside the threaded location inside the coupling. Testing determined that corrosion induced low cycle fatigue and potential misalignment were the most likely causes for the TCV actuator rod failure.

Q. What corrective actions have been initiated to address this event?

A. FPL replaced the actuator assembly and completed testing to ensure it was operating as designed.

Q. How many days was Turkey Point Unit 3 out of service due to this event?

A. Unit 3 was at reduced power for approximately 9 days and shut down for approximately 3 days.

<u>November 2021 Turkey Point Unit 3</u>

Q. Please describe the circumstances related to the Turkey Point Unit 3 return-to-service delay in November 2021.

A. Turkey Point Unit 3 experienced a delay in return to service from the refueling outage in November 2021. The largest impacts on the outage extension were associated with equipment issues due to troubleshooting and replacement of the manipulator gripper, an RCS leak, and boric acid accumulation on CET tubing identified while bringing the unit back online during reactor vessel inspections.

Q. Please describe the equipment issues related to the manipulator gripper.

A. While performing post-maintenance gripper inspections, prior to core offload, the manipulator gripper did not work as designed. Manipulator crane technicians reported having load oscillations and relay chattering. Visual inspection of the manipulator gripper assembly found that there was an issue with the latching mechanism. The manipulator gripper assembly was removed to determine the cause of the latch issue. Following plant procedure, a visual inspection was performed on malfunctioning components and checks were initiated to compare the components' dimensions to vendor drawings.

Additionally, forensic testing was performed by Framatome, at its facility. Framatome found that all components appeared to be present with no missing or loose parts noted. Since results were inconclusive, Framatome recommended replacing the manipulator gripper that malfunctioned with a new one.

Q. What corrective actions have been initiated to address this event?

A. FPL replaced the relay down slack (slack cable relay) to address the issue. Additionally, since the cause of the latch issue was not fully understood and could not be replicated, Framatome recommended replacing the manipulator gripper. FPL engaged Framatome to replace promptly the manipulator gripper.

Q. Please describe the issues due to the CET tubing.

A. During the normal operating pressure and operating temperature reactor vessel inspections, a boric acid leak was identified on CET 51 and 57 tubing. Based on initial available information, a through-wall tube leak was suspected of causing the boric acid accumulation.

The CET tubing was sent to Southwest Research Institute for a leak cause determination. No through-wall tubing pressure boundary flaw was identified. Southwest Research Institute’s forensic analysis concluded that the connection fitting was the likely cause of the leakage.

Q. What corrective actions have been initiated to address this event?

A. Unit 3 was cooled down from Mode 3 to Mode 5 to perform repairs. FPL repaired the affected fitting by cutting and capping the damaged tubing. FPL confirmed no leakage was present before returning the unit back to service.

Q. How many days was Turkey Point Unit 3 out of service due to this event?

A. The Unit 3 return to service delay was approximately 14 days.

<u>December 2021 St. Lucie Unit 1</u>

Q. Please describe the circumstances related to the manual shut down associated with the steam generator that impacted St. Lucie Unit 1 in December 2021.

A. In December 2021, the pressure differential indicating switch (PDIS) at St. Lucie was being replaced due to a steam leak. In the process of landing the wires from the new PDIS on the terminal strip, the technician made inadvertent contact with the enclosure housing causing the supply fuse to blow and a loss of high-pressure heater level control resulting in a reduction of steam generator feed flow.

Q. What corrective actions were initiated to address this event?

A. FPL replaced the supply fuse and restored the heater level control circuit and PDIS.

Q. How many days was St. Lucie Unit 1 out of service due to this event?

A. The Unit 1 outage due to steam generator pressure levels was approximately 2 days.

<u>2022 Unplanned Outage Event</u>

Q. Please describe the unplanned outage at St. Lucie that occurred in 2022 for which FPL wishes to provide further information.

A. In January 2022, while St. Lucie Unit 2 operators were conducting surveillance testing on rod control, Control Element Assembly (CEA) No. 27 slipped while being exercised for the surveillance testing. Unit 2 reduced power to attempt to move the CEA without success before the unit was manually shut down to address the issue. FPL's response to the unplanned outage was prudent and efficient, and the unit was returned to service safely. Below are details on this outage.

January 2022 St. Lucie Unit 2

Q. Please describe the circumstances related to the St. Lucie Unit 2 CEA displacement in January 2022.

A. In January 2022, Unit 2's CEA failed to remain properly engaged during testing. This displacement caused a position deviation greater than allowed according to the unit technical specifications. Westinghouse was therefore contacted for support to move the CEA back into place. Attempts were unsuccessful, and power was reduced to 70%. While the unit was at reduced power, FPL continued attempts to move the CEA back into its place. The subsequent attempts were ineffective and after time limitations established by technical specifications expired, the unit was shut down.

Q. What did FPL determine was the reason for the displacement?

A. FPL, using readings from the Rod Control System, determined that the Control Element Drive Mechanism (CEDM) had malfunctioned and was the likely cause of the CEA displacement. The CEDM is an electromagnetic jacking device mounted atop the reactor vessel head that is used to position the CEAs. FPL contracted Westinghouse to assist with removal of the CEDM motor from its housing for inspection. After removal of the CEDM, FPL identified a small metallic object adhered to the bottom of the latch magnet. The CEDM was sent to the Westinghouse facility for further inspection.

Q. What did the Westinghouse inspection determine?

A. Westinghouse determined that the characteristics of the metallic object corresponded with an L-slot pin from a Shaft Coupling and Uncoupling Tool (SCOUT), which is used during refueling activities. The L-slot pin blocked the CEDM from inserting and caused the displacement. FPL subsequently sent the SCOUT used during refueling activities to Westinghouse for evaluation. Westinghouse confirmed that two L-slot pins were missing from the latching mechanism of the SCOUT. Westinghouse concluded that the pin had no consequence to the RCS components or the major primary system components such as the reactor vessel, steam generators, pressurizer, reactor coolant, nor reactor coolant pumps.

Q. Please describe how the SCOUT was used during the referenced refueling.

A. FPL employs Framatome, a highly qualified vendor, to support refueling activities with workers experienced in refueling. In the previous refueling outage, CEA coupling activities were performed by the vendor. Framatome's crew noted while coupling a CEA, there was difficulty disengaging the tool from the extension shaft L-slot. The crew was unaware that damage had occurred to the tool. In fact, the coupling activities were completed with the same tool for an additional 40 CEAs without issue. This was possible because FPL now knows that the SCOUT will function with only one pin. When the SCOUT was unable to engage onto the extension shaft to the remaining CEAs, the tool was replaced with a backup tool.

