ENCLOSURE

NON-CONCURRENCE 2016-018

ELECTRICAL NON-CONCURRENCE ON MITIGATION OF

BEYOND DESIGN-BASIS-EVENT RULEMAKING

NON-CONCURRENCE PROCESS
COVER PAGE

The U.S. Nuclear Regulatory Commission (NRC) strives to establish and maintain an environment that encourages all employees to promptly raise concerns and differing views without fear of reprisal and to promote methods for raising concerns that will enhance a strong safety culture and support the agency's mission.

Employees are expected to discuss their views and concerns with their immediate supervisors on a regular, ongoing basis. If informal discussions do not resolve concerns, employees have various mechanisms for expressing and having their concerns and differing views heard and considered by management.

Management Directive, MD 10.158, "NRC Non-Concurrence Process," describes the Non-Concurrence Process (NCP), http://nrcweb.nrc.gov:8600/policy/directives/catalog/md10.158.pdf.

The NCP allows employees to document their differing views and concerns early in the decision-making process, have them responded to (if requested), and attach them to proposed documents moving through the management approval chain to support the decision-making process.

NRC Form 757, "Non-Concurrence Process" is used to document the process.

Section A of the form includes the personal opinions, views, and concerns of a non-concurring NRC employee.

Section B of the form includes the personal opinions and views of the non-concurring employee's immediate supervisor.

Section C of the form includes the agency's evaluation of the concerns and the agency's final position and outcome.

NOTE: Content in Sections A and B reflects personal opinions and views and does not represent official factual representation of the issues, nor official rationale for the agency decision. Section C includes the agency's official position on the facts, issues, and rationale for the final decision.

At the end of the process, the non-concurring employee(s):

- ☐ Concurred
- ☑ Continued to non-concur
- ☐ Agreed with some of the changes to the subject document, but continued to non-concur
- ☐ Requested that the process be discontinued

    - ☐ The non-concurring employee(s) requested that the record be non-public.
    - ☑ The non-concurring employee(s) requested that the record be public.

- ☐ This record is non-public and for official use only.
- ☑ This record has been reviewed and approved for public dissemination.

NRC FORM 757
NRC MD 10.158
(07-2015)

U. S. NUCLEAR REGULATORY COMMISSION

NON-CONCURRENCE PROCESS

NCP TRACKING NUMBER: NCP-2016-018

SECTION A - TO BE COMPLETED BY NON-CONCURRING EMPLOYEE

TITLE OF SUBJECT DOCUMENT: Mitigation of Beyond-Design-Basis Events Rule (ML16292A026)	ADAMS ACCESSION NO.: ML16292A063, ML16291A186
DOCUMENT SIGNER: Bill Dean	SIGNER TELEPHONE NO.: 415-1270
TITLE: OFFICE DIRECTOR	ORGANIZATION: NRR
NAME OF NON-CONCURRING EMPLOYEE(S): Roy K. Mathew and Thomas Koshy	TELEPHONE NUMBER: 8324/2154
TITLE: Team Leader and Senior Electrical Engineer	ORGANIZATION: NRR/DE/EEEB; RES/DE/ICEEB

☐ DOCUMENT AUTHOR ☐ DOCUMENT CONTRIBUTOR ☐ DOCUMENT REVIEWER ☑ ON CONCURRENCE

NON-CONCURRING EMPLOYEE'S SUPERVISOR: Jake Zimmerman / Ian Jung

TITLE: Branch Chief	ORGANIZATION: NRR/DE/EEEB; RES/DE/ICEEB

☑ I WOULD LIKE MY NON-CONCURRENCE CONSIDERED AND WOULD LIKE A WRITTEN EVALUATION IN SECTION B AND C.

☐ I WOULD LIKE MY NON-CONCURRENCE CONSIDERED, BUT A WRITTEN EVALUATION IN SECTIONS B AND C IS NOT NECESSARY.

WHEN THE PROCESS IS COMPLETE, I WOULD LIKE THE NCP FORM: ☑ PUBLIC ☐ NON-PUBLIC

REASONS FOR THE NON-CONCURRENCE, POTENTIAL IMPACT ON MISSION, AND THE PROPOSED ALTERNATIVES
(use continuation pages or attach Word document)

See Attached

SIGNATURE: Roy Mathew / Thomas Koshy	DATE: 10/27/16

Use ADAMS Template NRC-006 (ML063120159)

REASONS FOR THE NON-CONCURRENCE, POTENTIAL IMPACT ON MISSION, AND THE PROPOSED ALTERNATIVES

Background:

The availability of alternating current (ac) and direct current (dc) electrical power is essential and critical for the safe operation and mitigation of consequences of an accident. Furthermore, ac and dc power is necessary to prevent severe accidents from occurring at commercial nuclear power plants (NPPs). This is evidenced from the events at Fukushima Dai-ichi plant in Japan where loss of ac and dc power led to core meltdown at three reactor units. Offsite power sources (preferred) normally supply this essential power from the electrical grid to the plant. The emergency power sources, typically onsite emergency diesel generators, supply the required power to the shutdown buses when offsite power sources are lost. The term "station blackout" (SBO) refers to the complete loss of ac electric power to the essential and nonessential switchgear buses in a nuclear power plant. SBO therefore involves the loss of offsite power (LOOP) concurrent with turbine trip and failure of the onsite emergency ac power system, but not the loss of available ac power to buses fed by station batteries through inverters or the loss of power from "alternate ac sources." For SBO, dc power is considered available due to the high reliability of battery systems. Because many safety systems required for reactor core decay heat removal and containment heat removal are dependent on ac power, the consequences of a SBO could be risk significant. In the event of a SBO, the capability to cool the reactor core is initially dependent on the availability of systems that do not require ac power from the essential and nonessential switchgear buses and recovery from SBO is dependent on the ability to restore ac power in a timely manner. Unavailability of ac and dc power can have a significant adverse impact on a plant's ability to achieve and maintain safe-shutdown conditions. In fact, risk analyses performed for NPPs indicate that the loss of all ac power can be a significant contributor to the risk associated with plant operation, contributing to more than 70 percent of the overall risk at some plants. Therefore, a LOOP and subsequent restoration of ac power are important inputs to plant risk models. These inputs must reflect current industry performance in order for plant risk models to accurately estimate the risk associated with LOOP initiated events and anticipated operational occurrences.

