DUKE ENERGY®

Steven D. Capps
Vice President
McGuire Nuclear Station

Duke Energy
MG01VP | 12700 Hagers Ferry Road
Huntersville, NC 28078

o: 980.875.4805
f: 980.875.4809
Steven.Capps@duke-energy.com

10 CFR 50.4
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December 07, 2015
MNS-15-096

Attention: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-001

Duke Energy Carolinas, LLC (Duke Energy)
McGuire Nuclear Station (MNS), Units 1 and 2
Docket Nos. 50-369 and 50-370
Renewed License Nos. NPF-9 and NPF-17

Subject: Final Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" and with Order EA-12-051, "Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation" for McGuire Nuclear Station

References:

1. Nuclear Regulatory Commission (NRC) Order Number EA-12-049, Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, Revision 0, dated March 12, 2012, (Agency wide Documents Access and Management System (ADAMS) Accession No. ML12054A735)
2. McGuire Nuclear Station (MNS) Overall Integrated Plan in Response to March 12, 2012, Commission Order to Modify Licenses With Regard To Requirements for Mitigation Strategies for Beyond Design Basis External Events (Order EA-12-049), dated February 28, 2013, (ADAMS Accession No. ML13063A185)
3. McGuire Nuclear Station, Units 1 and 2 - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies), dated January 16, 2014, (ADAMS Accession No. ML13338A406)
4. NRC Order Number EA-12-051, Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation, dated March 12, 2012, (ADAMS Accession No. ML12054A679)
5. Letter from Duke Energy to NRC, Overall Integrated Plans in Response to March 12, 2012, Commission Order Modifying Licenses With Regard To Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated February 28, 2013, (ADAMS Accession No. ML13086A095)

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6. McGuire Nuclear Station, Units 1 and 2 - Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, dated October 28, 2013, (ADAMS Accession No. ML13281A791).McGuire Nuclear Station, Units 1 and 2 Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation to Orders EA-12-049 and EA-12-051, dated October 9, 2014, (ADAMS Accession No. ML14241A454)
7. Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" and with Order EA-12-051, "Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation" - McGuire Nuclear Station Unit 1, dated November 18, 2014, (ADAMS Accession No. ML14335A322)

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design-Basis External Events" and Order EA-12-051, "Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation," (Reference 1 and Reference 4, respectively).

The Orders require holders of operating reactor licenses and construction permits issued under Title 10 of the *Code of Federal Regulations* Part 50 to submit for review, Overall Integrated Plans (OIPs) including descriptions of how compliance with the requirements of each Order will be achieved. By letter dated February 28, 2013 (Reference 2), the OIP for MNS in response to Order EA-12-049 was submitted. In a separate correspondence, the OIP for MNS in response to Order EA-12-051 was submitted by letter dated February 28, 2013 (Reference 5).

Order EA-12-049, Section IV.A.2 and Order EA-12-051, Section IV.A.2 requires completion of full implementation to be no later than two (2) refueling cycles after submittal of the overall integrated plan, as required by Condition C.1.a or December 31, 2016, whichever comes first. In addition, Section IV.C.3 of Orders EA-12-049 and EA-12-051 require that Licensees and CP holders report to the NRC when full compliance is achieved. For MNS, Units 1 and 2, the current requirement for full implementation of NRC Orders EA-12-049 and EA-12-051 is prior to restart from the 2EOC23 refueling outage.

On October 8, 2015, MNS Unit 2 entered Mode 2 (Startup) following the 2EOC23 refueling outage. As such, October 8, 2015, is the compliance date for MNS Unit 2 for being in full compliance with Orders EA-12-049 and EA-12-051 as demonstrated by this submittal and any other docketed correspondence concerning these Orders. This determination is based on the best available information and analyses that have been completed as of the date of this letter. Notification of full compliance with Orders EA-12-049 and EA-12-051 for MNS Unit 1 was provided by Reference 8.