After the SCOUT was removed from the area, Framatome's crew supervisors checked the tool including looking down the head at its pins. The individuals did not recognize that the L-slot pins were missing given that these pins are inside the tool itself and cannot be examined without Westinghouse disassembling the tool.

Q. What corrective actions were initiated to address this event?

A. FPL addressed the CEDM malfunction and ensured it was working properly before returning the unit back to service. Additionally, FPL incorporated a new complex tool inspection process in its Foreign Material Exclusion Plan which will be completed prior to every use to document and ensure integrity of its equipment. Procedures used for CEA coupling have been updated to address the SCOUT failure. Prior to this event and consistent with practice throughout the nuclear operations industry, the SCOUT had not been recognized as a complex tool.

Q. Would this new complex tool inspection process have identified the missing L-slot pins had it been used prior to and after using the SCOUT?

A. No. The additional inpsections will provide the best opportunity to identify future complex tool issues. As noted previously, however, the pins in question are inside the SCOUT and therefore would not have been noticed as present or as missing even if the SCOUT was thoroughly inspected before and after use.

Q. How many days was St. Lucie Unit 2 out of service due to this event?

A. The Unit 2 outage due to displacement issues of the CEA was approximately 14 days.

Q. Does this conclude your testimony?

A. Yes, it does.

INITIAL

4.25 Cubicle Inspection (continued)

7. **INSPECT** switchgear cubicle for the following:

A. **INSPECT** control wiring for integrity of insulation and tightness of connections.

B. IF any control wiring is found loose, THEN **TIGHTEN** connections and **RECORD** any abnormal findings in Section 5.2, Step 1.

C. **VERIFY** left and right interior rail assemblies are **NOT** distorted.

D. **VERIFY** edges of rail assembly where breaker wheels roll are **NOT** mushroomed, rounded off, or bent inward or outward.

E. **REPLACE** rails, if necessary.

F. **VERIFY** breaker element levering pins welded on each rail are intact and undistorted.

G. **VERIFY** breaker release latch **NOT** bent and touches bottom of cell rail.

H. **PRESS** release latch by hand to its limit and **VERIFY** release latch springs back when released.

I. Cell positioning stop bracket **NOT** distorted.

J. Switchgear that the secondary contact assembly phenolic material **NOT** cracked.

K. Switchgear secondary contact assembly conductive surface **NOT** abnormally or unevenly worn.

L. Ground contact **NOT** corroded, **NOT** loose, and surface **NOT** abnormally or unevenly worn.

M. **REMOVE** cell switch covers.

N. **VERIFY** cell switch contacts are clean.

O. IF cell switch contacts require cleaning or lubrication, THEN:

(1) **CLEAN** with a cloth and isopropyl alcohol.

(2) **APPLY** grease (G77).

4.25 Cubicle Inspection (continued)

7. (continued)

P. **PRESS** spring-loaded plunger several times and **VERIFY** smooth and unbinding operation of switch.

Q. With spring-loaded plunger pressed, **VERIFY** correct contact configuration and contact resistance using a ohmmeter.

Functional Criteria: 1 ohm or less

R. With spring-loaded plunger released, **VERIFY** correct contact configuration and contact resistance using a ohmmeter.

Functional Criteria: 1 ohm or less

S. **INSTALL** cell switch covers.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

FLORIDA POWER & LIGHT COMPANY

TESTIMONY OF JOEL GEBBIE

DOCKET NO. 20240001-EI

JANUARY 5, 2024

Q. Please state your name and title.

A. My name is Joel Gebbie. I am the President of JPG Advisory, LLC located in New Buffalo, Michigan.

Q. Please describe your job role immediately prior to your position with JPG Advisory, LLC.

A. I retired in July 2022 from American Electric Power (AEP). At the time of my retirement, I was the Chief Nuclear Officer, overseeing all nuclear operations for AEP.

Q. Please provide a summary of your professional background and nuclear industry experience.

A. I graduated from the Ohio State University in 1986 with a degree in mechanical engineering and thereafter began my career with AEP as a nuclear and coal power plant design engineer at AEP's corporate office. Among many engineering assignments, I functioned as a team leader for a project to reconstitute all of the post-construction drawings and calculations for large bore safety-related piping at Donald C. Cook Nuclear Plant (Cook Plant). After ten years, I was transferred to work on-site at the Cook Plant. At Cook Plant, I worked in plant engineering for ten years holding positions of increasing responsibility, consisting of system engineer, engineering supervisor, engineering manager, and engineering director. As an engineering leader, I sponsored several root cause evaluations from 2000 to 2007. During my time in plant engineering I was responsible for the implementation of several plant reliability programs, including the preventive and predictive maintenance program, system performance monitoring program, and single point vulnerability programs. I also established the Plant Health Committee, a multi-disciplinary leadership team responsible for driving improvements to equipment reliability at Cook Nuclear Plant.

In 2007, I became the plant manager at Cook Plant. As plant manager, I was chairman of the station's Corrective Action Review Board. I was promoted to Site Vice President at Cook Plant in 2010. In 2016, AEP's Board of Directors approved my appointment as Chief Nuclear Officer. As the Site Vice President and Chief Nuclear Officer, I oversaw the implementation of the Cook Plant Life Cycle Management project, an investment of one billion dollars in Cook Plant's long-term operation.

Q. Have you served in nuclear industry leadership roles aside from your work with AEP?

A. Yes. From 2021-2022, I served as chairman of the Nuclear Energy Institute's Nuclear Strategic Issues Advisory Council. I also served as chairman of the board of directors for the Utility Service Alliance from 2019 to 2022. Utility Service Alliance is a strategic alliance of seven United States nuclear utilities formed to drive cost-effective performance and promote scale in nuclear procurement. In addition, I participated on the continuous monitoring advisory committee and corporate monitoring advisory committee for the Institute of Nuclear Power Operations (INPO). Finally, I served as the executive sponsor of the World Association of Nuclear Operators (WANO) corporate oversight recovery team for a nuclear power plant in South Africa.

Q. On whose behalf are you testifying?

A. I am submitting this testimony to the Florida Public Service Commission on behalf of Florida Power & Light Company (FPL).

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to provide my opinion on the prudence of FPL's actions associated with the unplanned outages discussed in the testimony of FPL witness Daniel DeBoer.