The SBO rule evolved from the results of several plant-specific probabilistic safety studies, operating experience, and reliability, accident sequence, and consequence analyses completed between 1975 and 1988. WASH-1400, "Reactor Safety Study," issued 1975, indicated that SBO could be an important contributor to the total risk from nuclear power plant (NPP) accidents. This study concluded that if an SBO persists for a time beyond the capability of the ac-independent systems to remove decay heat, core melt and containment failure could follow.

In 1980, the Commission designated the issue of SBO as Unresolved Safety Issue (USI) A-44, "Station Blackout," and the staff completed several technical studies to determine if any additional safety requirements were needed. These technical studies also reviewed and addressed reliability concerns of dc power systems via Generic Issue A-30 program. Therefore, in March 1986, a Notice of Proposed Rulemaking on Station Blackout (SBO) was published in the Federal Register (51 FR 9829). The final rule was published on July 21, 1988, in the Federal

Register (53 FR 23203) as 10 CFR 50.63. The SBO Rule's objective is to reduce the risk of severe accidents resulting from SBO by maintaining highly reliable ac electric power systems and, as additional defense-in-depth, assuring that plants can cope with a station blackout of some period. LOOPs or loss of emergency ac power systems including dc power systems due to natural phenomena (design basis or beyond design basis such as the Fukushima event) were not considered to occur with sufficient frequency to require explicit criteria and were not considered in the current SBO rule.

After implementation of the SBO rule at all facilities, the Electrical Engineering Branch (EEEB) staff noted that licensees were not updating their coping analysis or SBO duration evaluations. When original SBO rule assumptions such as 1) number of LOOPs, 2) duration of LOOPs, 3) recovery time for offsite power, and 4) frequency of grid blackout events increased, the NRC did not take action for licensees to update their coping analysis or SBO duration evaluations. In addition, the EEEB staff noted that the plant Class 1E batteries relied upon to perform the SBO mitigation function were not required to be periodically tested to demonstrate SBO coping capability. These changes in assumptions have a significant effect on the SBO duration and coping analyses performed by the licensees relying on coping strategies without alternate power sources (typically 4 hours). Based on the number of LOOPs and grid blackout events occurred in the last 20 years, the EEEB staff determined that SBO duration for some of the plants may change from four hours to eight or sixteen hours. In 2011, EEEB staff took the initiative to revise the SBO rule. However, this initiative was cancelled because of the July 12, 2011, severe accidents at Fukushima Dai-ichi that required further regulatory actions for addressing external events in SBO area. We note that one of the primary reasons of the severe accident was the common cause failure of electric power systems (both ac and dc). Thus ac and dc power systems are critical for conventional light water reactors to mitigate the effects of design bases events and severe accidents.

After the Fukushima accident, a task force of senior NRC staff reviewed the circumstances of the event to determine what lessons could be learned. In July 2011, the task force provided recommendations to enhance U.S. reactor safety, and these became the foundation of the NRC's post-Fukushima activities. In SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011, the Near-term Task Force (NTTF) provided its recommendations to the Commission regarding the station blackout and the need for revising the U.S. SBO rule (§ 50.63). These recommendations did not specifically identify the consideration of loss of dc power or extended loss of ac power for addressing the lessons learned from the Fukushima Dai-ichi event including the current issues with the 50.63 rule as discussed above.

The NRC staff developed and provided to the Commission a proposed rule in SECY-15-0065, "Proposed Rulemaking: Mitigation of Beyond-Design-Basis Events (RIN 3150-AJ49)," on April 30, 2015 (ADAMS Accession No. ML15049A201). The Commission issued its direction on the proposed rule on August 27, 2015, in Staff Requirements Memorandum (SRM)-SECY-15-0065 (ADAMS Accession No. ML15239A767). In accordance with the Commission's direction, the staff revised the proposed rule and issued it for a 90-day public comment period on November 13, 2015 (80 FR 70609). We provided the following comments during this comment period

because the concerns were not satisfactorily resolved during the NRC internal review process for the proposed rule.

"The proposed rule does not fully address the lessons learned from the meltdown of three nuclear units and loss of spent fuel pool cooling at multiple units at the Fukushima Dai-ichi site. One of the root-causes of the accident was due to the total loss of all power systems (loss of all alternating current (AC) and direct current (DC) power systems including power from inverters. Based on my review of the proposed rule, 10 CFR 50.155 "Mitigation of Beyond-Design-Basis Events to Address Mitigation of Beyond-Design-Basis Events," and the Mitigation Strategy Order (EA-12-049) and its implementing guidance documents such as NEI 12-01 and JLD-ISG-2012-01, I noted that the proposed rule did not consider the loss of direct current (DC) electric power and AC power produced by inverters through station batteries. The current mitigation strategies developed by the industry are based on the availability of power from Batteries and the inverters. Without the initial assumption of loss of all power systems (AC and DC systems) and appropriate Phase 1 mitigation strategy to address loss of all power, the U.S nuclear power plants will not be able to prevent a future beyond design basis event such as the Fukushima Dai-ichi accident. It should be noted that the current station blackout rule (10 CFR 50.63) also did not consider the loss of dc and vital ac power from inverters. For passive plants such as the AP 1000 and ESBWR reactor designs, mitigating strategies involving an initiating event that causes the loss of DC power is detrimental in preventing a nuclear reactor accident such as the Fukushima Dai-ichi.

