OPERATING EXPERIENCE SMART SAMPLE (OpESS) 2020/01

FLEX EQUIPMENT DESIGN CONTROL, MAINTENANCE, AND TESTING

CORNERSTONE: MITIGATING SYSTEMS

APPLICABILITY

- This voluntary OpESS applies to all licensed operating commercial nuclear reactors.
- This OpESS supplements sample selection for Inspection Procedures (IP) 71111.12, 71111.13, 71111.18, 71111.19, 71111.21M, 71111.22, and 71152.

OpESS 2020/01-01 OBJECTIVES

01.01 Provide support for baseline inspection activities in the areas of Diverse and Flexible Coping Strategies (FLEX) equipment design, maintenance, and testing.

01.02 Provide examples of FLEX equipment that has been challenged in the ability to provide FLEX functions and ensure the ability to implement FLEX strategies is maintained.

OpESS 2020/01-02 BACKGROUND

02.01 FLEX Implementation.

After the events at Fukushima, the NRC ordered every U.S. commercial reactor to develop mitigation strategies for dealing with the long-term loss of normal safety systems following the occurrence of a beyond-design-basis external event (NRC Order EA-12-049, ML12054A735). FLEX increases defense-in-depth for beyond-design-basis scenarios to address loss of power and loss of the ultimate heat sink occurring simultaneously at all units on a site.

Implementation guidance for FLEX is found in Nuclear Energy Institute (NEI) 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” and endorsed via Japan Lessons Learned Project Directorate Interim Staff Guidance (JLD-ISG) 2012-01, “Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events.” Various revisions are in effect. NEI 12-06, Revision 0 (ML12242A378) is endorsed via JLD-ISG 2012-01, Revision 0 (ML12229A174). NEI 12-06, Revision 2 (ML15348A015) is endorsed via JLD-ISG 2012-01, Revision 1. NEI 12-06, Revision 4 (ML16354B421) is endorsed via JLD-ISG 2012-01, Revision 2.

The NRC completed rulemaking for 10 CFR 50.155, “Mitigation of Beyond-Design-Basis Events,” that codified the requirements of Order EA-12-049. The final rule was published in the *Federal Register* on August 9, 2019 (84 FR 39684), with an effective implementation date of September 9, 2019. Regulatory Guide 1.226, Revision 0, “Flexible Mitigation Strategies for

Beyond-Design-Basis Events" (ML19058A012), endorses NEI 12-06, Revision 4, with clarifications, as a process that the NRC considers acceptable for meeting, in part, the regulations in 10 CFR 50.155.

02.02 Operating Experience.

Temporary Inspection procedure (TI) 2515/191 verified each licensee's implementation of the mitigation strategies as described in their Final Integrated Plan and the NRC's plant safety evaluation as required by Order EA-12-049. FLEX inspection activities have been integrated into the Reactor Oversight Process (ROP) baseline inspection, including IP 71111.22, "Surveillance Testing," which requires selection of at least one FLEX equipment sample per year.

These inspection activities have identified licensee issues with establishing and maintaining the design control, maintenance, and testing of FLEX equipment to ensure that the capability to provide FLEX functions and the ability to implement FLEX strategies. In some cases, these licensee issues were identified during infrequently performed tests.

Examples of licensee performance issues include:

River Bend Station, September 2019

On September 26, 2019, River Bend Station attempted to run FLEX diesel generator 5 (EG-5) as part of planned surveillance testing for FLEX pump P-1. During this test, EG-5 failed to continue running beyond a few seconds after starting. The FLEX diesel vendor arrived onsite in late October to troubleshoot EG-5. During troubleshooting the vendor found that the engine tripped on overvoltage, and they were able to get EG-5 to start and continue to run after one additional attempt. River Bend Station also attempted to run four additional FLEX EGs (EG-1, 2, 3, and 4) while the vendor was onsite. The licensee experienced operational issues with all four EGs such as high coolant temperature trips and engine overspeed conditions. None of the EGs were able to be operated without vendor troubleshooting, adjustments, and/or repairs. While the vendor was able to get EG-3 and EG-4 to run properly after a few starts, EG-1 and EG-2 required additional troubleshooting by the vendor, and they would not have been able to fulfill their beyond-design-basis function of providing power to the station battery chargers in the event of an extended loss of AC power (ELAP).