Q. Please summarize your conclusions regarding the unplanned outages at FPL's nuclear plants.

A. FPL's actions associated with each unplanned outage were prudent. In addition, FPL's response to each unplanned outage ensured the units were returned to service in a safe and efficient manner. The supporting detail for my conclusions is included below.

Q. How is the rest of your testimony organized?

A. In Section I, I will discuss the purpose of causal evaluations as they are used in the nuclear industry. Section II presents my assessment of the two unplanned outages addressed in the testimony of Daniel DeBoer that were challenged specifically in 2022 by Richard Polich on behalf of the Office of Public Counsel (OPC). Section III presents my assessment of the unplanned outages and outage extensions addressed in the testimony of Daniel DeBoer, which have not been specifically challenged by OPC or any other intervenor.

I. CAUSAL EVALUATIONS

Q. Why do U.S. nuclear power plants conduct causal evaluations?

A. In the U.S. nuclear power industry, United States Nuclear Regulatory Commission (NRC) regulations require that every nuclear power plant have a corrective action program to address conditions adverse to quality. An example of a condition adverse to quality can be a violation of a plant procedure, a minor leak on plant equipment, a personnel error, or an unplanned equipment failure that results in a plant outage. The NRC mandates that nuclear power plant operators find and fix conditions adverse to quality. When nuclear power plant operators find these conditions adverse to quality they enter them into their corrective action programs. United States nuclear power plant operators fix these conditions adverse to quality by using their corrective action programs. The primary way to do this is by performing a causal evaluation.

Q. Did you gain experience with causal evaluations during your career in the nuclear industry?

A. Yes. While working as a design engineer for AEP, I participated in root cause evaluator training. Thereafter, from 2000 to 2007, I sponsored multiple root cause evaluations in my role as an engineering leader. And, as I mentioned above, I was chairman of the Cook Plant's Corrective Action Review Board, which is the body that reviews and approves all root cause evaluations conducted by plant personnel.

Q. Describe the approaches employed when performing causal evaluations.

A. A causal evaluation is a rigorous, formal analysis of the drivers, or reasons, that led to the occurrence of a condition adverse to quality. Plant personnel who conduct causal analyses undergo formal training and qualification before they can produce a causal evaluation product. Causal evaluation products are typically reviewed by an independent oversight committee, such as the Corrective Action Review Board (known at FPL as the Management Review Committee), to validate the quality and effectiveness of the product. Causal evaluations use several techniques to identify the direct, apparent, or root cause for an identified condition adverse to quality, then specify corrective actions that should preclude the condition adverse to quality from occurring again. Many of these techniques are used in other industries like the airline industry and the medical industry and have names like barrier analysis, why-staircase, and support/refute analysis. This is the straightforward manner to comply with NRC regulations.

Causal evaluations are conducted using a graded approach. A simple condition adverse to quality may only require a "broke/fix" evaluation. An equipment failure or personnel error that has the potential to jeopardize nuclear safety or reliability would require an apparent cause evaluation conducted by a single individual. A more significant condition adverse to quality, like a plant outage, requires a root cause evaluation, typically conducted by a dedicated, multi-disciplinary team using the techniques discussed above. Root and apparent causal evaluations cannot result in an indeterminate cause. In the absence of a clear cause, evaluators will systematically refute all other possible causes to arrive at a root or one or more apparent causes. They will then specify a comprehensive set of corrective actions to ensure that specified condition adverse to quality cannot recur.

Q. Should negative findings in causal evaluations be considered admissions or proof of imprudence?

A. No, not in most circumstances. As U.S. nuclear power plants have evolved into learning organizations, causal evaluations have gone beyond compliance with NRC regulations and have become more thorough tools used to understand organizational and programmatic drivers to conditions adverse to quality, have become performance trending instruments, and have become a process to drive power plant performance to a level of excellence. The U.S. nuclear power plant industry is said to "aim for perfection but settle for excellence." This has been very successful with U.S. nuclear power plants leading the world in safety and efficiency performance.

In order for this process to enable the achievement of world-class performance, plants must utilize absolute candor and "make mountains out of mole hills" when conducting causal evaluations. What every other industry considers to be a "one-off" event or bad luck is considered by the U.S. nuclear power industry to be an opportunity to pursue perfect performance, even if the actions and pre-existing procedures met satisfactory levels of care. For this reason, nuclear power plant causal evaluations generally should not be used to assess fault, negligence or imprudence in legal proceedings. Using causal evaluations as a generalized basis for fault would set a dangerous precedent and could motivate power plant operators to not exhibit absolute candor when conducting causal evaluations and would stifle continuous improvement.

II. OUTAGES CHALLENGED BY OPC WITNESS POLICH

July 2020 Outage at Turkey Point-4

Q. Please describe the July 5, 2020 Main Generator Lockout that caused a turbine trip and automatic reactor trip at Turkey Point-4, resulting in an approximately 15-day forced outage.

A. An electrical fault in the permanent magnet generator (PMG) of the main generator exciter caused a loss of voltage regulation for the main generator. Protective features of the main generator caused it to lockout, resulting in an automatic reactor trip and a forced outage.

The PMG stator and exciter work together to produce direct current. This direct current creates the magnetic field inside the main generator that allows it to produce electricity. The exciter is physically coupled to the main generator and rotates at the same speed as the main generator. The PMG stator is attached to the exciter and both are enclosed in a weather-resistant housing.

The main generator is on the non-nuclear side of the plant and is frequently inspected during refueling outages. On the non-nuclear side of the power plant, utilities frequently rely on inspections to determine when large components, such as main generator and exciter components should be rewound or replaced. This is known as a condition-based preventive maintenance program. The component involved in the July 5, 2020 outage was considered to be worn, but not yet in need of replacement.

All electrical components, like the main generator exciter PMG that failed, must be shielded from moisture, typically within an enclosure housing. During previous work on the main generator exciter by the original equipment manufacturer (OEM) maintenance organization, the enclosure housing that protects the exciter PMG from moisture was installed in a manner that allowed water to leak into the cabinet. This moisture combined with the worn nature of the PMG resulted in its failure and the resulting main generator lockout.

Q. Please respond to OPC witness Polich's contention that the outage was caused by FPL personnel improperly installing the seals.