"(b) Integrated response capability. Each applicant or licensee shall develop, implement, and maintain an integrated response capability that includes:

(1) Mitigation Strategies for Beyond-Design-Basis External Events. Strategies and guidelines to mitigate beyond-design-basis external events from natural phenomena that result in an extended loss of all ac power concurrent with either a loss of normal access to the ultimate heat sink or, for passive reactor designs, a loss of normal access to the normal heat sink. These strategies and guidelines must be capable of being implemented site-wide and must include...."

The above stated condition addresses only loss of all AC. In Fukushima, the DC was also lost and most of the electrical switchgear including AC & DC was not in condition to be reenergized. DC batteries are centrally located, usually 2 sets (Train A & B). These batteries are also susceptible for failure as a consequence of the severe accident. For, certain models of BWR, different voltage levels of safety power supply is needed for addressing a simple station black out (250V DC for valve operation and 125VDC for control and in certain cases 24V for indication). Unless a de-centralized DC power (appropriate DC supplies locally) for non-electric cooling systems (Diesel-driven/ steam driven pumps) the system operation cannot be assured under severe accident conditions. A reactor trip following a full power operation would require these capabilities to be immediately available for preventing core damage.

Therefore, assuming loss of AC power alone is clearly inadequate."

In addition to the above comments, a third commenter from the public stated the following:

> The proposed rule does not fully address the improvements that are needed to be made to further enhance safety. The root cause of the accident was due to the total loss of all power systems (both AC and DC power systems). The current proposal does not consider the total loss of DC power nor AC power from inverters through station batteries. The rule does not relate the electrical power system enhancements to address the total loss of all AC Power leading to a station blackout. For example, it does not require a back-up power supplied by a portable diesel generator(s) to be made readily available to allow key instrumentation and control equipment and key electrical loads to remain operable. The rule also does not take into account the load shedding strategy to extend the existing station's battery life to ensure that the connection of portable generators can be completed before batteries are depleted. It doesn't take a proactive approach to ensure the availability of backup power. There needs to be an evaluation to determine if the batteries can be extended past 8 hours that may be needed to mitigate beyond design basis accident. A predefined time is required to be determined between the total loss of AC power and connection of additional power sources such as having readily available portable generator. Therefore, the most important initial assumptions the licensees need to consider for mitigating beyond design basis events such as in the Fukushima accident is the loss of all DC and AC power systems.

The NRC response (ADAMS Accession No. ML16271A063) to the above comments stated the following:

> "The NRC disagrees with these comments. These three comments state that the NRC did not address a loss of all ac and dc power events and that the MBDBE rule should require that this condition be assumed in light of the events at Fukushima. The NRC concludes that the MBDBE rule requirements do not have to be revised. The MBDBE rule does address the condition cited by the commenters, although it does not address this condition in the manner that the comments propose. The MBDBE rule addresses the loss of all ac power, including ac power from inverters fed by batteries or dc power directly from batteries, as follows:

(1) An extended loss of ac power and loss of normal access to the ultimate heats sink (or loss of access to the normal heat sink for passive designs) is assumed for the purposes of developing the supporting analysis, determining the resultant conditions, and establishing times for key actions that support the development and implementation of mitigation strategies providing additional capability for beyond-design-basis external events.

(2) Initial conditions exceeding the conditions described above that include the loss of all ac power, including power from batteries either directly or through inverters, are addressed through contingencies within the mitigation strategies that involve sending personnel to locally and manually operate non-ac driven core cooling pumps (e.g., a turbine driven auxiliary feedwater or reactor core isolation cooling pump) to maintain or restore core

cooling. These contingencies include the capability to obtain instrument readings using portable multimeters at locations that do not rely on the functioning of intervening electrical equipment.

The NRC received other comments that indicated it should only require that an extended loss of ac power be assumed and no other actions are necessary to comply with the proposed requirements. These comments caused the NRC to conclude that the proposal was not clear with regard to the "loss of all ac power" requirements. First, the word "extended" is removed from 10 CFR 50.155(b)(1) because the NRC concludes that it contributes to the confusion regarding the requirement. The requirements in 10 CFR 50.155(b)(1) require that a loss of all ac power be assumed and that the strategies be capable of maintaining or restoring the key safety functions, indefinitely or until the mitigation strategies are no longer needed, and this includes the acquisition of offsite resources to sustain those functions. As such, the requirements are clearly requiring a capability to address an "extended" loss of ac power, and the word "extended" is not necessary in (b)(1). Additionally, changes were made to the SOC of the final MBDBE rule to clarify the meaning and intent of "loss of all ac power" (refer to SOC Comments 1 and 10). These changes to the rule and SOC address the three comments above (Rule Comment 36)."

Issue:

The final rule § 50.155(b), the Statement of Considerations (SOC) and associated guidance documents do not require consideration of loss of all electric power (loss of ac and dc power systems) as an initial condition for developing mitigation strategy at a nuclear station. Specifically, the integrated response capability for mitigation strategies for beyond-design-basis external events did not require consideration of loss of dc power and ac power to buses fed by station batteries through inverters. In other words, the initial assumptions for availability of electric power systems for § 50.155 is the same as § 50.63. Therefore, the final rule as written and accompanying guidance do not address mitigating beyond design basis events such as the Fukushima accident, where the plants lost complete electric power systems. The current mitigation strategy is to use the Class 1E batteries as long as possible by load shedding until the plant can transition to Phase 2. We believe, the current operating US fleet cannot withstand the loss of dc power systems along with loss of ac power systems and the proposed strategy, as implemented by the operating reactors, has the potential to result in a severe accident as seen in Fukushima Dai-ichi site unless alternate solutions are designed and implemented.

