

August 28, 2013

MEMORANDUM TO: Stewart N. Bailey, Chief
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Office of Nuclear Reactor Regulation

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FROM: Jack R. Davis, Director */ra/*
Mitigating Strategies Directorate
Office of Nuclear Reactor Regulation

SUBJECT: SUPPLEMENTAL STAFF GUIDANCE FOR ADDRESSING
ORDER EA-12-049 ON MITIGATION STRATEGIES FOR
BEYOND-DESIGN-BASIS EXTERNAL EVENTS

Attached is the current version of the supplemental staff guidance for use by your staff to assist in addressing Order EA-12-049. As NRC staff only rarely reviews documents associated with beyond-design-basis events, this should assist in achieving the proper level of review. The Mitigating Strategies Projects Branch is assigned ownership to revise this document as decisions are made by the Mitigating Strategies management team.

Enclosure:
Supplemental Staff Guidance

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**SUPPLEMENTAL STAFF GUIDANCE FOR ADDRESSING ORDER EA-12-049 ON
MITIGATION STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS
August 27, 2013**

Purpose - The purpose of this attachment is to provide additional insights and guidance to the staff regarding the scope of the review of licensee responses to the Mitigation Strategies order.

The NRC is performing these evaluations, with contractor support, to provide the licensee and the public the status of the NRC's review of the licensees' mitigation strategies. The contractors are well qualified professionals allowing the NRC staff reviewers to concentrate on verifying that positions stated are consistent with NRC policy and technically accurate rather than performing full independent reviews of the plans. Full implementation of the order is required in 2016 and licensees are in the planning stages of their strategies. Licensees will still need to do a considerable amount of work in completing the strategies as well as in the areas of design, fabrication, procurement and training. It is not possible at this point to make a finding of compliance with the order. The NRC's interim staff evaluation will help the licensees gauge their progress for compliance with the order, and allow them to proceed with confidence in acquiring equipment for their FLEX strategies.

Requirements – The Mitigating Strategies Order EA-12-049 (Agencywide Access and Management System (ADAMS) Accession No. ML12054A735) can be thought of as setting forth a dual set of requirements, one set for the maintenance of core cooling, containment, and spent fuel pool (SFP) cooling capabilities and the other set for the restoration of those capabilities. This is addressed in the regulatory guidance for the order, Nuclear Energy Institute (NEI) NEI 12-06, Revision 0 (ADAMS Accession No. ML12242A378) as endorsed by Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01 (ADAMS Accession No. ML12229A174), in setting the objective of the guidance and strategies for maintaining the capabilities as being to establish an indefinite coping capability to prevent damage to the fuel in the reactor and SFPs and to maintain the containment function by using installed equipment, on-site portable equipment, and pre-staged off-site resources. This objective is accomplished through the development of the guidance and strategies relying on the initial conditions and assumptions included in NEI 12-06. If the capabilities addressed above cannot be maintained, the licensee will attempt to restore the capabilities, transitioning to severe accident management guidelines (SAMGs) if appropriate. The NRC staff should concentrate on the maintenance of the capabilities rather than the restoration. This is discussed further in the “Focus of the Review” section of this document.

NRC Finding - The NRC's objective in preparing the interim staff evaluations is to provide a finding to the licensee whether or not their submitted plan, if implemented as described and to the extent it is developed, provides a reasonable path for compliance with the order. The following terms may be used in the interim staff evaluation:

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Open Item: An item may be listed as open if the licensee has not presented a sufficient basis for issue resolution, or the NRC staff has rejected the basis that was presented. The intent behind designating an issue as an open item is to document significant items that need resolution during the review process rather than being verified through the inspection process. The determination of whether an issue should be designated as an open item will include considerations of aspects of the issue that would significantly impact the success of the mitigation strategies, such as the margin between the time in which a certain action must be accomplished and the time in which a licensee can reasonably take that required action. Designation as an open item would be appropriate where the time limitations would call into question the licensee's capability for timely action.

Confirmatory Item: An issue may be designated as a confirmatory item if the NRC staff finds the licensee's basis for resolution incomplete, but determines that the item is not significant enough to require closure through the review process. Confirmatory items can include issues of an operational nature, such as writing procedures or completing plant modifications. The NRC may verify completion of select confirmatory items, on a sampling basis, through on-site audits or inspections.