The inspectors identified a Green non-cited violation of NRC Order EA-12-049 for the licensee's failure to maintain strategies to restore and maintain core cooling and containment cooling capabilities following a beyond-design-basis external event. Specifically, the licensee failed to maintain the FLEX program elements such that both EG-1 and EG-2, the primary and backup (N and N+1) FLEX EGs required for the ELAP response strategy were nonfunctional for an extended period of time. Licensee performance issues included:

- A missed opportunity to identify a new failure mode when digital control panels were replaced on all five EGs. The digital control panels were not replaced with a like-for-like panel by the licensee's vendor and found not to be suitable for the requirements of the FLEX program. Since FLEX equipment is typically commercial grade equipment, the licensee's process did not require thorough engineering evaluations and a formal engineering change was not completed.
- A failure of installed equipment to maintain engine block temperatures warm enough to allow the EG to start properly on the first attempt. A possible contributor was that the

preventative maintenance frequency was based on generic vendor guidelines rather than specific vendor recommendations for the EGs the licensee actually procured. The vendor recommended running River Bend's FLEX EGs every 2-4 weeks, but the licensee was only testing them every 3-6 months.

The results of the inspection can be viewed in Inspection Report (IR) 05000458/2019015 (ML20106F203).

River Bend Station, April 2020

On April 1, 2020, plant operators at River Bend Station again attempted to perform periodic testing of FLEX pump P-1, powered by EG-5. Operators were to start EG-5 and connect it to the uncoupled motor for FLEX pump P-1. The licensee started EG-5, but the generator tripped on an undervoltage condition following closure of the pump disconnect switch. Following replacement of the diesel generator voltage regulator and fuel pump by the vendor, the licensee once again attempted the test on April 16, 2020. Again, EG-5 tripped on an undervoltage condition. Troubleshooting by the licensee revealed that the trip was caused by an incorrect configuration of the EG-5 output breaker time delay setpoints. 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 setpoints 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 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.

The NRC performed a special inspection at River Bend from May 18-22, 2020. The results of this inspection can be viewed in IR 05000438/2020050 (ML20240A258).

Clinton Power Station, July 2019

In July 2019, Clinton Power Station performed phase rotation checks on the 'A' FLEX diesel generator. The phase rotation checks identified that the connections on the FLEX diesel generator and the connections to in-plant equipment were reversed. If the FLEX diesel was connected to in-plant equipment, then it would cause phase-dependent loads to rotate backwards and had the potential to damage in-plant safety-related equipment. The inspectors identified a Green finding for the licensee's failure to verify that the 'A' FLEX diesel generator phase rotation was appropriate. The results of this inspection can be viewed in IR 05000461/2020001 (ML20132A319).

Summary

The examples of FLEX equipment above are provided to support inspectors conducting baseline inspection activities in the areas of FLEX equipment design, maintenance, and testing. In addition to meeting the requirements of their mitigating strategies, many licensees are also using their onsite FLEX equipment to mitigate risk related to out of service safety-related systems, to risk inform security applications such as target sets, or to reduce the plant's overall risk profile. 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.

OpESS 2020/01-03 INSPECTION GUIDANCE

The following inspection guidance may be applied as appropriate to support baseline inspection activities. Inspector judgment should be used when determining the extent to which this OpESS should be used to inform inspection activities under the applicable baseline IPs.

03.01 General.

If available, collect the following plant-specific information related to FLEX equipment (installed or staged) which directly performs a key mitigating strategy for core cooling, containment, or spent fuel pool cooling capabilities in a beyond-design-basis external event, as applicable. The data should be appropriately labeled (i.e., Official Use Only and Proprietary Information) and provided to NRR/DRO/IOEB.

a. What changes/revisions have been made to the licensee's FLEX program document or Final Integrated Plan since the issuance of the NRC safety evaluation?
    1. Verify the engineering basis for these changes is documented and ensure that the change in FLEX strategy continues to ensure the key safety functions are met (NEI 12-06, Section 11.8).

b. Does the licensee credit FLEX equipment in their probabilistic risk assessment (PRA)? What is the PRA risk significance (e.g., Birnbaum importance measure) of the FLEX equipment?
    1. If so, how does the licensee determine their FLEX equipment reliability values?
    2. If so, how does the licensee determine their FLEX human reliability values?

03.02 Maintenance Effectiveness, Post Maintenance Testing, and Surveillance Testing.

The recommended inspection activity described below supports IP 71111.12, "Maintenance Effectiveness," IP 71111.19, "Post Maintenance Testing," and IP 71111.22, "Surveillance Testing."

a. Does FLEX equipment maintenance and testing follow the guidance provided in the industry's Equipment Reliability Process (e.g., Institute of Nuclear Power Operations' (INPO's) AP 913, *Equipment Reliability Process Description*, or an acceptable alternative) to verify proper function? (NEI 12-06, Section 11.5)
    1. Review testing conditions for the FLEX equipment to ensure the conditions are similar to how they will be used per their mitigating strategies. Verify that tests are properly challenging the critical function.