In addition, environmental qualification requirements (hardened), for ensuring capability of instrumentation to remain functional during severe accident conditions for key electric and instrumentation and control (I&C) equipment, needed for monitoring and mitigating a severe accident condition are not included in the final rule. Thus, there is no reasonable assurance that essential equipment needed for monitoring or mitigating a severe accident would be able to perform its functions.

REASONS FOR THE NON-CONCURRENCE

Our review of the Mitigation of Beyond-Design-Basis Events rule package (rule, SOC, and the associated implementation guidance) indicates that the final rule does not address the lessons learned from the meltdown of three nuclear units at the Fukushima Dai-ichi site. Specifically, it did not require consideration of loss of dc power and ac power to buses fed by station Class 1E batteries through inverters. We do not agree with the NRC staff's statements that "the MBDBE rule addresses the loss of all ac power, including ac power from inverters fed by batteries or dc power directly from batteries." This is not true because the current mitigation strategies developed by the industry (NEI 12-06) and endorsed by the NRC (JLD-ISG-2012-01 and Regulatory Guide 1.226) are based on the availability of power from batteries and the inverters. Specifically, these documents state that licensees should use the criteria and assumptions for analyses used to establish a baseline coping capability. The assumptions include the initial conditions listed in section 3.2.1.3 that include a loss of offsite power affecting all units at a plant site and the specification that "[a]ll design basis installed sources of emergency on-site ac power and SBO alternate ac power sources [as defined in 10 CFR 50.2] are assumed to be not available and not imminently recoverable." Our review indicates that the criteria and assumptions for analyses used to establish a baseline coping capability during phase 1 mitigation strategy is relying on permanently installed safety-related Class 1E battery capacity and may include battery load shedding to extend the battery life and ac power to buses fed by station batteries through inverters.

At Fukushima Dai-ichi, the dc power and ac power from batteries were also lost and most of the electrical switchgears including ac and dc were not in a condition to be reenergized in a period of 8 to 10 hours. The physical location of all ac and dc power systems in the U.S NPPs are similar to Fukushima Dai-ichi NPP, which is centrally located, usually 2 sets (Train A & B) and four channels of instrumentation and controls (I&C) systems. Our technical position is that if an external beyond-design-basis event results in LOOP and loss of both trains of emergency ac power systems, it is reasonable and logical to assume that the dc power systems are also lost because they are physically located at the same area.

The specific assumptions include: 1) The loss of offsite ac power is commonly experienced failure because the transmission towers and substations cannot withstand seismic events or heavy winds; 2) The emergency diesel generators at the nuclear stations were developed from diesel generators that were designed for railway motive power and the early versions of these engines continue to be used in that area; and the rule does not recognize the fragility of a Battery System with plastic or glass jars with lead plates generally hung from top, assembled with 50 or more jars, and inter-cell connections with lead bars (breakage of inter-cell lead bars can fully disable a battery), is significantly less than Class 1E seismically qualified emergency diesel generators.

The base assumption in the 50.155 rule that an external event that disables the redundant 1E emergency diesel generators and the alternate ac power source would fail but the batteries, that are more fragile and vulnerable to external events, will remain intact to support non ac-driven core cooling systems cannot be technically supported or justified. Therefore, we find the initial

assumptions used for developing mitigation strategy are not technically sound, in error, and does not adequately address the safety concerns.

Without the initial assumption of loss of all power systems (ac and dc systems), phase 1 mitigation strategy cannot be accomplished and most certainly lead to core meltdown as occurred in Fukushima Dai-ichi. The staff states, in response to our comments, that "if all ac and dc power supplies are lost, contingencies within the mitigation strategies that involve sending personnel to locally and manually operate non-ac driven core cooling pumps (e.g., a turbine driven auxiliary feedwater or reactor core isolation cooling pump) to maintain or restore core cooling. These contingencies include the capability to obtain instrument readings using portable multimeters at locations that do not rely on the functioning of intervening electrical equipment." It should be noted that these contingencies cannot be implemented because non-ac driven core cooling pumps still need dc power to perform their design functions (i.e., opening of the steam supply valves against significant differential pressure, starting the diesel engine/turbine, and operation of respective control systems) and instrument readings cannot always be obtained because of potential environmental conditions as the nuclear industry learned from the Fukushima Dai-ichi accident. If these were possible and successful, the Fukushima Dai-ichi severe accidents at three units would have been prevented. Therefore, the most important initial assumptions the new rule must require the licensees to consider for mitigating beyond design basis external events such as in the Fukushima accident is the loss of all ac and dc power supplies as initial assumptions. A reactor tripping from full power has the most decay heat in the initial hours and in the absence of any heat sink, time is very critical for initial cooling that can achieved only with installed backup equipment for prompt cooling to prevent a nuclear accident transitioning to a severe accident as experienced at Fukushima Dai-ichi.

In addition, these power systems including I&C equipment are also susceptible to failure as a consequence of the accident (more severe harsh environmental conditions than the current 10 CFR 50.49 requirements). The final rule also does not identify requirements for special qualified equipment to be available for use in harsh environment. Since the permanently installed instrumentation and equipment or portable equipment will not survive severe accident conditions, a qualification process is needed to ensure equipment can function in its expected environment. This is neither addressed in the final rule nor in the implementing industry and NRC guidance documents.

Therefore, the new rule must include the loss of all ac and dc power supplies as initial assumptions as the criteria and assumptions for analyses used to establish a baseline coping capability and mitigation strategy and equipment qualification of key electric equipment. This is required to provide continued reasonable assurance of adequate protection of public health and safety.

POTENTIAL IMPACT ON MISSION

The NRC mission to protect public health, safety, and the environment is directly affected because the new rule did not consider all of the lessons learned from the Fukushima Dai-ichi accident. To provide continued reasonable assurance of adequate protection of public health and safety, the rule must require licensees to include the loss of all ac and dc power supplies as

initial assumptions for analyses used to establish a baseline coping capability and mitigation strategy and equipment qualification of key electric equipment.