The staff conclusion in the interim staff evaluation will be similar to the following, if the licensee's submittals are satisfactory:

In response to Order EA-12-049, the licensee is developing strategies and guidance for additional defense-in-depth measures to supplement the capabilities of permanently-installed plant structures, systems, and components that could become unavailable following a beyond-design-basis event. [Reference licensee submittals, NEI-12-06 endorsed by ISG, and pertinent generic issue endorsements.]

The NRC's objective in preparing the interim staff evaluations is to provide a finding to the licensee on whether or not their submitted plan, if implemented as described and to the extent it is developed, provides a reasonable path for compliance with the order. For areas where the NRC staff has insufficient information to make this finding (identified above as Open Items), the staff will review these areas as they become available or address them as part of the inspection process. The staff notes that the licensee has the ability to modify their plans as stated in NEI 12-06, Section 11.8.

The NRC staff has reviewed the licensee's plans for additional defense-in-depth measures. The staff finds that the proposed measures, properly implemented, will provide reasonable assurance of adequate protection of public health and safety in mitigating the consequences of a beyond-design-basis external event that impacts offsite power and ultimate heat sink. The staff will verify proper implementation of the proposed measures via the inspection process.

Focus of the Review – The focus of the staff’s analytical review should be on the feasibility of the mitigation strategies for complying with the first set of requirements of Order EA-12-049, maintenance of core cooling, containment, and SFP cooling capabilities. This review will be limited by the initial conditions and assumptions laid out in the regulatory guidance and discussed herein, or as defined by the licensee if deviations from the guidance were made. The review of the remaining set of requirements, restoration of the capabilities, will be from an operational perspective, rather than an analytical review of the restoration strategies (i.e., has the licensee addressed the considerations and interfaces for the strategy, and can the strategy be reasonably implemented?). The staff is expected to use considerable engineering judgment and reliance upon existing knowledge and expertise in determining the acceptability of the mitigation strategies. The review is expected to be substantially different from the review of design basis accidents, wherein acceptability is often based on endorsement of deterministic engineering codes and standards or compliance with existing staff positions for design basis accidents.

Licensees will have proposed rather basic fluid systems for some of the mitigation strategies. A detailed NRC review of the fluid systems is not necessary. Rather, the review should focus on unique aspects of the design, and relevant interfaces with existing plant systems that are necessary to ensure success. Best estimate analyses may be used, as well as allowing the use of operator actions using non-safety-related equipment. Operator actions already proceduralized in existing emergency operating procedures (EOPs) or SAMGs do not require re-review, except to the extent that the equipment expected to be utilized will be available under the proposed conditions. We are requesting that the licensees make the EOP for loss of all ac power available in the e-portals. If additional plant procedures are needed, please have your branch chief request that the Mitigating Strategies Projects Branch have them added to the e-portals. The reviewer should confirm that the licensee committed to develop new procedures as necessary for their mitigation strategies, but a review of the strategy licensees propose is sufficient, rather than a review of the detailed procedures. We will refer to these new procedures as FLEX Support Guidelines (FSGs), following the nomenclature of NEI 12-06.

Definition of the Initiating Event – While the initiating event is undefined, it results in an extended loss of all ac power (ELAP) with loss of normal access to the ultimate heat sink (LUHS), which should be considered a surrogate for a beyond-design-basis external event. The initial conditions and assumptions for the analyses to be reviewed by the staff are laid out in NEI 12-06, and include the following:

1. The reactor is assumed to have safely shutdown with all rods inserted (subcritical).
2. The dc power supplied by the plant batteries is initially available, as is the ac power from inverters supplied by those batteries; however, over time the batteries may be depleted.
3. There is no core damage initially.
4. There is no assumption of any concurrent event.

5. Because the loss of all ac power presupposes random failures of safety-related equipment (emergency power sources), there is no requirement to consider further random failures.
6. Although the order requires a mitigation strategy for all modes of plant operation, the reviewer should concentrate on the response with initial operation at 100% power, since plants are in this mode about 92% of the time and decay heat is highest in this mode. While other modes and configurations can be more limiting, these modes and configurations are addressed by licensees pre-planning responses prior to entering those configurations. For example, prior to entering mid-loop operations licensees ensure that vital equipment is functional, the operators are briefed and additional management oversight is provided. These will be overseen through the reactor oversight process rather than at this integrated plan review stage.