Attachment 1 provides a brief summary of the key elements associated with compliance to Orders EA-12-049 and EA-12-051 for MNS, Unit 2. Attachment 2 provides the open and pending items from the Audit Report (Reference 7). For each open and pending item identified in Attachment 2, a brief summary response in support of closure is provided. As such, Duke Energy Carolinas Inc. (Duke Energy) considers these items complete pending NRC closure. Attachment 3 provides all answers to the Diverse and Flexible Strategies Interim Staff

Evaluation open and confirmatory items contained in Reference 3. Attachment 4 provides all answers to the Spent Fuel Pool (SFP) instrumentation Interim Staff Evaluation (ISE) Request For Additional Information contained in Reference 6. Attachment 5 provides the bridging document between vendor technical information and MNS specific considerations for SFP instrumentation, which compares MNS assumptions to the vendor's assumptions for the SFP instrumentation. Attachment 6 provides the MNS FLEX Final Integrated Plan. Attachment 7 provides the MNS RCP Seal Leakage Margin Assessment.

In support of the ongoing NRC Audit process, Duke Energy will continue working with the NRC staff in the issuance of a combined Safety Evaluation (SE) for both the Mitigation Strategies and the Spent Fuel Pool Level Instrumentation Orders.

There are no regulatory commitments contained in this letter or its attachments. Please address any comments or questions regarding this matter to George Murphy at 980-875-5715.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on December 07, 2015.

Sincerely,

Steven D. Capps

Attachments:

1. MNS, Unit 2 Summary of Compliance Elements for Orders EA-12-049 and EA-12-051
2. MNS NRC Audit Report Open and Pending Items
3. MNS, Response to Diverse and Flexible Strategies Interim Staff Evaluation Open and Confirmatory Items
4. MNS, Response to Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order-12-051, Reliable Spent Fuel Pool Instrumentation
5. Design Bridge Document Between Vendor Technical Information and MNS Specific Considerations for Spent Fuel Pool Instrumentation
6. MNS, Final Integrated Plan
7. MNS, RCP Seal Leakage Margin Assessment - ELAP

xc:

C. Haney, Region II Administrator
U.S. Nuclear Regulatory Commission
Marquis One Tower
245 Peachtree Center Avenue NE, Suite 1200
Atlanta, Georgia 30303-1257

J.P. Boska, Project Manager (NRR/JLD/JOMB)
U.S. Nuclear Regulatory Commission
One White Flint North, Mailstop 13 F15
11555 Rockville Pike
Rockville, MD 20852-2738

G.E. Miller, Project Manager (CNS & MNS)
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Mail Stop 8 G9A
Rockville, MD 20852-2738

J. Zeiler
NRC Senior Resident Inspector
McGuire Nuclear Station

Justin Folkwein
American Nuclear Insurers
95 Glastonbury Blvd., Suite 300
Glastonbury, CT 06033-4453

ATTACHMENT 1

MNS, UNIT 2 SUMMARY OF COMPLIANCE ELEMENTS FOR ORDERS EA-12-049 AND EA-12-051

The elements identified below for MNS, Unit 2 as well as the Overall Integrated Plans (OIP) for Orders EA-12-049 and EA-12-051 (References 1 and 10, respectively), the 6-Month Status Reports for Orders EA-12-049 and EA-12-051 (References 4 thru 8 and 11 thru 15, respectively), and any additional docketed correspondence, demonstrate compliance with Orders EA-12-049 and EA-12-051.

STRATEGIES - COMPLETE

MNS, Unit 2 strategies are in compliance with Order EA-12-049. All strategy related Open Items, Confirmatory Items, or Audit Questions/Audit Report Open Items have been addressed and are considered complete pending NRC closure.

MODIFICATIONS - COMPLETE

The modifications required to support the FLEX strategies for MNS, Unit 2 have been fully implemented in accordance with the station design control process. The design of the Spent Fuel Pool Level Instrumentation installed at MNS, Unit 2 comply with the requirements specified in the order and described in NEI 12-02, Revision 0, "Industry Guidance for Compliance with NRC Order EA-12-051". The instruments have been installed in accordance with the station design control process.