PROPOSED ALTERNATIVES

A loss of dc power from batteries and vital ac power from inverters must be considered in the initial assumption for developing mitigating strategies to maintain or restore core cooling, and containment cooling capabilities since both safety-related ac and dc systems are located in the same area where most likely the same beyond design basis external initiating event would disable both ac and dc power systems. Power supplies (dc power supply and uninterruptible ac power supply) must be installed locally or hardened locations (different location than where the Class 1E ac and dc systems are installed) for non-electric cooling systems (Diesel-driven/ steam driven pumps) as initial mitigation strategy upon a MBDBE when a reactor trip following a full power operation would require these capabilities to be immediately available for preventing core damage.

In addition, the final rule package must require hardening the equipment (reliable and rugged equipment) to be immediately available for use in harsh environment upon a MBDBE because the instrumentation and electric equipment currently installed cannot survive a beyond design basis accident as evidenced during the Fukushima Dai-ichi accident.

IAEA Document Excerpts and References that support the above perspectives

1. Instrumentation and control systems that are necessary during beyond design basis accidents need to remain operable in order to monitor essential plant safety parameters and to facilitate plant operations

2. Robust and reliable cooling systems that can function for both design basis and beyond design basis conditions need to be provided for the removal of residual heat

Reference for 1&2: Fukushima Daiichi Accident – Report By the Director General, Section 2 Observations and Lessons Sub Section 2.2 Nuclear safety Considerations: Page 80

3. Critical instrumentation needs to be designed and maintained so that it continues to function during severe accidents.

Reference for 3: Technical Volume 2/5 Safety Assessment, Section 2. Assessment of the Failure to Maintain Fundamental Safety Functions, 2.2.14 Observations and Lessons, Page 89

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NRC MD 10.158
(02-2016)

U. S. NUCLEAR REGULATORY COMMISSION

NCP TRACKING NUMBER

NCP-2016-018

NON-CONCURRENCE PROCESS

SECTION B - TO BE COMPLETED BY NON-CONCURRING EMPLOYEE'S SUPERVISOR

TITLE OF SUBJECT DOCUMENT	ADAMS ACCESSION NO.
Mitigation of Beyond-Design-Basis Events Rule	See Section A

NAME
Ian Jung

TITLE	TELEPHONE NUMBER
Branch Chief	415-2969

ORGANIZATION
Office of Nuclear Regulatory Research / Division of Engineering / Instrumentation, Controls, and Electrical Engineering Branch

COMMENTS FOR THE NCP REVIEWER TO CONSIDER (use continuation pages or attach Word document)
See the attached file.

SIGNATURE	DATE
Ian C. Jung	11/7/2016

Use ADAMS Template NRC-006 (ML063120159)

Section B

Comments for the NCP Reviewer to Consider

I appreciate the agency allowing my staff an opportunity to concur on this rulemaking package. This opportunity supports the agency's continuous effort to maintain an open and collaborative working environment that encourages all NRC employees to raise concerns and differing views promptly without fear of reprisal.

I also appreciate my staff for sharing his safety concerns before and during the concurrence process with me, management and his agency colleagues. His prompt review of the rulemaking package materials and timely submittal of the non-concurrence form detailing the concerns and proposed alternatives are also appreciated.

I agree with my staff on some aspects of the non-concurring views described in NCP-2016-018 and also disagree on other aspects. I agree that the initial assumptions in the rule do not include loss of dc power or ac power sources fed by batteries. The rule and the staff guidance allow the assumption of dc power or ac power sources fed by batteries being available. I also agree that dc power or ac power sources fed by batteries can play a very important role for events involving loss of all ac power. Based on this, I find that my staff's recommendation, if adopted, could provide added assurance of safety, or of defense-in-depth, beyond what is intended by this rule.

However, I am not fully convinced that the added assurance is critical enough to require the changes to the rule as recommended by my staff. When I reviewed the rule and other relevant documents, I find that the high-level requirements of the rule encompass the potential scenarios involving the availability of dc power sources or ac power sources subsequent to the initial assumptions. §50.155(b)(1) requires that the strategies and guidelines developed under the initial assumptions must be capable of maintaining or restoring the key safety functions including core cooling. If an applicant or licensee determines in their mitigating strategies for the particular scenario that dc power sources or ac power sources fed by batteries are relied upon, §50.155(b)(3) requires that the equipment must have sufficient capacity and capability to perform the functions required. I find that the nature of the rule is beyond-design-basis, performance-based, and functionally-based to allow the mitigating strategies to be flexible and adaptable. As such, adding specific, prescriptive requirements on dc power sources or ac power sources fed by batteries may not be consistent with the intended nature of the rule. Further, it is generally recognized, and I agree, that the beyond-design-basis external events are unlikely. My review of the relevant guidance (e.g., the latest versions of RG 1.226 and NEI 12-06) shows that it recognizes the importance of the systems such as AFW/HPCI/RCIC/IC during the early stage of the postulated event, and suggests plant procedures/guidance to assure the initiation of one of the systems even if local initiation and control is required. NEI 12-06 also states that plant guidance should address "reactive transitions in the event plant equipment degrades or fails." Based on these, I find that the guidance addresses the applicant's or licensee's responsibility to ensure the necessary availability of the system(s) be available to meet the

requirements of maintaining or restoring the key safety functions. Therefore, I am not convinced that the rule needs to be changed as suggested by my staff.