A. As a threshold matter, it is important to correct witness Polich's testimony suggesting that the seals were incorrectly installed by FPL personnel. The installation was performed by the turbine OEM vendor, Siemens. Therefore, assessment of whether FPL was prudent requires examination of whether it was appropriate for FPL to rely on the vendor, Siemens; and whether FPL personnel should have detected the missing or incorrectly installed seals.

Q. Was it appropriate for FPL to rely on Siemens to install the seals on the exciter housing?

A. Yes. Utilities, like FPL, properly rely on vendor experts to conduct maintenance on their power plants. Utility personnel do not have the same level of training and experience that vendor personnel have for the equipment the OEM designed, manufactured and installed. Power plant maintenance personnel tend to be generalists, which is suitable for most maintenance, but not for maintenance of the more complex, larger equipment. The OEM vendor typically performs these inspections and maintenance activities at several fossil and nuclear power plants, making them far more proficient at this type of work than utility maintenance personnel are. This is coupled with the fact that during refueling outages utilities must bring in a large number of supplemental workers – often a workforce that is much larger than the utility power plant staff – to complete a refueling outage in a reasonable amount of time. Without the service of vendor partners, a 20 to 30-day refueling outage could take 60 to 90 days, significantly increasing costs utility customers must bear. Additionally, it would require utility workers, who do not have the same training and expertise as their vendor partners, to perform all of the maintenance work.

Q. FPL was aware of the potential for water intrusion into the main generator exciter based on a 2001 event. Was it reasonable for FPL to continue to rely on Siemens in light of the 2001 event?

A. Yes. The 2001 event was a ground fault in a main generator exciter based on water intrusion. Water was drawn in into the exciter through the enclosure and through pipes that had their plugs removed in preparation for an upcoming outage. This ground fault did not result in a reactor trip. In response to the 2001 event FPL updated its exciter enclosure installation procedures and shared the operating experience with the industry and the OEM vendor, Siemens. It was reasonable to expect that Siemens would use the operating experience that FPL shared, along with its own OEM vendor expertise, to update its procedures for exciter installation.

Q. Should FPL personnel have detected the missing or incorrectly installed seals through periodic inspections?

A. No. When a component, like an exciter cabinet is assembled and in operation, inspecting subcomponents, like the water intrusion seals, is not possible. It would not be safe for plant personnel to disassemble the cabinet with the exciter in service. In addition, removing the exciter from service to conduct routine inspections would require removing the unit from service, thereby significantly increasing costs to utility customers.

Nuclear power plants must always balance nuclear and personnel safety with unit reliability, and reasonable refueling outage duration and cost to properly serve their customers and protect the public. When an outage such as the July 2020 event occurs, nuclear power plants use their learning organization behaviors and processes to thoroughly understand and prevent recurrence of the cause that led to the outage.

Q. Do you believe it was appropriate for FPL to have employed a condition-based maintenance approach for its PMG?

A. Yes. All U.S. nuclear power plants have increased the use of condition-based preventive maintenance programs. The primary reasons for this are that time-based preventive maintenance programs typically result in maintenance being performed on equipment that does not need any maintenance performed on it. This can cause three unintended problems:

1. Unneeded maintenance introduces the potential for unplanned latent equipment failures due to "infant mortality" of new components or human error during the work.
2. The performance of unnecessary maintenance activities on power plant equipment distracts plant operators and maintenance personnel from the vital maintenance activities needed for safety-related and important-to-unit-reliability equipment.
3. It results in additional maintenance costs to be recovered from utility customers.

Q. Why did FPL's corrective actions for the PMG failure specify a time-based preventative maintenance task for PMG stator rewind?

A. Like all nuclear power plants in the U.S., FPL's nuclear power plants use OEM and industry guidance to specify the type and frequency of preventive maintenance on plant equipment. All U.S. nuclear power plants are learning organizations, and industry and NRC standards for root cause evaluations are to prevent recurrence of significant conditions adverse to quality. In this case, even though vendor and industry standards do not require time-based rewinds of PMG stators, the PMG stator rewind is intended to prevent recurrence of the issue that tripped Turkey Point-4 in July 2020.

Q. Please summarize your assessment of FPL's actions associated with the July 5, 2020 outage at TurkeyPoint-4.

A. FPL personnel took reasonable action to ensure that industry-standard exciter maintenance was performed by vendor experts before the unplanned outage. After the outage occurred, FPL conducted an in-depth causal analysis to understand the causes and take actions to prevent recurrence. FPL acted prudently.

<u>March 2021 Outage at Turkey Point-3</u>

Q. Please describe the March 1, 2021 unplanned outage at Turkey Point-3.

A. On March 1, 2021, Turkey Point personnel were performing a quarterly test that verifies the reactor trip breakers function properly. Reactor trip breakers allow control room operators to immediately shut down the unit by operating one switch to open the reactor trip breaker from the main control room. This is a safety feature that allows operators to immediately shut down the reactor if directed by operating procedure. When the reactor trip breaker is in the closed position, the control rods are kept from dropping into the reactor core. When the reactor trip breaker is in the opened position, the control rods drop into the reactor core, tripping the reactor. This test involves racking in breakers that bypass the reactor trip breakers so that cycling the reactor trip breakers open during the test does not actually allow the control rods to drop into the reactor.

When operators resumed the testing and put the reactor breaker into its normal, closed position, they proceeded to open the reactor trip bypass breaker to allow the reactor trip breaker to perform its normal function. When this occurred, a cell switch in the reactor trip breaker cubicle indicated to reactor protective systems that the reactor trip breaker was open (it was closed) causing the control rods to drop into the reactor core, and automatically trip the reactor. FPL's root cause analysis determined that the above-mentioned cell switch likely malfunctioned, actuating protective systems to trip the reactor.

Q. Explain how the FPL root cause evaluation identified the reactor trip breaker cell switches as the cause of the unplanned reactor trip.

A. FPL never found an actual "smoking gun" for the failure of the reactor trip breaker cubicle cell switches. The root cause evaluation team relied on comparing the FPL maintenance practices to one set of Westinghouse – OEM for the breaker – maintenance practices and on a conclusion drawn from the Westinghouse failure analysis of the reactor trip breaker and its cell switches. The Westinghouse failure analysis report documents the fact that FPL did not follow the Westinghouse Maintenance Program Manual (MPM) and that there was evidence of hardened graphite grease on the cell switches removed from the breaker cubicle. Westinghouse also correctly concludes that the presence of hardened graphite grease can provide a current path for the switch contacts. However, when Westinghouse tested both cell switches, the contacts that would have provided the invalid breaker position were operated 50 times and operated successfully all 50 times. The cell switches contain four sets of contacts. The only contacts that did not operate successfully were those considered to be "extras." They were not wired to anything in the plant.

