UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 24, 2020

Mr. Don Moul
Executive Vice President, Nuclear Division and
Chief Nuclear Officer
Florida Power & Light Company
NextEra Energy Seabrook, LLC
Mail Stop: NT3/JW
15430 Endeavor Drive
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SUBJECT: SEABROOK STATION, UNIT NO. 1 – CLOSEOUT OF BULLETIN 2012-01, "DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM" (EPID L-2017-CRS-0063)

Dear Mr. Moul:

On July 27, 2012, the U.S Nuclear Regulatory Commission (NRC) issued Bulletin (BL) 2012-01 "Design Vulnerability in Electric Power System" (Agencywide Documents Access and Management System Accession No. ML12074A115), to all holders of operating licenses for nuclear power reactors, except those that have permanently ceased operation and have certified that fuel has been removed from the reactor vessel.

BL 2012-01 requested information about each facility's electric power system designs in light of operating experience involving the loss of one of the three phases of the offsite power circuit (single-phase open circuit condition) at Byron Station, Unit No. 2. Specifically, the NRC requested licensees to provide information to address the following:

- How the protection scheme for engineered safety features buses (Class 1E for current operating plants or non-Class 1E for passive plants) is designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on an offsite power circuit or another power source.

- The operating configuration of engineered safety features buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (i.e., normal operating condition).

The NRC staff has reviewed the information submitted by Seabrook Station, Unit No. 1 (Seabrook), and concludes that its response to BL 2012-01 is acceptable. As summarized in the enclosure, the NRC staff verified that Seabrook has provided the necessary information requested in BL 2012-01 to close out the open phase condition issue.

If you have any questions, please contact the Seabrook Project Manager, Justin Poole, at 301-415-2048 or by e-mail to Justin.Poole@nrc.gov.

Sincerely,

/RA/

Justin C. Poole, Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosure:
As stated

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SUMMARY OF NRC BULLETIN 2012-01

"DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM" RESPONSE REVIEW

NEXTERA ENERGY SEABROOK, LLC, ET AL.*

SEABROOK STATION, UNIT NO. 1

DOCKET NO. 50-443

1.0 INTRODUCTION

On July 27, 2012, the U.S Nuclear Regulatory Commission (NRC) issued Bulletin (BL) 2012-01 "Design Vulnerability in Electric Power System" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12074A115), to all holders of operating licenses for nuclear power reactors, except those that have permanently ceased operation and have certified that fuel has been removed from the reactor vessel.

BL 2012-01 had the following purposes:

1. To notify the addressees that the NRC staff is requesting information about the facilities' electric power system designs, in light of the recent operating experience that involved the loss of one of the three phases of the offsite power circuit (single-phase open circuit condition) at Byron Station, Unit 2, to determine if further regulatory action is warranted.

2. To require that the addressees comprehensively verify their compliance with the regulatory requirements of General Design Criterion (GDC) 17, "Electric Power Systems," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR [Title 10 of the *Code of Federal Regulations*] Part 50, "Domestic Licensing of Production and Utilization Facilities," or the applicable principal design criteria in the updated final safety analysis report and the design criteria for protection systems under 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3).

3. To require that addressees respond to the NRC in writing, in accordance with 10 CFR 50.54(f).

Specifically, the NRC requested licensees to provide information by October 25, 2012, regarding the protection scheme to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on General Design Criterion 17 power circuits and operating configuration of engineered safety features (ESFs) buses at power.

The NRC staff reviewed the information that the licensees provided and documented the details of this review, in the summary report dated February 26, 2013 (ADAMS Accession No. ML13052A711). Specifically, by letter dated October 22, 2012 (ADAMS Accession

Enclosure

No. ML12299A467), NextEra Energy Seabrook, LLC (NextEra, the licensee) provided its response for Seabrook Station, Unit No. 1 (Seabrook), to the BL 2012-01 specific questions. By letter dated December 20, 2013 (ADAMS Accession No. ML13351A314), the NRC staff sent a request for additional information (RAI) to verify that licensees had completed interim corrective actions and compensatory measures and to obtain the schedule and status of long-term corrective actions. Seabrook responded to the RAI by letter dated January 29, 2014 (ADAMS Accession No. ML14035A217). In its response, NextEra described the various actions taken to ensure plant operators can promptly diagnose and respond to open phase conditions (OPCs). The response also stated that a single, credible failure that could cause an undetected OPC is not a credible event at Seabrook; thus, no plant design changes and modifications are being pursued to resolve issues with an OPC in the offsite power system.