EQUIPMENT – PROCURED AND MAINTENANCE & TESTING - COMPLETE

The equipment required to implement the Mitigation Strategies and Reliable Spent Fuel Pool Level Instrumentation has been procured and is ready for use at MNS, Unit 2. Testing and Maintenance processes have been established through the use of Industry endorsed Electric Power Research Institute (EPRI) Guidelines and the MNS Preventative Maintenance program such that FLEX equipment reliability is achieved. Operating and maintenance procedures for the Spent Fuel Pool Instruments for MNS, Unit 2 have been developed, and integrated with existing procedures. These procedures have been verified and are available for use in accordance with the site procedure control program. Site processes have been established to ensure the Spent Fuel Pool Instruments are maintained at their design accuracy.

PROTECTED STORAGE - COMPLETE

The storage facilities required to implement the FLEX strategies for MNS, Unit 2 have been completed and provide protection from the applicable site hazards. The equipment required to implement the FLEX strategies for MNS, Unit 2 is stored in its protected configuration and is ready for use.

PROCEDURES - COMPLETE

FLEX Support Guidelines (FSG) and procedures for the maintenance and use of the Spent Fuel Pool Level Instrumentation for MNS, Unit 2 have been developed in accordance with NEI 12-06, revision 0 Section 3.2.2 and NEI 12-02, Revision 1, Section 4.2. The FSGs and affected existing procedures have been verified and are available for use in accordance with the site procedure control program.

TRAINING - COMPLETE

Training for MNS, Unit 2 has been completed using the MNS Systematic Approach to Training (SAT) as recommended in NEI 12-06, Revision 0, Section 11.6 and in NEI 12-02, Revision 1, Section 4.1.

STAFFING - COMPLETE

The staffing study for MNS has been completed in accordance with NEI 12-01, Revision 0 and 10CFR50.54(f), "Request for Information Pursuant to Title 10 of the Code of Federal Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force review of Insights from the Fukushima Dai-ichi Accident," Recommendation 9.3, dated March 12, 2012 (Reference 8), as documented in letter dated May 20, 2014 (Reference 9) and September 24, 2014 (Reference 10). The staffing study confirmed that MNS has adequate staffing to perform the actions to mitigate beyond design basis events.

NATIONAL SAFER RESPONSE CENTERS - COMPLETE

Duke Energy has established a contract with the Pooled Equipment Inventory Company (PEICo) and has joined the Strategic Alliance for FLEX Emergency Response (SAFER) Team Equipment Committee for off-site facility coordination. It has been confirmed that PEICo is ready to support MNS with Phase 3 equipment stored in the National SAFER Response Centers in accordance with the site specific SAFER Response Plan.

VALIDATION - COMPLETE

Duke Energy has completed performance of validation in accordance with industry developed guidance to assure required tasks, manual actions and decisions for FLEX strategies are feasible and may be executed within the constraints identified in the Overall Integrated Plans (OIP) for Order EA-12-049.

FLEX PROGRAM DOCUMENT - ESTABLISHED

The FLEX Program Document for MNS has been developed in accordance with the requirements of NEI 12-06, Revision 0.

REFERENCES

1. McGuire Nuclear Station Overall Integrated Plan in Response to March 12, 2012, Commission Order to Modify Licenses With Regard To Requirements for Mitigation Strategies for Beyond Design Basis External Events (Order EA-12-049), dated February 28, 2013, (ADAMS Accession No. ML13063A185).
2. Nuclear Regulatory Commission Order Number EA-12-049, Order Modifying Licensees With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, Revision 0, dated March 12, 2012, (ADAMS Accession No. ML12054A735).
3. NRC letter, McGuire Nuclear Station, Units 1 and 2 - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies), dated January 16, 2014, (ADAMS Accession No. ML13338A406).
4. McGuire Nuclear Station First Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-basis External Events (Order Number EA-12-049) Dated August 28, 2013 (ADAMS Accession No. ML13254A204).
5. McGuire Nuclear Station Second Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-basis External Events (Order Number EA-12-049) Dated February 27, 2014 (ADAMS Accession No. ML14073A462).
6. McGuire Nuclear Station Third Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-basis External Events (Order Number EA-12-049) Dated August 27, 2014 (ADAMS Accession No. ML14253A188).
7. McGuire Nuclear Station Fourth Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-basis External Events (Order Number EA-12-049) Dated February 26, 2015, (ADAMS Accession No. ML15075A016).
8. McGuire Nuclear Station Fifth Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-basis External Events (Order Number EA-12-049) Dated August 26, 2015, (ADAMS Accession No. ML15253A198).
9. NRC Order Number EA-12-051, Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation, dated March 12, 2012, (ADAMS Accession No. ML12054A679).
10. Duke Energy Letter, Duke Energy Carolinas, LLC, (Duke Energy) Overall Integrated Plans in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated February 28, 2013 (ADAMS Accession No. ML13086A095).