Kickout Clause – The staff should keep in mind that the intent of the order was for licensees to provide substantial additional equipment and supplies on site to support development of robust mitigation strategies. While licensees will make use of existing plant equipment and utilize best estimate analysis, the intent of the order was not to analyze the issues away. Rather, significant improvements in the capability of plants to respond to beyond-design-basis accidents are anticipated. The staff should quickly elevate to management any issues wherein it appears that licensees may have preferentially attempted to "analyze away" issues rather than providing needed plant improvements, or where licensees are proposing mitigation strategies that seem counter to traditional notions of reactor safety.

Phases of the ELAP Response

- Phase 1 – the initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment, and SFP cooling capabilities.
- Phase 2 – The transition phase requires providing sufficient portable onsite equipment to maintain or restore these functions until resources can be brought from off site.
- Phase 3 – The final phase requires obtaining sufficient offsite resources to sustain these functions indefinitely.

Considerations for Maintenance of Containment Capabilities

- Heat removal: For Pressurized-Water Reactors (PWRs), generally the removal of core decay heat will be accomplished using the SGs and the turbine-driven auxiliary feedwater (TDAFW) pump, and there will be a long time, well into Phase 2 or Phase 3, before the containment heats up enough to require cooling of the containment. For Boiling Water Reactors (BWRs), generally the removal of core decay heat will be accomplished by Reactor Core Isolation Cooling (RCIC) (only Oyster Creek, Nine Mile 1, and Dresden 2 and 3 have isolation condensers). Using RCIC, the core decay heat is vented to the suppression pool, which heats up. Containment venting may be required for decay heat removal purposes when the suppression pool reaches the boiling point. There may be reasons to vent earlier than when the suppression pool reaches this point, but such situations should be handled as part of the generic concern on anticipatory venting (discussed below).
- BWR Mark I and Mark II Anticipatory Venting: This is a generic concern. If a licensee proposes anticipatory venting, note it in the Audit Questions.
- BWR Suppression Pool Cooling Strategies:
 - Several BWRs, including Mark IIIs, propose to “feed and bleed” the suppression pool to assist in the removal of core decay heat. Staff will review these strategies using the following guidance:
 - (1) Recognize that this is unisolating the containment and providing a potential path for fission product release to the environment.
 - (2) There should be a method to isolate the bleed path and restore containment integrity.
- Isolation: There should be methods for isolating the containment. Generally, the containment isolation actions will be accomplished in the current EOP for loss of all ac power.
- Combustible gas control: For BWR Mark III and PWR Ice Condenser containments that are not inerted, there should be a method of providing backup power to the hydrogen igniters. Large dry containments are not required to have combustible gas control equipment. BWR Mark I and II containments are inerted with nitrogen, but the effectiveness may be reduced if venting of the containment is used for decay heat removal.

Considerations for Maintenance of Spent Fuel Pool Cooling – Due to the ELAP event, normal cooling to the SFP is lost. Generally the licensees will allow the SFP to boil to remove decay heat, and will provide makeup water to replace the water lost. The reviewer should verify that the fuel will remain covered by water, using the maximum design heat load or other heat load that may be justifiable. The reviewer should ensure that the licensee considers the effect of the condensation from the boil-off, and provide a vent path or determine there is no effect on safety functions from the condensation.

Analyses Demonstrating Available Times – The most critical time is the time at which transition from Phase 1 to Phase 2 is necessary. The technical reviewers should review the licensees' determination of that time. Generally it will be affected by the need to refill the isolation condenser, or by the length of time that RCIC or the TDAFW can supply cooling water. If there is substantial margin from when the Phase 2 equipment can be functional compared to when the Phase 1 equipment is no longer functional, then a less detailed review will suffice.

Specific Review Areas – The attached table discusses various traditional review areas that the NRC staff encounters in overseeing nuclear power plants. Some general guidance is provided in this table with regard to how these traditional review areas should be considered in addressing consideration of the mitigation strategies to address these beyond-design-basis events. This table is not inclusive of all NRC review areas; rather, it is illustrative of various issues and how those issues are to be considered. In addressing review areas not listed on the table, the staff should develop positions that are in line with the overall philosophy for addressing beyond-design-basis accidents.

