UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

September 15, 2020

NRC INFORMATION NOTICE 2020-02: FLEX DIESEL GENERATOR OPERATIONAL CHALLENGES

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a combined license under 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent operational challenges involving diverse and flexible coping strategies (FLEX) equipment at nuclear power plants. NRC licensees use this equipment to implement FLEX capability for long-term core cooling, spent fuel cooling, and containment integrity in a beyond-design-basis event scenario. The NRC expects that recipients will review the information in this IN for applicability to their facilities and consider actions, as appropriate, to ensure continued compliance with NRC Order EA-12-049, "Order Modifying Licenses with regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (Agencywide Document Access and Management System (ADAMS) Accession No. ML12054A735) and 10 CFR 50.155, "Mitigation of beyond-design-basis events." INs may not impose new requirements, and nothing in this IN should be interpreted to require specific action.

DESCRIPTION OF CIRCUMSTANCES

River Bend Station

Event #1

On September 26, 2019, the licensee at River Bend Station (River Bend) began periodic testing of FLEX pump P-1, a pump intended to provide core cooling capability during a beyond-design-basis event. FLEX diesel generator EG-5 powers the pump. This was the first time the licensee attempted to start EG-5 without the diesel generator vendor on site to support this activity. When the licensee attempted to start EG-5, it started but immediately shut down. The licensee was not able to determine the cause of the shutdown and contacted the vendor to schedule corrective maintenance.

On October 31, 2019, the vendor arrived on site to troubleshoot EG-5. The licensee also decided to check the operation of four other FLEX diesel generators: EG-1, EG-2, EG-3, and

EG-4 with the vendor on site for assistance. The licensee was able to start EG-3, EG-4, and EG-5, but shortly after starting the engines tripped either on overspeed (EG-3 and EG-4) or overvoltage (EG-5) conditions. After several attempts, the vendor was able to successfully run EG-3, EG-4, and EG-5. When the licensee tested EG-1 and EG-2, both started but immediately tripped on high coolant temperature. The vendor determined that sensor contacts on the coolant temperature switches in EG-1 and EG-2 had failed closed, indicating a false high coolant temperature condition. The vendor bypassed the sensors and successfully ran both diesel generators. After 30 seconds of operation, the sensor contacts opened, and the diesel generators subsequently started and operated without issue.

The NRC performed a follow-up baseline inspection in December 2019. The inspection report is available at ADAMS Accession No. ML20106F203.

Event #2

On April 1, 2020, the licensee at River Bend again attempted to perform periodic testing of FLEX pump P-1, powered by EG-5. The licensee started EG-5, but the generator tripped on an undervoltage condition following closure of the disconnect switch connecting it to the uncoupled pump P-1 motor (unloaded condition). After the vendor replaced the diesel generator voltage regulator, fuel pump, and fuel injectors, the licensee attempted the test on April 16, 2020. Again, EG-5 tripped on an undervoltage condition. Licensee troubleshooting revealed the cause of the trip as an incorrect configuration of the EG-5 main breaker instantaneous overcurrent setpoint and voltage controller time delay setpoints for over/under frequency and over/under voltage. The main breaker instantaneous overcurrent setpoint and voltage controller time delay setpoints for over/under frequency and over/under voltage were at the factory default values of 1.5 (main breaker instantaneous overcurrent) and zero seconds (over/under frequency/voltage), respectively. These settings caused the output breaker to trip during the temporary undervoltage condition resulting from starting a large inductive load such as FLEX pump P-1.

The licensee's extent of condition revealed that the main breaker instantaneous overcurrent setpoint and voltage controller time delay setpoints for over/under frequency and over/under voltage were similarly misconfigured on four other FLEX diesel generators (EG-1, EG-2, EG-3, and EG-4). This condition would have prevented EG-3, EG-4, and EG-5 and their associated pumps from performing their functions of pumping water from the suppression pool to the reactor low-pressure injection point (EG-3 and EG-4), or pumping cooling water to the suppression pool cooling heat exchanger (EG-5) in the event of a beyond-design-basis scenario that required these components. Based on licensee testing that confirmed the margins in the FLEX diesel generator sizing calculations, the NRC confirmed that EG-1 and EG-2 would still have been capable of performing their beyond-design-basis function of providing backup power for the station battery chargers and other FLEX loads.

From May 18-22, 2020, the NRC performed a special inspection at River Bend. The inspection report is available at ADAMS Accession No. ML20240A258.

<u>Clinton Power Station</u>

On July 11, 2019, the licensee at Clinton Power Station (Clinton) discovered that the electrical phase rotation of the "A" FLEX diesel generator was opposite to that of the load center for its in-plant loads. If the facility had used the "A" FLEX diesel generator to power any in-plant equipment, it would have caused phase-dependent loads to rotate backwards, potentially

damaging in-plant safety-related equipment. The licensee took corrective action to change the "A" FLEX diesel generator output wiring so that its phase rotation matched the load center. The licensee also performed phase rotation checks on the "B" FLEX diesel generator, which is the alternate power supply in the licensee's FLEX strategy. The phase rotation of the "B" FLEX diesel generator was correct. The "A" FLEX diesel generator is permanently installed in the plant, and the "B" FLEX diesel generator is staged in the FLEX equipment building. In the event of a failure of the "A" FLEX diesel generator, the licensee would have deployed the "B" FLEX diesel generator to power the in-plant loads.