2. Verify test procedures include or reference test objectives, test requirements, applicable prerequisites, and acceptance criteria contained in the applicable technical documents.
3. For FLEX generators, review how it has been shown that required loads can be supported.
    (a) Verify the licensee is demonstrating the ability to start and run the loads each generator is supposed to support.
    (b) Review testing conditions for FLEX generators. If load testing is completed using a load bank, does it adequately simulate the starting loads of motors (or other inductive loads) that will be powered by the generator to ensure FLEX functions per their mitigating strategies is met?
4. For rotating equipment (generators, motors, pumps, etc.), how is the proper rotation verified?
    (a) Review how the phase rotation of rotating FLEX equipment and any supported equipment is tested (includes installed and moveable FLEX equipment). Verify that the appropriate phase rotation is confirmed by procedure prior to use. If not, can it be easily identified and corrected by operators in the field and do the procedures provide instructions to correct the rotation?
    (b) Self-powered pumps: Review test procedures to determine how proper rotation is verified during testing. Verify that the appropriate rotation is confirmed prior to use. If not, can it be easily identified and corrected by operators in the field and do the procedures provide instructions to correct the rotation?
    (c) Electrically driven pumps: Review testing conditions, such as testing with the same power source that will be used to support the mitigation strategies. Verify that the appropriate rotation is confirmed by procedure prior to use. If not, can it be easily identified and corrected by operators in the field and do the procedures provide instructions to correct the rotation?

b. What guidance does the licensee follow for scheduling FLEX preventive maintenance (e.g., EPRI guidance or vendor-recommended guidance)? (NEI 12-06, Section 11.5)
    1. Review that maintenance and testing frequency is determined based on equipment type and expected use.
    2. Verify deviations from EPRI guidance or vendor recommendations have received a technical justification. Verify whether the assumptions in the justification remain valid.

c. If preventive maintenance and/or testing is performed by a licensee's vendor, how is the licensee providing oversight of the vendor? (NEI 12-06, Section 11.5)
    1. Verify that any applicable administrative or regulatory requirements are specified in procurement documents/vendor contracts/work orders and comply with the FLEX equipment functions.

d. How does the licensee ensure personnel relied upon to operate FLEX equipment are familiar with equipment operations? (NEI 12-06, Section 11.6)
    1. Verify personnel relied upon to operate FLEX equipment have been trained in accordance with the capabilities required for the mitigating strategies.

03.03 Maintenance Risk Assessments and Emergent Work Control.

The recommended inspection activity described below supports IP 71111.13, “Maintenance Risk Assessments and Emergent Work Control.”

a. How has the licensee used FLEX equipment for applications other than beyond-design-basis strategies, such as compensatory actions, risk reduction for maintenance or outage activities, or Technical Specification Allowed Outage Time extensions?

b. If the licensee has a risk-informed completion time program, has FLEX equipment been credited to extend a risk-informed completion time?

c. Does FLEX equipment maintenance and testing follow the guidance provided in the industry’s Equipment Reliability Process (e.g., Institute of Nuclear Power Operations’ (INPO’s) AP 913, *Equipment Reliability Process Description*, or an acceptable alternative) to verify proper function? (NEI 12-06, Section 11.5)
    1. Review testing conditions for the FLEX equipment to ensure the conditions are similar to how they will be used per their mitigating strategies. Verify that tests are properly challenging the critical function.
    2. Verify test procedures include or reference test objectives, test requirements, applicable prerequisites, and acceptance criteria contained in the applicable technical documents.

d. If preventive maintenance and/or testing is performed by a licensee’s vendor, how is the licensee providing oversight of the vendor? (NEI 12-06, Section 11.5)
    1. Verify that any applicable administrative or regulatory requirements are specified in procurement documents/vendor contracts/work orders and comply with the FLEX equipment functions.

e. Has the FLEX equipment undergone any changes/modifications? (NEI 12-06, Section 11.2)
    1. Verify that changes/modifications made to FLEX equipment do not introduce potential new failure modes or inadvertently impact critical functions in the mitigating strategies.
    2. Verify any post-modification tests properly challenge the critical function.