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NRC MD 10.158
(02-2016)

U. S. NUCLEAR REGULATORY COMMISSION

NON-CONCURRENCE PROCESS

NCP TRACKING NUMBER: NCP-2016-018

SECTION B - TO BE COMPLETED BY NON-CONCURRING EMPLOYEE'S SUPERVISOR

TITLE OF SUBJECT DOCUMENT	ADAMS ACCESSION NO.
Mitigation of Design Basis Events Rule	See Section A

NAME
Jacob I. Zimmerman

TITLE	TELEPHONE NUMBER
Chief, Electrical Engineering Branch	(301) 415-1220

ORGANIZATION
NRR/DE/EEEB

COMMENTS FOR THE NCP REVIEWER TO CONSIDER (use continuation pages or attach Word document)

Electrical engineering technical support for the subject document and rulemaking activity was reassigned from the Electrical Engineering Branch (EEEB) to the Japan Lessons Learned Directorate in 2014. Therefore, I have no specific comment on the issues raised in Section A. Nonetheless, I believe that the issues raised should be carefully considered and appropriately dispositioned in accordance with the Non-Concurrence Process, while demonstrating the NRC's organizational values.

SIGNATURE	DATE
Jacob I. Zimmerman	11/8/16

NRC FORM 757
NRC MD 10.158
(02-2016)

U. S. NUCLEAR REGULATORY COMMISSION

NON-CONCURRENCE PROCESS

NCP TRACKING NUMBER: NCP-2016-018

SECTION C - TO BE COMPLETED BY NCP COORDINATOR

TITLE OF SUBJECT DOCUMENT	ADAMS ACCESSION NO.
Electrical Non-concurrence on Mitigation of Beyond-Design-Basis Event Rule	ML16301A005

NAME: Joseph Sebrosky

TITLE	TELEPHONE NUMBER
Senior Project Manager	(301) 415-1132

ORGANIZATION: NRR/JLD/JHMB

AGREED UPON SUMMARY OF ISSUES (use continuation pages or attach Word document)
SEE ATTACHED

EVALUATION OF NON-CONCURRENCE AND RATIONALE FOR DECISION (use continuation pages or attach Word document)
SEE ATTACHED

TYPED NAME OF NCP COORDINATOR	TITLE
Joseph Sebrosky	Senior Project Manager

ORGANIZATION: NRR/JLD/JHMB

SIGNATURE--NCP COORDINATOR	DATE
	11/10/16

TYPED NAME OF NCP APPROVER	TITLE
William M. Dean	Director

ORGANIZATION: NRR

SIGNATURE--NCP APPROVER	DATE
	11/10/16

Use ADAMS Template NRC-006 (ML063120159)

Non-Concurrence Process Documentation
NCP-2016-018; Section C (Document Sponsor)

Summary of Issues

The staff members submitting the nonconcurrence on the Commission paper providing the draft final rule for the mitigation of beyond-design-basis events (MBDBE) rulemaking make the following two assertions:

1. The final rule, § 50.155(b), the Statement of Considerations, and associated guidance documents do not require consideration of loss of all electric power (loss of ac and dc power systems) as an initial condition for developing mitigation strategies at a nuclear station. The initial assumptions used for developing mitigation strategy are not technically sound, in error, and do not adequately address the safety concerns and lessons learned from the Fukushima Dai-ichi accident. Assuming an external event disables the redundant Class 1E emergency diesel generators and the alternate ac power source, but the batteries, that are more fragile and vulnerable to external events, will remain intact to support non ac-driven core cooling systems cannot be technically supported or justified. The current mitigation strategy is to use the Class 1E batteries as long as possible by load shedding until the plant can transition to Phase 2. The initial conditions exceeding the current assumptions (loss of dc power system) cannot be implemented successfully as part of any contingencies, such as by sending personnel to locally and manually operate non-ac driven core cooling pumps without any dc electric power. It requires extensive detailed guidance and specific requirements in the final rule. The current operating U.S. fleet cannot withstand the loss of dc power systems along with loss of ac power systems and the proposed strategy, as implemented by the operating reactors, has the potential to result in a severe accident as seen in Fukushima Dai-ichi site unless alternate solutions are designed and implemented.

2. Environmental qualification requirements (hardened), for ensuring capability of instrumentation to remain functional during severe accident conditions for key electric and instrumentation and control (I&C) equipment, needed for monitoring and mitigating a severe accident condition are not included in the final rule. Thus, there is no reasonable assurance that essential equipment needed for monitoring or mitigating a severe accident as seen in Fukushima Dai-ichi site would be able to perform their functions.

For the reasons provided below, the NRC staff disagrees with these assertions. Specifically, the staff concludes that the safety enhancements being implemented under Order EA-12-049 and being proposed in the MBDBE rulemaking are technically sound and fully justified, and that they appropriately address lessons learned from the Fukushima Dai-ichi accident. These actions have resulted in a significant enhancement to the capability of U.S. nuclear power plants to cope with beyond-design-basis external events.

(1) Loss of Power Assumptions for Mitigating Strategies

Discussion/Summary

The NRC issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," on March 12, 2012. The order required licensees to develop and implement mitigating strategies for an assumed simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink (UHS). The NRC also required licensees to reevaluate flooding and seismic hazards and the NRC staff assessed other issues and recommendations to determine if additional regulatory actions were warranted to address the lessons learned from the Fukushima accident. The combination of these efforts ensures that licensees will have additional capabilities in place to deal with extreme external events beyond those considered in the design basis. The NRC carefully considered how the various activities provided additional confidence in the protection of key equipment from external hazards and the ability to mitigate the possible unavailability of safety systems, such as emergency onsite ac power supplies. The results of these evaluations and interactions with stakeholders led to the requirements imposed through Order EA-12-049 and related guidance, such as interim staff guidance (ISG) 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," and Nuclear Energy Institute (NEI) document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide." The expected availability of dc systems was discussed during the development of requirements and guidance and during interactions with NRC's Japan Lessons-Learned Steering Committee, the Advisory Committee for Reactor Safeguards (ACRS), and other internal and external stakeholders. The topic of dc power supplies was addressed in issued guidance, the proposed MBDBE rule, and numerous other documents describing the NRC's actions following the Fukushima accident. An example of such discussions during the initial development of Order EA-12-049 and the related guidance can be found in the transcripts of a meeting of the ACRS held on February 9, 2012 (ADAMS Accession No. ML12054A574). In summary, internal and external stakeholders have critically examined the development of the post-Fukushima orders, guidance documents, and MBDBE rulemaking. NRC senior management and the Commission have been involved at key points to ensure that agency actions result in meaningful safety improvements in accordance with agency regulations, including Section 50.109 to Title 10 of the *Code of Federal Regulations*, "Backfitting," and the issue finality provisions of Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