11. Duke Energy Letter, Duke Energy Carolinas, LLC, (Duke Energy), First Six-month Status Reports in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated August 26, 2013 (ADAMS Accession No. ML13242A009).
12. Duke Energy Letter, Duke Energy Carolinas, LLC, (Duke Energy), Second Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated February 27, 2014 (ADAMS Accession No. ML14073A467).
13. Duke Energy Letter, Duke Energy Carolinas, LLC, (Duke Energy), Third Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated August 27, 2014 (ADAMS Accession No. ML14253A187).
14. Duke Energy Letter, Duke Energy Carolinas, LLC, (Duke Energy), Fourth Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated February 26, 2015 (ADAMS Accession No. ML15075A017).
15. Duke Energy Letter, Duke Energy Carolinas, LLC, (Duke Energy), Fifth Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated August 26, 2015 (ADAMS Accession No. ML15246A032).
16. NRC letter, McGuire Nuclear Station, Units 1 and 2- Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Instrumentation Related to Orders EA 12-049 and EA 12-051 (TAC Nos. MF1160, MF1161, MF1062 and MF1063), dated October 9, 2014 (ADAMS Accession No. ML14241A454).
17. 10CFR50.54(f), "Request for Information Pursuant to Title 10 of the Code of Federal Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force review of Insights from the Fukushima Dai-ichi Accident", Recommendation 9.3, dated March 12, 2012, ADAMS Accession No. ML12053A340.
18. Duke Energy Letter, Response to March 12, 2012, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendation of the Near- Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, Enclosure 5, Recommendation 9.3, Emergency Preparedness - Staffing, Requested Information, Phase 2 Staffing Assessment, dated May 19, 2014, (ADAMS Accession No. ML14161A232).
19. NEI 12-06, Revision 0 "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide."
20. NEI 12-02, Revision 1 "Industry Guidance for Compliance with NRC Order EA-12-051, 'To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation.'"
21. NEI 12-01, Revision 0 "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities."
22. NRC letter, McGuire Nuclear Station, Units 1 and 2 - Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA 12-051, Reliable Spent Fuel Pool Instrumentation (TAC Nos. MF1062 and MF1063) dated October 28, 2013, (ADAMS Accession No. ML13281A791).

ATTACHMENT 2
MNS NRC AUDIT REPORT OPEN AND PENDING ITEMS

Duke Energy affirms that MNS is in full compliance with Orders EA-12-049 and EA-12-051 as demonstrated by the docketed correspondences concerning these orders. Briefly, MNS FLEX Interim Staff Evaluation (ISE) Open and Confirmatory Items are complete pending NRC closure; MNS FLEX OIP Open Items are complete pending NRC Closure; MNS FLEX Audit Questions are complete pending NRC closure; MNS FLEX NRC Audit Report Open Items are complete pending NRC closure; and the MNS Request for Additional Information (RAI) provided in the Spent Fuel Pool Level Instrumentation (SFPLI) ISE are complete pending NRC closure.

Duke Energy provides the following response for the Audit Report Open and Pending Items and considers them to be complete pending NRC closure for McGuire Nuclear Station:

Item	Description	Summary Response
ISE CI 3.1.1.4.A	Off-Site Resources The NRC staff requests that the licensee provide a copy of the SAFER Response Plan on the E-Portal once it's finalized.	<u>McGuire Response:</u> Reference Attachment 3 for response.
ISE CI 3.2.4.4.A	Lighting and Communications The NRC staff requested that the licensee provide confirmation of the modifications to the communications systems once completed.	<u>McGuire Response:</u> Reference Attachment 3 for response.
Licensee Identified OIP Open Item 5	Process Connections The NRC staff requested that the licensee provide a summary of the plant modifications to implement the FLEX strategy for staff review.	<u>McGuire Response:</u> For U1 and U2 the FLEX/SFPLI modifications were completed during the 1EOC23 and 2EOC23 RFOs respectively, and a summary of these modifications has been placed on the E-Portal.
ISE CI 3.2.3.A, Containment Functions Strategies	Containment Functions Strategies The licensee has provided a response to the question on the E-Portal; however, the staff requests that the calculations be posted on the E-Portal.	<u>McGuire Response:</u> Calculation DPC-1552.08-00-0280, revision 2 ("Extended Loss of AC Power (ELAP) - Ice Condenser Containment Response with FLEX Mitigation Strategies") has been placed on the E-Portal. ELAP response actions associated with Containment Functions are primarily contained in 1, 2-FSG-12, which also have been placed on the E-Portal.

ISE CI 3.2.4.9.A, Portable Equipment Fuel	Portable Equipment Fuel Provide information on the fuel quality from the trucks that will be onsite to initially refuel FLEX equipment.	McGuire Response: The McGuire FLEX equipment fuel and fuel quality evaluation is complete and has been placed on the E-Portal. Additionally, details can be found in the McGuire FLEX Program Document, which has also been placed on the E-Portal.
SE Review Item 5	NOTRUMP Code Licensee needs to confirm applicability of the PWROG white paper and any plant-specific conditions, as the staff has not agreed with generic scaling methodology. Based on additional discussions with PWROG and vendor after audit as well as NRC staff confirmatory calculations, staff believes that NOTRUMP code is adequate for simulation of ELAP event. However, because of simplifications made in scaling method, comparison of key plant parameters such as initial RCS mass, accumulator mass dumped, and final cooldown pressure are necessary to confirm applicability of coping time from generic case.	McGuire Response: This is an ongoing generic NRC issue related to the ELAP RCP seal leakage issue and the time required to begin makeup to the RCS. To address this item, the NRC requested sites using standard RCP seal packages to provide a RCP Seal Leakage Margin Assessment paper. MNS provided a draft of this assessment to the NRC via the E-Portal, and a final version is in Attachment 7. Reasonable assurance of compliance with endorsed guidance is achieved via in-house evaluations confirming McGuire's FLEX strategies remain bounded by the WCAP-17601-P, revision 1 reference case as well as subsequent PWROG evaluations. As such, closure of this issue was not a requirement for Unit startup. Duke Fleet Fukushima Response/PWROG continue to work with the NRC to close this generic issue.
SE Review Item 7	RCP Leakage Rate Licensee needs to provide calculations/analyses demonstrating that (1) piping rupture in seal leakoff line would not occur during ELAP, or that (2) seal leakage rates would not increase if piping in seal SE Review Item 7 RCP Leakage Rate leak-off line were to rupture under ELAP conditions. Licensee also needs to	McGuire Response: This is an ongoing generic NRC issue related to the ELAP RCP seal leakage issue and the potential rupture of the #1 seal leak-off line. The current NRC position is that the leak-off piping should maintain integrity up to 2500 psia. To address this item, the NRC requested sites using standard RCP seal packages to provide a RCP Seal Leakage Margin Assessment paper. MNS provided a draft of this