The NRC included this issue in a quarterly baseline inspection report which is available at ADAMS Accession No. ML20132A319.

DISCUSSION

In response to the Fukushima Dai-ichi accident in Japan in March 2011, the NRC issued Order EA-12-049 to all power reactor licensees in March 2012. The order requires a three-phase approach for mitigating beyond-design-basis external events. It requires licensees to have installed plant equipment and resources (Phase 1) and portable onsite equipment and consumables (Phase 2) to maintain or restore core cooling, containment cooling, and spent fuel pool cooling capabilities until resources can be brought in from off site (Phase 3) to mitigate a beyond-design-basis external event. The order requires licensees to develop strategies to maintain these functions if there is an extended loss of all alternating current power and loss of normal access to the ultimate heat sink.

In August 2012, the Nuclear Energy Institute (NEI) issued NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," which is endorsed by the NRC and provides industry guidance on a methodology that licensees may use to meet the requirements of Order EA-12-049. The guidance and subsequent NRC-endorsed revisions contain information on the development of site-specific strategies, and on the storage, procedures, maintenance, testing, and training for FLEX equipment. The licensees at River Bend and Clinton each described how they follow the guidance in NEI 12-06 in a final integrated plan submitted to the NRC.

Section 11 of the NEI 12-06 guidance allows licensees to procure FLEX equipment as commercial grade equipment and outlines standards for design, storage, maintenance, testing, and configuration control. As such, the equipment associated with FLEX strategies is generally not required to be procured, tested, or otherwise maintained in accordance with the quality requirements of 10 CFR Part 50. The events at River Bend and Clinton demonstrate that it is important for licensees to ensure that design characteristics, maintenance, testing, and modifications that could impact the ability of FLEX equipment to perform when needed are maintained in a consistent and up-to-date manner. As commercial grade equipment, FLEX diesel generators come equipped with components and setpoints intended to protect the engine. These components can fail and cause false trip signals, and factory setpoints can result in unintended trip signals that prevent the diesel generators from fulfilling their design function. A false trip signal caused the EG-1 and EG-2 failures at River Bend in October 2019, and factory setpoints on the generator output breaker caused EG-5 to trip in April 2020.

NEI 12-06 Section 11.5 states that the licensee's maintenance program should ensure that FLEX equipment reliability is being achieved, and that testing of FLEX equipment should be done to verify the design requirements and/or basis. Design, maintenance, and testing practices contributed to the FLEX diesel generator performance challenges at River Bend. Initial acceptance and post-maintenance testing of the FLEX diesel generators was performed

by the vendor using step/resistive loading instead of the actual instantaneous loading that would be experienced during a beyond-design-basis external event. When EG-5 was tested under realistic loading conditions in April 2020, it failed because the previous testing had not considered the impact of instantaneous loading on trip setpoints.

In January 2019, the FLEX diesel generator vendor replaced the digital controllers on EG-1 through EG-5 at River Bend. This was done under a commercial-grade process, and licensee's oversight of these functions by the vendor was not appropriately controlled. The change impacted the operation of the diesel generator coolant temperature switches, which caused EG-1 and EG-2 to trip on high coolant temperature during subsequent testing runs in October 2019. The vendor-recommended post-installation testing was not adequate because the licensee failed to identify and document critical FLEX diesel generator characteristics and ensure that changes were properly implemented, verified, and incorporated into site documentation.

The guidance in NEI 12-06 states that any deviations from vendor recommendations for periodic testing and maintenance should be justified. At River Bend, the vendor recommended performing load testing every 2 weeks for EG-1 and EG-2, and monthly for EG-3, EG-4 and EG-5. Because the vendor recommendations are based on continual use of equipment and not for equipment in standby use, the licensee based its preventive maintenance frequency on generic Electric Power Research Institute guidance and ran the diesel generators every six months. However, the licensee did not document its justification for deviating from the vendor-recommended testing periodicity. Following the operational challenges at River Bend in September 2019, the NRC noted that the licensee's causal analysis cited the 6-month testing periodicity as a possible contributor to the failures of the diesel generators to remain running after initial start.

At Clinton, the phase rotation check, which was identified as a critical parameter in the engineering change document, was not translated into a work instruction when performing initial testing on the "A" FLEX diesel generator. As a result, the licensee did not identify the incorrect phase rotation during original installation. When NRC inspectors questioned the phase rotation during the post-compliance inspection, the licensee created an action request to follow up on the question. The action request was not properly evaluated and resolved by the licensee, which thus missed a second opportunity to correct the phase rotation.

In addition to meeting the requirements of EA-12-049, many licensees also use onsite FLEX equipment to mitigate the risk related to taking safety-related systems out of service and to reduce the plant's overall risk profile. Examples include license amendment requests to increase the allowed outage times of safety-related equipment, requests for enforcement discretion, and modifications to plant probabilistic risk assessment models. While FLEX equipment may be used to reduce risk and allow increased operational flexibility, it is also important to note that FLEX equipment should be reliable if it is to be credited for use as a backup for any safety-related structures, systems, or components.

CONTACTS

Please direct any questions about this matter to the technical contacts listed below.

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Note: NRC generic communications may be found on the NRC public Web site, https://www.nrc.gov, under “NRC Library,” “Document Collections.”

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