As I mentioned in Section I of my testimony, root cause evaluations conducted in the U.S. nuclear power industry must find a root cause. There is no allowance for an indeterminate cause. This often results in utility root cause analysis teams finding a most likely cause, specifying it as the root cause, then specifying a comprehensive set of corrective actions to ensure every possible cause has been bounded and addressed. In order to establish a corrective action to preclude recurrence, FPL elected to implement time-based preventive maintenance activities with specific direction to clean and lubricate the cell switches in response to the reactor trip breaker possible cell switch malfunction.

Q. OPC witness Polich opines that FPL contributed to the reactor trip breaker failure, or that the reactor trip breaker problem could have been found prior to failure because FPL failed to follow the Westinghouse MPM. Do you agree that FPL's activities caused the failure?

A. No. As a starting point, even OPC witness Polich acknowledged that the cause of the reactor breaker trip malfunction "was not directly determined." (Polich 2022 testimony at 40:7). He appears to attribute fault based solely on the fact that FPL identified the different OEM maintenance practice and decided to align with it after the event. As is often the case with nuclear industry root cause evaluations, however, the root cause analysis teams find a most likely cause, specify it as the root cause, and then specify a comprehensive set of corrective actions to ensure every possible cause has been identified and addressed.

Accordingly, it appears that in order to establish corrective actions, FPL found a likely cause and elected to implement time-based preventive maintenance activities in response to the reactor trip breaker possible cell switch malfunction, even though there was no direct evidence that the existing practice was inappropriate.

Q. Was FPL's condition-based maintenance approach for the cell switches consistent with industry practice?

A. Yes. FPL's approach was consistent with industry practice and vendor requirements for extending the qualified life of the cell switches considering periodic refurbishments and FPL's inspections, combined with the fact that the exact same switch can operate for thousands of cycles in a different application on the breaker. As stated in the FPL root cause evaluation: "With proper maintenance and inspection of the circuit breaker and cell at the interval recommended the breaker and cell values can be exceeded…. The service/cycle life of the breaker and its components are based on industry standards, testing and analysis."

In fact, other nuclear power plants confirmed that use of a condition-based maintenance strategy for the cell switches was in alignment with industry practices. As I previously stated, all U.S. nuclear power plants have increased the use of condition-based preventive maintenance programs to avoid maintenance being performed on equipment that does not need it, thereby avoiding the three unintended consequences I described above.

Q. Was there any evidence to indicate that the cell switch functioned properly under FPL's condition-based maintenance practice?

A. Yes. There were at least two observations that call into question whether hardened grease on the cell switch and lack of lubrication on the spring caused the failure. First, the breaker and cell switches operated successfully several times when tested. Further, the remaining reactor trip breaker cell switches, which are located adjacent to the reactor trip breakers that failed, were operating properly under the same maintenance program and no major degradation was observed.

Q. Has the nuclear industry studied the consequences of performing equipment tests such as the type FPL was engaged in when the March 2021 event occurred?

A. Yes. U.S. nuclear utilities conduct testing on safety related components on short frequencies specified by their operating licenses, sometimes resulting in spurious failures and unit trips, similar to what occurred at Turkey Point-3. Utilities are now using industry experience and probabilistic risk assessment modeling to extend the time between these types of high-risk tests that could result in loss of generation. Initiatives like this risk-informed maintenance/testing program will result in fewer high-risk tests in the future because many of these high-generation-risk tests can be done during a refueling outage instead of while the unit is online.

Q. Is FPL following this new model that is based on industry experience?

A. Yes. FPL has begun the process of implementing a risk-informed maintenance/testing program. This should result in fewer unplanned outages during maintenance and testing in the future.

Q. Please summarize your assessment of FPL's actions associated with the March 1, 2021 outage at TurkeyPoint-3.

A. FPL followed industry-standard maintenance practices. After the outage occurred, FPL conducted an in-depth causal analysis to understand the causes and develop actions intended to prevent recurrence. FPL acted prudently.

III. REMAINING OUTAGES DISCUSSED BY FPL WITNESS DeBOER

<u>Outage Extensions</u>

Q. Before assessing the extended outages identified by witness DeBoer, could you please describe the purpose of refueling outages in a nuclear plant.

A. Nuclear power plants are the only form of electricity generation that can keep enough fuel on hand to run continuously for 18 months. The purpose of a refueling outage is to refuel the reactor for the next 18-month operating cycle and to complete required maintenance and modification work that can only be done when the unit is shut down. Importantly, the inspection and testing of the structures, systems, and components that had been supporting operations for the entire 18-month cycle are also completed while the unit is shut down for refueling.

Q. What is the purpose of inspections and tests conducted during refueling outages?

A. Inspections and tests are not conducted to determine that everything is fine. Their purpose is to identify failed or degraded equipment and correct it to ensure that the unit can be operated safely and reliably through the next operating cycle. Even though FPL and the rest of the U.S. nuclear industry have invested in diagnostic and predictive technology, some equipment can only be assessed using the traditional, "failure-finding" methods. Sometimes those inspections and tests reveal issues that must be corrected before returning the unit to service to ensure a safe and reliable operating cycle. Utilities like FPL devote extensive resources to the planning and scheduling of refueling outages, but sometimes the corrective actions to repair degraded or failed equipment may extend the outage duration beyond what the utility originally estimated before it had the benefit of the inspection results.

Q. Please explain the operational difference between identifying and correcting issues during refueling outages compared to doing so while the unit is on-line.

A. It is always better to identify and correct issues when the unit is shut down for a refueling outage, even if it means the length of the outage will be extended. Issues that occur while the unit is on-line may result in having to remove the unit from service. Removing the unit from service requires significant additional time and risk associated with maneuvering the plant from full power operation to shutdown conditions. And then the resources necessary to address the issue need to be acquired. During the refueling outage, the unit is already in a condition to address issues and the additional resources, including equipment, tools, and personnel are already on-hand to support the outage.