03.04 Plant Modifications.

The recommended inspection activity described below supports IP 71111.18, “Plant Modifications.”

a. How does the licensee control changes/modifications to FLEX equipment such that the equipment will continue to perform as intended? (NEI 12-06, Section 11.2)
    1. Ensure that the licensee has design requirements (such as inputs and assumptions) and supporting analysis for FLEX equipment.
    2. Verify that changes/modifications made to FLEX equipment do not introduce potential new failure modes or inadvertently impact critical functions in the mitigating strategies.
    3. Verify any post-modification tests properly challenge the critical function.
    4. Review modification for impact on plant operations, such as procedure changes or changes to operator training.

b. If modifications are performed by the licensee's vendor, how does the licensee provide oversight of the vendor for the modifications? (NEI 12-06, Section 11.5)
    1. Verify that any applicable administrative or regulatory requirements are specified in procurement documents/vendor contracts/work orders and comply with the FLEX equipment functions.
    2. Review the procurement documents/vendor contracts/work orders to see if specific post-modification testing requirements are provided. Ensure any post-modification tests properly challenge the critical function.

03.05 Problem Identification and Resolution and Design Bases Assurance Inspection (Teams).

The recommended inspection activity described below supports IP 71152, "Problem Identification and Resolution," and IP 71111.21M, "Design Bases Assurance Inspection (Teams)," as applicable.

a. For selected items related to FLEX in the Corrective Action Program (CAP), assess the following items.
    1. Verify conditions or deficiencies affecting FLEX equipment are identified, documented, and adequately assessed per licensee procedures.
    2. Verify any corrective actions are taken in a timely manner per licensee procedures.
    3. Verify that for conditions affecting FLEX equipment, the extent of condition is reviewed when applicable.
    4. Verify the licensee has appropriately tracked out of service time for non-functional FLEX equipment (NEI 12-06, Section 11.5).

b. For operating experience reviews of items related to FLEX equipment and/or mitigating strategies, assess the following items.
    1. Verify that conditions discussed in the operating experience either are not applicable or have been adequately addressed by the licensee to ensure FLEX equipment functions are maintained.
    2. Verify any corrective actions are taken in a timely manner per licensee procedures.
    3. Verify that for conditions affecting FLEX equipment, the extent of condition is reviewed when applicable.

OpESS 2020/01-04 REFERENCES

These references may include pre-decisional information contained on NRC internal websites. Once the agency has formally evaluated an OpE issue and has determined that it meets the criteria for agency action, the NRC communicates the issue to the public and the industry through one or more appropriate methods (e.g., generic communication, rulemaking public comment periods, etc.).

04.01 Inspection Manual Chapters and Procedures.

IP 71111.12, "Maintenance Effectiveness"

IP 71111.13, “Maintenance Risk Assessments and Emergent Work Control”

IP 71111.18, “Plant Modifications.”

IP 71111.19, “Post Maintenance Testing”

IP 71111.21M, “Design Bases Assurance Inspection (Teams)”

IP 71111.22, “Surveillance Testing”

IP 71152, “Program Identification and Resolution”

04.02 Correspondence.

Information Notice 2020-02, “FLEX Diesel Generator Operational Challenges,” (ML20196L822)

Regulatory Guide 1.226, Rev. 0, “Flexible Mitigation Strategies for Beyond-Design-Basis Events,” (ML19058A012)

OpESS 2020/01-05 REPORTING RESULTS/TIME CHARGES/ADDITIONAL ISSUES

If information from this OpESS is used to inform a baseline inspection sample, reference the OpESS number in the scope section of the report. In addition, if any findings or violations are identified in conjunction with this OpESS, include a statement similar to the following in the description section of the finding write-up:

“This finding was identified in connection with a review of Operating Experience Smart Sample (OpESS) 2020/01.”

Inspection time for this OpESS is to be charged to the normal baseline procedure under which it is being used and the level of effort is expected to be within normal baseline inspection sample resource estimates.

OpESS 2020/01-06 CONTACTS

For technical support regarding the performance of this OpESS and emergent issues, contact: Michael Montecalvo (NRR/DRA/APOB) at 301-415-1678 or Michael.Montecalvo@nrc.gov, or Julie Winslow (NRR/DRO/IOEB) at 301-415-0593 or Julie.Winslow@nrc.gov.

Revision History for OpESS 2020/01

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment Resolution and Closed Feedback Form Accession Number (Pre-Decisional, Non-Public Information)
N/A	ML20220A261 10/21/20 CN 20-053	Initial issuance to provide support for initial baseline inspection activities.	N/A	ML20223A004