Review Area	Scope	Discussion
Quality Assurance – Part 50, Appendix B	Appendix B does not apply to portable equipment used to address beyond-design-basis events.	Existing equipment retains its quality classification based on its current function in the plant. Quality attributes of equipment are documented in NEI 12-06, Section 11. If the licensee uses abandoned plant equipment, such as piping, for mitigating strategies functions, that abandoned equipment should conform to the quality attributes of NEI 12-06.
Cascading Events and Failures	The event is limited to the ELAP and LUHS, and any resulting failures from this (called consequential failures, e.g., battery depletion leading to loss of RCIC, or suppression pool heatup leading to loss of RCIC, or reactor coolant pump (RCP) seal leakage leading to loss of reactor coolant system (RCS) inventory). Cascading events such as a loss-of-coolant accident are not within the scope. Traditional single failure criteria are not applied.	Because the event leading to an ELAP includes prior single failures of safety-related equipment (i.e., emergency power sources), it is inappropriate to postulate additional random failures. This may limit the scope of review of analyses supporting the maintenance of core cooling where a licensee discusses reliance on a safety-related structure, system, or component (SSC), such as RCIC, but includes discussion of the use of a different SSC, such as high pressure coolant injection (HPCI) as a backup in the event RCIC fails or is unavailable. The backup functionality would be considered responsive to the “restore” branch of compliance and not require analytical support due to the undefined time and mode of failure of the first SSC.
ASME and IEEE codes and standards	Utilization of typical codes and standards for assessment of beyond-design-basis accidents is not required.	If a licensee utilizes such codes and standards, any acceptance criteria within the codes and standards associated with short-term conditions or ultimate strength of materials is permitted, but not required.

Review Area	Scope	Discussion
External events such as seismic, tornados, flooding	The ELAP is not attributed to any particular event. As such, the design of mitigation strategies does not need to address any specific internal or external event.	NEI 12-06 does require addressing how the storage and deployment of portable equipment can be successful following conditions such as seismic events, flooding, high winds, and extreme temperatures.
Reactor Criticality	For the ELAP, the reactor is assumed to have all rods inserted at the beginning of the transient. The buildup of negative reactivity from xenon can be credited.	There is not expected to be any need to review reactor criticality issues as long as the current loss of all ac power procedures are followed. The expectation is that the operators will follow the existing EOPs for loss of all ac. The most likely change is that when the procedure progresses to a point of “response not obtained” for a step requiring restoration of ac power, and it is clear that ac power will not be recovered, the EOP will direct the operators to follow the FSGs while continuing in the EOPs. At least one source range nuclear instrument should remain operating in order to check for signs of criticality.
Boron mixing	For PWRs, recriticality is possible at low temperatures if there is no boron addition. Therefore, some capability of boron addition is required. The mixing following addition is a generic concern.	Mixing of the boron is difficult to model while on natural circulation cooling.

Review Area	Scope	Discussion
Core Cooling	The ELAP event is a beyond-design-basis event, but does not proceed to core damage. As such, the core configuration is assumed to remain in a coolable configuration throughout the event.	Analytical support for the strategies is only necessary for the portion of compliance related to maintenance of core cooling. Either a heat exchanger (e.g., a steam generator (SG) or isolation condenser (IC)) is used to cool the core, or water is supplied to the reactor vessel and allowed to boil off to remove decay heat. The amount of water supplied should be at least that listed in the NRC's Response Technical Manual, Rev 5, Section A, Method A.1. At least one channel of reactor vessel level should remain in operation.
Use of analytical code Modular Accident Analysis program (MAAP)	Some BWR licensees have used MAAP to provide the thermal-hydraulic analyses required by the order. The range of plant conditions that MAAP is capable of analyzing is being treated as a generic concern. If the licensee used MAAP, note that in the Audit Questions.	NRC is not sure of the capabilities of this code under ELAP conditions.
Use of analytical code CE Nuclear Transient Simulation program (CENTS)	Some PWR licensees have used CENTS to provide the thermal-hydraulic analyses required by the order. The range of plant conditions that CENTS is capable of analyzing is being treated as a generic concern. If the licensee used CENTS, note that in the Audit Questions.	WCAP-17601 section 4.1.2.2 discussed CENTS. CENTS is an NRC-approved code limited to single phase natural circulation cooling. One concern may be to determine when two phase natural circulation occurs as a limitation on CENTS results.
Battery duty cycles	IEEE standards support only 8 hour duty cycles for plant batteries. NEI will provide manufacturer's data and analyses indicating the capability for longer duty cycles.	
Reactor coolant pump seals	The pump seal leak rate greatly affects the outcome of the thermal-hydraulic analyses. This is being treated as a generic concern.	