The NRC recognizes the importance of the protection of key equipment (including batteries, the ac and dc distribution systems, and related components) from beyond-design-basis external events and carefully considered how the various activities discussed above provide additional confidence in the protection of this equipment. The NRC addressed challenges facing the pending MBDBE rulemaking that resulted from the mitigating strategies being developed and implemented before some information was available from the reevaluation of external hazards. The agency made adjustments to both the MBDBE rulemaking and the approach to reevaluated

hazards to achieve the desired outcome. A change incorporated into the rule and the related guidance involves assessments of mitigating strategies against reevaluated seismic and flooding hazards to ensure the initial strategies remain effective or to identify appropriate changes to the strategies to address the loss of equipment, such as the dc power systems, as a result of the site being impacted by beyond-design-basis external events. Revision 2 to NEI 12-06, which was endorsed by JLD-ISG-2012-01, Revision 1, includes Appendices G and H, which describe the mitigating strategy assessments against reevaluated flooding and seismic hazards. In summary, based on the staff's proposal in the MBDBE rule, licensees will need to demonstrate that any equipment relied on in their mitigating strategies, including ac and dc power and distribution systems that may be used, is appropriately protected from the reevaluated seismic and flooding hazards.

Consistent with the reliability principle from the NRC's Principles of Good Regulation, the staff is using the best available knowledge from research and operational experience as part of its work implementing lessons learned from the Fukushima Dai-ichi accident. For example, in developing the requirements for mitigating strategies, the staff leveraged the work that was done for 10 CFR 50.54(hh)(2) for loss of large areas of a plant due to explosions or fire. Specifically, in addition to the mitigating strategies assessments, licensees have also identified contingencies for the local operation of steam-driven pumps and associated controls in case of the unavailability of control power, whether ac or dc. These contingencies were emphasized in the responses to public comments on the draft guidance for Order EA-12-049 (ADAMS Accession No. ML12229A253) and more recently in the draft resolution of public comments on the proposed MBDBE rulemaking referenced by the staff members submitting the nonconcurrence (ADAMS Accession No. ML16271A063 (not publicly available as of November 8, 2016, but made available to the nonconcurring individuals during development of this documentation)). A discussion of these contingencies is provided in an NRC research work product, NUREG/CR-7110, "State-of-the-Art Reactor Consequence Analysis [SOARCA] Project - Volume 2: Surry Integrated Analysis," as summarized below:

> The seismic events considered in SOARCA result in loss of offsite and onsite AC power (i.e., LTSBO [long-term station blackout]) and, for the more severe seismic events, loss of DC power (i.e., STSBO [short-term station blackout]). Under these conditions, the use of the turbine driven auxiliary feedwater (TDAFW) system is an important mitigation measure. Diverse procedures have been developed for PWRs, including a procedure to start and operate the TDAFW system without DC control power, which facilitates a managed response to station blackout (SBO) conditions. These procedures were discussed during site visits. This is known as TDAFW blackstart. Under 10 CFR 50.54(hh), mitigation measures also include the long-term operation of the TDAFW system without electricity (i.e., TDAFW blackrun), using a portable generator to supply indications such as steam generator level, to allow the operator to manually adjust TDAFW flow to prevent steam generator overfill and flooding of the TDAFW turbine. For a LTSBO, TDAFW can be used to cool the core until

> battery exhaustion. After battery exhaustion, TDAFW blackrun can be used to continue to cool the core.

Volume 1 of NUREG/CR-7110 includes a similar discussion, provided below for the reactor core isolation cooling (RCIC) system for the Peach Bottom analysis:

> Manual operation of RCIC under blackstart and blackrun conditions would delay (blackstart) or prevent (blackrun) core damage during an STSBO. A calculation assuming RCIC blackstart (but not blackrun) is described in Section 5.3. This calculation shows RCIC blackstart delays the onset of core damage by more than 5 hours, which is sufficient time to mobilize and align equipment added under 10 CFR 50.54(hh), i.e., the independent diesel-driven pump. The independent diesel-driven pump would then be used as a means of direct injection into the RPV [reactor pressure vessel] if RCIC operation could not be sustained via blackrun. Alternatively, long term operation of RCIC could be maintained under blackrun conditions if the portable electric generator energized the instrumentation that measures and indicates RPV water level. Based on the calculation described in Section 5.3, this action would need to be completed within 3.4 hours of the initiating event to prevent failure of RCIC due to RPV overfill. The independent diesel-driven pump could then be aligned to replenish the CST [condensate storage tank], thereby maintaining RCIC suction from a source that is not adversely affected by the absence of suppression pool cooling and resulting increases suppression pool water temperature. Full mitigation (i.e., prevent core damage and long term containment heat removal) would result if portable equipment necessary to manually open and close a containment vent path is available. This equipment was described in Section 3.1.3 for the LTSBO accident sequence. The resulting plant response would be very similar to the mitigated LTSBO described in Section 5.2.