By letter dated March 31, 2014 (ADAMS Accession No. ML14083A614), the NRC staff requested NextEra to provide a summary of the licensee's engineering assessments of all operating events identified in the industry, including OPC events due to circuit breaker malfunctions that occurred at South Texas Project, Unit 2, and Forsmark Nuclear Power Plant (Forsmark), Unit 3. In its letter dated April 30, 2014 (ADAMS Accession No. ML14122A359), NextEra provided its engineering assessment of potential failure of breakers that could cause OPCs.

2.0 NRC STAFF EVALUATION

The NRC staff reviewed NextEra's response to BL 2012-01, as well as responses to the RAIs, which assert that there is no credible failure mode of switchyard components that could cause an undetected OPC. Specifically, the NRC staff focused on various switchyard configurations and bus and breaker connections that could cause potential OPCs due to exposure to the outdoor environment.

The NRC staff noted that the transmission grid connections that provide offsite power to Seabrook consist of three 345 kilovolt (kV) transmission lines that are designed and built to provide the electrical and structural independence necessary to ensure continuity of offsite electrical power to the station. At Seabrook, the three lines terminate at separate terminating structures. From the terminating structures, each circuit is routed in a metal-enclosed, sulfur hexafluoride (SF6) gas-insulated bus to a common switching station. Two separate and independent safety-related 4.16 kV emergency buses and associated diesel generators are the source of power for the plant auxiliaries, protection system, and ESF loads during normal, abnormal, and accident conditions. The normal supply to the train A (ESF bus E5) and train B (ESF bus E6) 4.16 kV emergency buses is supplied from separate unit auxiliary transformers (UATs). When the unit is operating, the turbine generator output is supplied through the generator circuit breaker and the UATs to the emergency buses. When the unit is shut down, the generator breaker is opened and the current flow is reversed through the generator step-up transformer (GSU) and supplied to the UATs. The reserve auxiliary transformers (RATs) provide an alternate source of power to the emergency buses. Upon loss of normal supply (i.e., a UAT) to a bus, the alternate supply (i.e., an RAT) is automatically connected. In addition to a normal and alternate supply, each emergency bus has an emergency power supply in the form of an emergency diesel generator.

NextEra stated in its BL 2012-01 response that an initiating event similar to the Byron Station event is not likely at Seabrook because of the design differences associated with the switchyard configuration and the bus connections to and from the auxiliary transformers. The NRC staff noted that the Seabrook 345 kV switchyard uses an SF6 gas-insulated isolated-phase bus

design. The switchyard ring bus is connected to the grid by three overhead air-insulated transmission lines or buses. Each transmission line, its associated 345 kV buses, and circuit breakers have the capacity to supply the power requirements of the station auxiliaries under all plant conditions. Failure of one or two phases of one of the air-insulated transmission lines would not result in an imbalance at the station auxiliary buses because balanced phase voltages would be maintained by the remaining two gas-insulated isolated-phase buses. The NRC staff noted that a simultaneous open circuit failure on the same phase of all three transmission lines or buses is not a credible event. The Seabrook GSUs and UATs are connected to the ring bus through two circuit breakers (11 and 12). The Seabrook RATs are also connected to the ring bus through two circuit breakers (52 and 695). As such, it is not credible that a single failure in one breaker would result in a loss of one or two phases in the switchyard supply circuit to either the GSU/UAT circuit or the RAT circuit.

The Seabrook GSUs and RATs are connected to the 345 kV switchyard by an SF6 gas-insulated, isolated-phase bus. Each single-phase bus section consists of two concentric tubes of aluminum. The inner tube is the conductor and the outer tube is the solidly grounded enclosure for each isolated phase. Two types of insulators – gas-barrier and non-barrier, are used to support the center conductor within the enclosure. The gas-barrier type is a full circumference-type insulator, and the non-barrier type is a tri-post design. These types of insulators keep the conductor centered and fully supported within the enclosure. The conductors in adjacent bus sections are interconnected using a plug and socket design that is not susceptible to open circuit failure. The conductor connection at the GSU and RAT bushings is a manually operated sliding link (plug and socket) design that is closed during normal operation. The bus enclosure sections are bolted together. This design is not susceptible to the same failure mode as the Byron Station event where an air-insulated line insulator failed and dropped the conductor.