Q. And yet, unplanned outages still occur. Please comment.

A. Yes, the U.S. nuclear power industry, including FPL's nuclear fleet, is the most reliable generation fleet in the world. Even with the best inspection and test plans, operating events still occur. But the overall safety and reliability built into the nuclear plants from all of the work that is completed during refueling outages results in a defense-in-depth approach yielding highly reliable, safe, clean, base load generation. In fact, FPL just finished a 505-day, "breaker-to-breaker" run following its Fall 2021 refueling outage at Turkey Point-3 and completed with the beginning of the Spring 2023 refueling outage, meaning the Unit had an uninterrupted online run of 505 days between refueling outages.

<u>May 2021 Outage Extension at St. Lucie-1</u>

Q. Please describe the refueling outage extension that occurred at St. Lucie in May 2021.

A. On May 8, 2021, while operators were preparing to restart St. Lucie-1 from a refueling outage, they discovered that the lower gripper coils for four control element assemblies had failed and were subsequently determined to have been damaged. Control element assemblies (CEA) are the arrays of rods that are lowered into or raised out of the reactor core to help control the nuclear reaction. CEAs are raised or lowered by electrical coils that energize and deenergize in a precise sequence to "grip" them and move them up or down.

Subsequent troubleshooting by FPL personnel determined that the lower gripper coils failed when excessive electric current was applied to them by the rod control system coil power management drawer (CPMD). The FPL troubleshooting team found that while revising CPMD firmware the OEM vendor for the CPMD made an unauthorized change that removed the overcurrent protection from the four failed lower gripper coils. The OEM vendor failed to follow its own software change requirements when making this unauthorized change to their proprietary firmware.

Q. Was it appropriate for FPL to rely on the OEM to execute software changes?

A. Yes. In this case the vendor made an unauthorized change to its proprietary software, causing the damaged coil stack that extended the refueling outage. The installation was performed by the vendor under the vendor quality assurance program and it involved the vendor's proprietary software, which FPL personnel do not have access to or permission to modify, thus bounding the scope of FPL's oversight. This conforms to FPL quality assurance and vendor oversight requirements and is consistent with standards employed at other U.S. nuclear power plants.

Q. Please summarize your assessment of FPL's actions associated with the May 2021 event at St. Lucie-1.

A. FPL's reliance on a vendor expert with proprietary software was prudent and in accordance with U.S. nuclear industry standards and practices. FPL is not at fault for this refueling outage extension.

November 2021 Outage Extension at Turkey Point-3

Q. Please describe the circumstances that led to the refueling outage extension at Turkey Point-3 in November 2021.

A. Several issues led to the subject outage extension. The two largest causes of the extension were the failure of the manipulator crane gripper and emergent work (work that that is not anticipated to have to be done before the refueling outage). The emergent work includes the leak identified on the core exit thermocouple (CET) number 57 during the Normal Operating Pressure and Temperature walkdown. Some, but not all, of the outage duration extension time was recovered by FPL personnel action to execute the outage in an efficient manner.

Q. Were FPL's actions associated with the failure of the manipulator crane gripper prudent?

A. Yes. FPL's response to the failure of the manipulator crane gripper was safe, prudent, and timely. The first issue that delayed the refueling outage was the malfunction of the manipulator crane gripper. This component latches on to irradiated fuel in the reactor core so it can be safely transported to the spent fuel pool. Irradiated fuel is highly radioactive and mishandling it can spread radioactive contamination, which could endanger the public. Nuclear power plants conduct extensive testing and maintenance of fuel handling equipment before outage refueling activities to maintain reliable operation.

When a malfunction occurs, or the reliability of the fuel handling equipment is questioned, the utility must make the conservative decision and be absolutely sure the equipment is reliable before it moves irradiated fuel. Conservative decision-making may call for the replacement of an entire subcomponent. This takes time but ensures that the highest level of nuclear safety is maintained. FPL had fuel handling equipment maintenance personnel already on site as a contingency, and made the conservative, safe decision which resulted in an extension of the refueling outage.

Q. Were FPL's actions associated with the CET prudent?

A. Yes, FPL's actions associated with the CET were safe, prudent, and timely. During the refueling outage, FPL discovered a boric acid deposit on a core exit thermocouple tube. All pressurized water reactors maintain a boric acid corrosion control (BACC) program in compliance with American Society of Mechanical Engineers (ASME) code requirements and the site's licensing basis. The ASME code forms the basis for how nuclear power plant pressure retaining components are built, inspected, and repaired. The BACC program is an especially vital program that became more important following the reactor vessel closure head damage discovered in 2002 at the Davis Besse Nuclear Power Station. At Turkey Point, boric acid was discovered on instrumentation tubing coming out of the nuclear reactor. The tubing connection was not worked on during the refueling outage.

This tubing is one of three fission product barriers that protect the public from radioactive contamination during a nuclear accident. Nuclear power plant operators must maintain the integrity of all three fission product barriers and conduct extensive inspections of these barriers before completing a refueling outage. Pursuant to the plant's operating license, the inspection that discovered the leaking CET has to be performed near the end of the refueling outage when the reactor coolant system has been brought to its normal operating pressure and temperature. FPL personnel documented that they conducted these required inspections. Plant personnel made the prudent, safe decision to pause reactor startup so they could investigate and repair the source of the boric acid leakage.

Other nuclear power plants have had to reverse progress in their refueling outages to repair boric acid leaks on mechanical connections that most often were not worked on during the refueling outage. If a nuclear power plant discovered a similar leak while it was online, the plant's operating license would require it to shut down within seven hours and repair the leak. The only way to prevent this would be to work on every connection each refueling outage. This would result in significantly longer, more costly, refueling outages and would introduce the possibility of equipment infant mortality or human error into the repair process.

Q. Do you have any overall observations about FPL's execution of refueling outages?

A. Yes. The FPL nuclear fleet, as part of the broader NextEra Energy, Inc. fleet, has developed a core competency for refueling outage execution. FPL conducts high-quality refueling outages and its refueling outage durations tend to be shorter than the average duration refueling outage in the U.S. nuclear power industry. According to S&P Global Commodity Insights data, reported by Platts Nuclear News on March 9, 2023, the average length of U.S. nuclear refueling outages in 2022 was 39.8 days. Most FPL nuclear plant refueling outages, even with unplanned extensions, have a shorter duration. In fact, St. Lucie-1 recently completed a refueling outage in 28 days. This results in FPL customers paying for less refueling outage replacement power than the customers of other utilities. FPL should not be penalized for unplanned, unpreventable refueling outage extensions when they are planning and executing world-class refueling outage durations.