The above discussions from the SOARCA reports include reference to mitigating measures under 10 CFR 50.54(hh). The requirements of 10 CFR 50.54(hh) were first imposed by NRC orders issued after the terrorist attacks of September 11, 2001. These same contingencies are also available should the loss of dc power occur during external natural events addressed by post-Fukushima actions, such as Order EA-12-049 and the pending MBDBE rulemaking. A demonstration of the capabilities to manually operate a TDAFW pump using handwheels and local indications is described in an NRC integrated inspection report dated August 9, 2013, for the Palo Verde Nuclear Generating Station (Inspection Report 05000528/2013003; ADAMS Accession No. ML13221A202).

The staff concludes that the actions taken to date and those to be incorporated into the MBDBE rulemaking adequately reduces the susceptibility of NRC-licensed power plants to the loss of key safety functions due to the loss of ac and dc power due to a natural event as occurred at Fukushima Daiichi. The additional evaluations, protection of equipment, development of

mitigating strategies, and identification of additional contingencies for the loss of dc power provide the needed safety enhancements to address lessons learned from the accident. As previously mentioned, the overall approaches and specific assumptions have been the subject of numerous assessments, discussions, and decisions by the NRC's senior management and Commission. Additional requirements as proposed in the nonconcurrence would, therefore, need to be evaluated on their own merits to determine if they would be justified using the NRC's requirements and guidance for imposing backfits on licensees.

Further, there have been many evaluations and analyses of the risks associated with losses of ac and dc power at nuclear power plants. Additional assessments have been performed as part of evaluating the lessons learned from the Fukushima accident. Relatively recent NRC studies include those performed as part of the SOARCA project, which focused on station blackout scenarios, including those where safety functions were lost early in an accident due to conditions such as a loss of dc power. The results from these and previous studies have been used to assess the possible safety benefits of additional regulatory requirements following Fukushima. The results from these assessments have been that additional measures have been shown to provide only marginal safety improvements for operating plants. These results stem from the low likelihood of severe beyond-design-basis external events combined with the actions already taken to identify site-specific vulnerabilities and put in place additional protections and mitigating strategies. SECY-16-0041, "Closure of Fukushima Tier 3 Recommendations Related to Containment Vents, Hydrogen Control and Enhanced Instrumentation," includes an assessment of possible regulatory actions to address scenarios involving the simultaneous loss of ac and dc power supplies (referred to as STSBO versus cases involving at least temporary availability of dc power and steam driven systems, which are referred to as LTSBO. The staff documented the following finding in SECY-16-0041:

> …The staff concludes that appropriate actions have been taken to address STSBO for plants with Mark I and Mark II containments and that consideration of STSBO versus LTSBO does not alter the conclusions that additional actions are not warranted for plants with other containment designs.
>
> The additional regulatory evaluation supports the staff's initial finding that regulatory actions in response to Recommendations 5.2 [containment protection for containment designs other than Mark I and Mark II] and 6 [hydrogen control] are not warranted for operating nuclear power plants. The staff bases this finding on conservative estimates of frequency-weighted risks to public health and safety in comparison to the NRC's established safety goals, insights from evaluations and agency decisions for Mark I and Mark II containments, past studies on the performance of other containment designs in terms of plant response and the timing of possible failures during severe accidents, considering both LTSBO and STSBO scenarios.

Conclusion

The staff is following established processes and guidance and will be providing the MBDBE rulemaking package, including the associated guidance documents, to the Commission for its consideration. NRC management and when appropriate, the Commission, has been involved in the development of Order EA-12-049, the MBDBE rulemaking, and associated guidance for the order, reevaluation of external hazards, and the pending rule. Previous assessments of additional requirements to address the inclusion of an assumed loss of dc power along with a loss of ac power and loss of normal access to the UHS finds that such a requirement would not provide a substantial safety improvement as required by NRC regulations such as 10 CFR 50.109.

Actions Taken

There were no changes to the rulemaking language being provided to the Commission as part of the draft final rule. The staff has revised the response to the disposition of public comments to provide a more thorough explanation as to why a loss of dc power need not be included as a generic assumption in the pending MBDBE rule.

(2) Environmental Qualification of Electrical and Instrumentation and Control Equipment

Discussion/Summary

The resolution of the question of whether the NRC should impose additional requirements for enhanced reactor and containment instrumentation for beyond-design-basis conditions, and specifically for severe accident conditions, was documented in SECY-16-0041. The following finding is provided in SECY-16-0041.

> Using the insights described above, the staff has determined that there is little likelihood that further study or research would make it necessary to recommend additional requirements for licensees to enhance reactor and containment instrumentation to support monitoring capability during severe accidents. Based largely on the analyses completed for the MBDBE rulemaking, the staff has concluded that the imposition of such a regulatory requirement would not represent a substantial safety benefit to public health and safety. As a result, enhanced reactor and containment instrumentation requirements are unlikely to satisfy the criteria in 10 CFR 50.109 for backfitting an operating reactor. The NRC staff's determination is also based on consideration of the substantial safety improvements already being implemented as part of NRC's post-Fukushima regulatory actions, such as Order EA-12-049, Order EA-13-109, the MBDBE rulemaking, and voluntary industry initiatives.

Conclusion

The staff is following established processes and guidance and will be providing the MBDBE rulemaking package, including the associated guidance documents, to the Commission for their consideration. NRC management, including the Commission when appropriate, has been involved in the development of Order EA-12-049, the MBDBE rulemaking, and associated guidance for the order and the pending rule. Environmental qualification of equipment for severe accident conditions is beyond the scope of the MBDBE rulemaking. However, the staff considered the matter within its resolution of other post-Fukushima recommendations and documented in SECY-16-0041 that no additional regulatory actions are warranted. The nonconcurring individuals have not raised any new issues that challenge the conclusions in SECY-16-0041 or that would cause the staff to reconsider the scope of the MBDBE rulemaking.

Actions Taken

There were no changes to the rulemaking language or supporting material being provided to the Commission as part of the final rule related to this issue.