Based on this design, the NRC staff noted that it is not credible that a single insulator failure will result in an open circuit. The conductor bus will remain in position due to the balance of remaining insulators and the rigidity of the plug and socket connections. With the SF6 bus design, should an internal insulator failure occur, it is postulated to initiate a phase-to-ground fault between the conductor and the enclosure and result in isolation of all phases in the affected circuit. Motor-operated and manually-operated disconnect switches in the 345 kV SF6 GSU and RAT circuits incorporate similar design features as the SF6 bus. These switches are maintained in the closed position during normal operation.

In addition, the Seabrook UATs are connected to the 25 kV system (secondary side) by an air-insulated, isolated-phase bus. Each single-phase bus section consists of two concentric tubes of aluminum. The inner tube is the conductor and the outer tube is the solidly grounded enclosure for each isolated phase. Insulators (bus support assemblies) are used to support the center conductor within the enclosure. This type of insulator keeps the conductor centered and fully supported within the enclosure. Conductor joints are welded except for connections to equipment, which utilize multiple flexible links with bolted connections. Based on this design, it is not credible that a single insulator failure will result in an open circuit. The conductor bus will remain in position due to the balance of the remaining insulators and the rigidity of the bolted connections. This design is not susceptible to the same failure mode as the Byron Station event where an air-insulated line insulator failed and dropped the conductor. With the air-insulated, isolated-phase bus design, should an internal insulator failure occur, it is postulated to initiate a phase-to-ground fault between the conductor and the enclosure and result in isolation of all phases in the affected circuit.

The connections from the RATs and UATs to the station's 13.8 kV and 4.16 kV buses are by a three-phase, non-segregated phase bus duct. This design consists of all three phase conductors being supported within a common metal enclosure. The bus bars are covered with insulation sufficient to withstand the full line voltage rating. The bus bars are supported internally within the enclosure by either polyester glass insulating channels (5 kV bus) or porcelain insulators (15 kV bus). To connect one section of the bus to another, the bus bar conductors are mechanically bolted together. This provides a rigid connection where failure by open circuit is not credible. Multiple flexible links with bolted connections are used to connect the bus conductors to other equipment such as transformer bushing terminals. Again, with this construction, an open phase circuit failure is not credible.

Based on the South Texas, Unit 2, and Forsmark, Unit 3, operating events, which identified open phase conditions due to circuit breaker malfunctions, NextEra stated that it has implemented an extensive preventive maintenance (PM) program for the Seabrook 345 kV SF6 gas-insulated switchyard and air-insulated switchyard. The PM activities are included and scheduled in accordance with the Seabrook PM program. In-house switchyard-qualified resources are utilized to perform these maintenance activities, which include detailed inspections of the entire switchyard looking for abnormal conditions on any equipment. Any physical degradation or failure of SF6 gas-insulated bus work systems or structures would be observed and reported during these inspections.

In addition, the licensee stated that the Seabrook design has pole disagreement protection features for the switchyard breakers that would protect against the condition of all breaker poles not opening or closing together. Upon detection of pole disagreement, the breaker gets a trip signal. If all poles do not open within a specified time delay, a second level of protection is available. The breaker failure scheme is initiated, and the adjacent breakers are tripped to isolate the failed breaker. Both pole disagreement and breaker failure protection schemes are redundant in the System 1 and System 2 protection. The redundant relaying protection scheme and a breaker-and-half switching station minimize the likelihood of any single failure to cause loss of more than a single circuit. With this switchyard breaker protection scheme, a failure of any switchyard breaker pole to open similar to the Forsmark event will be quickly isolated.

Based on the above, due to Seabrook's unique design, configuration of 345 kV switchyard and station buses, and proper operating and maintenance practices, the initiating event similar to the operating experience the NRC staff has seen to date is not a credible event at Seabrook.

4.0 CONCLUSION

As discussed above, the NRC staff has verified that the licensee has provided the information requested in BL 2012-01. Specifically, Seabrook responded to each of the questions in BL 2012-01 as requested. In addition, the licensee has adequately addressed the NRC staff's RAIs. The NRC staff concludes that Seabrook has completed all of the requirements of BL 2012-01, and no further information or actions under BL 2012-01 are needed.

SUBJECT: SEABROOK STATION, UNIT NO. 1 – CLOSEOUT OF BULLETIN 2012-01, “DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM” (EPID L-2017-CRS-0063) DATED MARCH 24, 2020

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