Unplanned Outages

November 2020 Generation De-rate at Turkey Point-3

Q. Please describe the Turkey Point-3 derate that occurred in November 2020.

A. On November 7, 2020, a component that controls valves in the secondary side of the plant failed, causing the valves it controls to fail to control secondary heat exchanger, tank, and pump recirculation parameters. By plant design, the main turbine control system automatically reduced power to 85% to prevent a turbine and reactor trip. Plant personnel worked around the clock to identify the failed component, then engaged FPL's vendor partner to conduct a failure analysis on the failed field control processor. An internal subcomponent called an optocoupler caused the field control processor to fail. On November 21, 2020, in order to isolate the correct secondary equipment to safely replace the repaired field control processor, FPL personnel reduced unit power to 25%. Following replacement of the field control processor and successful post-maintenance testing, the unit was returned to 100% power.

Q. Is 14 days a reasonable amount of time to identify and correct the malfunction that caused the 15% reduction in power?

A. Yes. Although located on the secondary side of the power plant, FPL personnel had to take great care in their troubleshooting activities to ensure they did not induce another secondary plant transient or turbine and reactor trip. This often involves complex troubleshooting that is carefully monitored by plant operators. FPL staff then engaged vendor experts to help understand and correct the cause of the component failure.

The external vendor was able to diagnose and specify a repair for the component that malfunctioned. An internal subcomponent was the cause of the malfunction and the defective part was replaced. FPL personnel performed an appropriate extent of condition, then used their corrective action program to specify corrective actions designed to prevent a similar failure from occurring again, or elsewhere.

Q. Please summarize your assessment of FPL's actions associated with the November 2020 event at Turkey Point-3.

A. FPL actions prior to and following the component failure were prudent and in alignment with U.S. nuclear power industry practices.

<u>January 2021 Outage at St. Lucie-2</u>

Q. Please describe the St. Lucie-2 outage that occurred in January 2021.

A. On January 20, 2021, St. Lucie-2 automatically tripped from 100% power. A non-safety related motor control center deenergized due to a design error that occurred in the 1980s, resulting in the diverse turbine trip system initiating a reactor and turbine trip. In 1983, an error in a design drawing did not clearly define power supply assignments for diverse, separated channels of undervoltage protection. This error resulted in inadvertently mis-assigning power to two of four undervoltage relays to the incorrect source of power when the St. Lucie-2 rod control system was replaced with an upgraded system in 2019.

Q. Why did FPL personnel not identify the legacy drawing error that when combined with the 2019 modification resulted in a reactor trip?

A. The latent legacy defect in plant drawings occurred in the 1980s. The drawing was prepared by one of the construction contractors, Ebasco. Prior to the mid-1990s, power plant design control across the U.S. nuclear industry, especially for drawings, were not as strong as they are now. This has resulted in legacy drawing errors at several nuclear power plants, primarily in non-safety related systems. Over the years, many power plants across the country assessed the cost associated with reconstituting plant drawings to discover and resolve legacy drawing errors. Utilities decided not to proceed with these initiatives due to the excessive cost estimates. As an example, I was personally involved in an effort to reconstitute the large bore piping drawings and calculations at a power plant and can attest that very little benefit was derived from the multi-million-dollar project.

Q. Given the less stringent design control standards implemented by the industry prior to the mid-1990s, how do nuclear plants discover and correct any legacy errors?

A. At present, nuclear plants typically rely on their design change processes to discover and correct these errors.

Q. FPL's root cause evaluation notes that a large project was implemented to replace its rod control system and that the subject components and drawing were outside the scope of the project. Was such a limitation in scope consistent with industry practice?

A. Yes, it is standard industry practice to limit the scope of nuclear plant design change projects. There are three main reasons for this. First, every time a utility changes the plant design, it impacts the overall plant design and could introduce unintended consequences. Therefore, it is very difficult and expensive to change the design of a nuclear power plant system, structure, or component. This leads to the second reason that utilities limit the size of design change projects: cost. Nuclear power plant design changes are several times more expensive than other power plant design changes because of the extensive engineering, design, and procurement control that must be maintained. The final reason is that expanding design change project boundaries increases the complexity and therefore the possibility of human error when implementing a design change. This leads nuclear operators, including FPL, to limit the scope of design changes to only what is necessary.

Q. Please summarize your assessment of FPL's actions associated with the January 2021 event at St. Lucie-2.

A. FPL personnel actions to discover and address the issue that caused the outage were prudent and met industry standards. FPL personnel discovered the vulnerability point while preparing for a maintenance procedure and included correction of the issue for the next scheduled unit outage. This is standard industry practice in the U.S. nuclear power industry to avoid unnecessary cycling of unit operation.

<u>February 2021 Power Reduction at Turkey Point-3</u>

Q. Describe the February 2021 power reduction at Turkey Point-3.

A. On February 2, 2021, operators observed the concentration of sodium in the feedwater system begin to increase. The feedwater system supplies secondary plant water to the steam generators, which turns into steam to drive the main turbine. Because the steam generator tubes are a barrier between the reactor coolant system water on the nuclear side of the plant, and feedwater on the secondary side of the plant, great care is taken to guard against leaks. Precise control of the chemistry of the water on both sides of the plant helps accomplish this. On the secondary side of the plant, contaminants, like sodium, can accelerate the wear of steam generator tubes which could lead to a leak. Accordingly, the allowable limits for the concentration of contaminants, like sodium, are very low.

Operators used their procedures to identify the likely source of sodium entering the feedwater system, removed applicable equipment from service, and stabilized the plant at 55% power. FPL personnel then worked around the clock to identify the source of the sodium ingress, repair it, and return the unit to 100% power.

Q. Was FPL's maintenance strategy sufficient to prevent a tube leak that could result in reduced generation?

A. Yes. FPL conducts heat exchanger tube integrity testing on about one-fourth of the tubes during refueling outages, and plugs any tubes that have excessive wear, or that are adjacent to other damaged tubes. This is standard nuclear power industry practice based on the Electric Power Research Institute (EPRI) Heat Exchanger Program documents for non-safety related heat exchangers like main condensers. EPRI is the central technical authority for the power generation industry, conducts research, and publishes practical application documents to guide the efforts of utilities, like FPL, to implement standard, high quality maintenance programs for major components like heat exchangers and condensers.

FPL uses a vendor expert, Curtiss-Wright, to inspect its main condenser tubes for deficiencies like cracks using what is known as eddy current testing. Eddy current testing is the process of running electronic probes through metal tubes to look for flaws, dents, or cracks in them. The Curtiss-Wright Eddy Current Inspection Report submitted after the tube was repaired confirms that FPL's maintenance strategy was adequate.