Review Area	Scope	Discussion
Procedures	Plants are assumed to initially respond to the ELAP event using existing procedures. New guidance (FSGs) will be needed; however, the procedures to be developed are not on a level commensurate with procedures controlled under an Appendix B program. Rather, the FSGs to be developed should be done so under a program consistent with that for SAMGs and the extensive damage mitigation guidelines (EDMGs) developed for the EA-02-026, Section B.5.b, the subsequently imposed license conditions and 10 CFR 50.54(hh)(2).	NEI 12-06, Section 11.8 provides the guidance for configuration control of the mitigating strategies. This area will be verified during a site-specific implementation inspection following full compliance by the licensees.
Training of Plant Personnel	The licensee should commit to training that conforms to NEI 12-06.	NEI 12-06, Section 11.6 provides the guidance for training. This area will be verified during a site-specific implementation inspection following full compliance by the licensees.
Technical Specifications	No aspects of the mitigation strategies are expected to rise to the level of incorporation into technical specifications.	The mitigating strategies do not meet Criteria 1 through 4 of 10 CFR 50.36(c)(ii), which renders them inappropriate to include in technical specifications. Licensees will use standard configuration control processes as allowed by 10 CFR 50.59 for screening procedural guidance with regard to the effects on their licensing bases. See TIA 2004-04, ML060590273 , for a discussion of this issue.

Review Area	Scope	Discussion
Single Failure Criteria	Single failure criteria considerations do not apply to the ELAP event. In addition, at the beginning of the event, it is assumed that all plant equipment is available regardless of the allowance for such equipment to be inoperable in the plant Technical Specifications.	The NRC review of the compliance to EA-12-049 by maintaining the capabilities should be limited to the capability of the primary equipment. NEI 12-06 includes requirements for contingencies to address certain elements that will be reviewed; see, e.g., NEI 12-06, Section 3.2.2, guideline (13) for a requirement for portable pumps regardless of installed coping capability, and the inclusion in NEI 12-06, Appendices C and D, specifying a local manual initiation capability for emergency core cooling systems(ECCS).
Redundancy	No redundancy of equipment is required, although licensees may identify redundant equipment when available.	The NRC review of the compliance to EA-12-049 by maintaining the capabilities should be limited to the capability of the primary equipment. NEI 12-06 includes requirements for contingencies to address certain elements that will be reviewed; see, e.g., NEI 12-06, Section 3.2.2, guideline (13) for a requirement for portable pumps regardless of installed coping capability, and the inclusion in NEI 12-06, Appendices C and D, specifying a local manual initiation capability for ECCS.

Review Area	Scope	Discussion
Diversity	No diversity in meeting a safety function is required, although licensees may identify diverse methods when available.	The NRC review of the compliance to EA-12-049 by maintaining the capabilities should be limited to the capability of the primary equipment. NEI 12-06 includes requirements for contingencies to address certain elements that will be reviewed; see, e.g., NEI 12-06, Section 3.2.2, guideline (13) for a requirement for portable pumps regardless of installed coping capability, and the inclusion in NEI 12-06, Appendices C and D, specifying a local manual initiation capability for ECCS
Equipment Qualification	Equipment qualification as stated in 10 CFR 50.49 is not required for mitigation strategies equipment.	The ELAP event is a beyond-design-basis event; however, the event should not proceed to core damage. The mitigation strategies equipment or connection points for the mitigation strategies equipment is expected to be installed in the auxiliary building or reactor building. Given that the ELAP should not proceed to core damage, there is no elevated radiation field for the equipment to operate in and environmental pressures, temperatures, and humidity are that associated with the auxiliary or reactor building. If the heatup of these buildings approaches temperatures for which the instrumentation or equipment has been qualified, the reviewer should determine if the instrumentation or equipment is likely to remain functional.
Periodic Testing of Equipment	The licensee commits to testing of equipment that conforms to NEI 12-06, this will be confirmed by inspection.	NEI 12-06, Section 11.5 provides the guidelines for testing of equipment.

Review Area	Scope	Discussion
Maintenance of Equipment	The licensee commits to maintenance of equipment that conforms to NEI 12-06, this will be confirmed by inspection.	NEI 12-06, Section 11.5 provides the guidelines for maintenance of equipment.
Inventory of Equipment	The NRC expects that licenses will implement a periodic inventory of the FLEX equipment, similar to that for the B.5.b equipment.	
Instrumentation	Enough instrumentation to assess the critical safety functions should remain in operation following load shed.	
FSG Procedure Development	The licensee commits to developing FSGs that conform to NEI 12-06.	NEI 12-06, Section 11.4 provides the guidelines for developing and validating FSGs.
Staffing of Plant Personnel	The question of staffing levels will be addressed under Emergency Preparedness R9.3 in the 50.54(f) letter.	