Q. Did FPL act prudently to limit the generation loss and consequently the replacement power costs for FPL customers?

A. Yes. The unit was at reduced power for 7 days to identify and plug a leaking main condenser tube. Main condenser tube leaks are a common occurrence at all U.S. power plants. Main condensers contain tens of thousands of tubes that are subjected to harsh operating conditions. Utility personnel conduct extensive main condenser crawl-throughs and repairs during refueling outages but it is nearly impossible to identify every degraded component in a main condenser during a refueling outage. In this case, a piece of heat exchanger lagging failed and impacted a tube.

In order to protect steam generator tube integrity, FPL monitors contamination levels through precise control of the chemistry of the water that surrounds the tubes. Consistent with nuclear industry standards for contaminant levels in secondary plant systems, FPL allows less than one part per billion. Once an exceedance is observed, the process to identify and plug a leaking condenser tube is imprecise and time-consuming. FPL personnel actions to address the tube leak and return the unit to full output were timely and prudent.

<u>August 2021 Outage at Turkey Point-3</u>

Q. Please describe the August 2021 outage at Turkey Point-3.

A. On August 5, 2021 the number 2 main turbine control valve at Turkey Point-3 unexpectedly closed. Main turbine control valves control the flow of steam from the steam generators to the high-pressure turbine. Because main turbine control valves cannot be worked on with the main turbine in service the unit was shut down to troubleshoot and repair the valve. FPL personnel determined that the actuator stem (rod) was sheared at a threaded connection inside the coupling between the actuator and valve. Further failure analysis by an offsite expert determined that the source of the failure was pitting in the stem that progressed into a crack leading to the shear failure of the stem. Pitting is a collection of small pieces of corrosion on the surface of a metallic component.

Q. Should FPL personnel have been able to identify and prevent the failure of the actuator rod that caused the control valve to close?

A. No. The Turkey Point investigation, supported by a failure analysis from an offsite expert, supports the conclusion that the failure of the rod was initiated by corrosion pitting on an area of the rod that was not coated. Turkey Point personnel would have been unable to prevent this failure until it became self-revealing. Since the subject subcomponent was part of a non-safety related system, there are no requirements for the nondestructive testing that is performed for safety-related components. Nuclear power plants focus the majority of their testing and maintenance resources on safety-related components over non-safety related components. Safety-related components have to function as designed, and as operators are trained to expect, to protect the public during off-normal or accident conditions. This is affirmed by the oversight of the NRC, who is considered to be the “safety regulator.”

As discussed in my assessment of the Turkey Point-4 July 2020 unit trip, when servicing non-safety related equipment utilities have to balance the cost/benefit of excessively long refueling outages and costs that are recovered from their customers. This is consistent with U.S. nuclear power industry practice and results in very infrequent unplanned non-safety related equipment failures.

<u>December 2021 Outage at St. Lucie-1</u>

Q. Please describe the December 2021 outage that occurred at St. Lucie-1.

A. On December 10, 2021, St. Lucie-1 operators followed their procedures and manually tripped the reactor due to lowering and unrecoverable levels in the steam generators. Although not at the automatic trip setpoint, operators were maintaining precise control of the reactor as required by their training. Steam generator levels were lowering due to transient flow conditions in the secondary plant initiated during maintenance worker replacement of a pressure differential indicating switch resulted in a blown fuse and loss of a power supply to control systems.

Q. Were the appropriate procedures in place to prevent the outage from occurring?

A. Yes, the appropriate procedures were in place. The unplanned outage was caused by a properly trained FPL supervisor, whose performance had been rated as acceptable, not enforcing the proper standards for instrumentation and control technician work. FPL had all of the required human error reduction tools available for the technicians to complete the work without causing the unit to trip. FPL appropriately applied accountability actions to the supervisor for not enforcing the use of human error reduction tools with his technicians. The instrumentation and control technicians were appropriately trained and qualified to perform the work. The plant conducted a training needs analysis for the work and determined that no further training was needed.

Q. Were FPL's actions associated with the December 2021 event at St. Lucie-1 prudent?

A. Yes. FPL had all of the required technical and human error reduction processes in place to prevent this error from occurring. This outage is an example of a supervisor not following established standards and requirements.

<u>January 2022 Outage at St. Lucie-2</u>

Q. Please describe the January 2022 outage at St. Lucie-2.

A. On January 6, 2022, operators were conducting a scheduled test of control rod movement at St. Lucie-2. During the test one control element assembly slipped, which means it did not respond to efforts to withdraw it from the core. Operators followed their procedures and reduced reactor power to 70% in accordance with the plant's operating license. FPL personnel conducted further troubleshooting, and, in compliance with the plant's operating license, shut down the reactor. After the reactor was moved to the cold shutdown condition, FPL personnel continued inspecting the control element drive mechanism and discovered a foreign object impeding the movement of the upper latch mechanism allowing the control element assembly to slip during the operational test being conducted.

Inspection of the object determined that it was a pin that had broken off a tool used to couple the control element assembly to its extension shaft during the refueling outage that occurred in September 2021 at St. Lucie Unit 2 (SL2-26).

Q. Were FPL's actions during the SL2-26 outage prudent?

A. Yes. FPL used an experienced reactor services vendor to conduct work on its reactor vessel closure head packages. This same vendor performs reactor service work at several U.S. nuclear power plants. Reactor service utility personnel and vendors are trained to not introduce foreign material into the reactor systems and are willing to stop work – even critical path refueling operations – when they encounter an unexpected condition.

During the SL2-26 refueling outage work, the vendor experts did not recognize that the tool they were using malfunctioned, resulting in a sheared pin dropping into the coil stack. The reason they did not recognize it is that the subject pin is unable to be observed when the tool is assembled.

Q. Had the nuclear industry experienced a pin dislodging from a similar tool before FPL's January 2022 event?

A. No. This was a learning for all U.S. nuclear power plants. The FPL causal analysis directed the development of new procedures that will significantly reduce the possibility of a similar event occurring again.

Q. Please summarize your assessment of FPL's actions associated with the January 2022 event at St. Lucie-2.

A. FPL personnel took the proper, industry standard precautions to prevent the equipment malfunction that led to the unplanned outage at St. Lucie-2.

Q. Does this conclude your testimony?

A. Yes.