	demonstrate adequacy of the model used to compute leak-off line pressures as a prerequisite (see item 8).	assessment to the NRC via the E-Portal and a final version is in Attachment 7. Reasonable assurance of compliance with endorsed guidance is achieved via in-house evaluations confirming McGuire's FLEX strategies are bounded by the WCAP-17601-P, revision 1 reference case as well as subsequent PWROG evaluations. As such, closure of this issue was not a requirement for Unit startup. Duke Fleet Fukushima Response/PWROG continue to work with the NRC to close this generic issue.
SE Review Item 8	RCP Seal Leakage Rate Licensee needs to confirm whether it is relying on generic analyses from the Westinghouse seal leakage model or using an alternative plant-specific analysis (e.g., MPR). Licensee needs to provide adequate justification for the seal leakage rates calculated according to the Westinghouse seal leakage model that was revised following the issuance of NSAL-14-1 or an alternative model (e.g., MPR). The justification should include a discussion of the following factors: 1. Benchmarking of the seal leakage model against relevant data from tests or operating events, 2. Discussion of the impact on the seal leakage rate due to fluid temperatures greater than 550°F resulting in increased deflection at the seal interface, 3. Clarification whether the second-stage reactor coolant pump seal would	<u>McGuire Response:</u> This is an ongoing generic NRC issue related to the ELAP RCP seal leakage issue and the RCP seal model used in evaluating LOSC response. To address this item, the NRC requested sites using standard RCP seal packages to provide a RCP Seal Leakage Margin Assessment paper. MNS provided a draft of this assessment to the NRC via the E-Portal and a final version is in Attachment 7. Reasonable assurance of compliance with endorsed guidance is achieved via in-house evaluations confirming McGuire's FLEX strategies are bounded by the WCAP-17601-P, revision 1 reference case as well as subsequent PWROG evaluations. As such, closure of this issue was not a requirement for Unit startup. Duke Fleet Fukushima Response/PWROG continue to work with the NRC to close this generic issue.

	remain closed under ELAP conditions predicted by the revised seal leakage model and a technical basis to support the determination, and, 4. Justification that the interpolation scheme used to compute the integrated leakage from the reactor coolant pump seals from a limited number of computer simulations (e.g., three) is realistic or conservative.	
ISE CI 3.2.4.10.A The staff will complete a vendor audit of the batteries.	Battery Sizing Calculations The staff will complete a vendor audit of the batteries.	McGuire Response: McGuire understands NRC staff will be auditing the battery vendor to close this item. Related to this open item, MNS determined that vital battery coping time post ELAP will be 18 hours and not 24 hours as originally communicated to NRC staff. The new information was included in the Fifth Six Month Status Update for EA 12-049 (ML15253A198) as a change to OIP item 52. This change required a calculation revision and related revisions to 1, 2-ECA-0.0 and FSG-5. The revised plant procedures and calculation have been placed on the E-Portal.
ISE CI 3.4.A	Off-Site Resources The NRC staff discussed with the licensee its plan to address minimum capabilities of off-site resources, outlined in the 10 guidelines in NEI 12-06. The licensee indicated that the National SAFER Response Center generated a generic response to address the guidelines, and coordination of McGuire strategies with the National SAFER Response	McGuire Response: Reference Attachment 3 for response.

	Centers is ongoing. During the onsite audit, the licensee provided a copy of the generic response and the NRC staff is still in the process of reviewing the document.	
AQ-35	Loss of Heat Tracing Effects, NEI 12-06, Section 3.2.2, Guideline 12 The staff is currently reviewing the licensee's response on the E-Portal	McGuire Response: A loss of heat tracing during an ELAP event does not significantly affect the MNS FLEX response strategies. FLEX procedure FSG-5 identifies actions that can be taken in cold weather as needed. FSG-5 and other information related to this item, discussed with NRC tech staff during the on-site Audit, was placed on the E-Portal.
ISE CI 3.2.1.7.A, Shutdown and Refueling Modes	Shutdown and Refueling Modes During the onsite audit, the licensee provided a copy of the PWROG interim generic guidance that identified minimal coping strategies for PWRs when an ELAP event occurs in a shutdown mode, and the NRC staff is still in the process of reviewing the document.	McGuire Response: McGuire followed the endorsed guidance given for shutdown modes response given in NEI 12-06, revision 0, the NRC-endorsed NEI White paper "Shutdown/Refueling Modes" (ML13273A514 / ML13267A382), and the clarifications provided by FLEX Guidance Inquiry 2013-10. Subsequent discussion with NRC regarding FWST robustness for airborne missiles generated a revision to FLEX procedures 1, 2-FSG-23 to provide additional water sources. The revised plant response procedures are on the E-Portal. MNS expects final guidance (which will incorporate the above) to be in NEI 12-06, Revision 1, which has been sent to NRC by NEI for approval as of October 2015. McGuire's shutdown ELAP response strategy as described in Attachment 6 is in compliance with the NEI 12-06, Revision 1 pending guidance document, as well as with the endorsed guidance on

		Shutdown/Refueling Modes.
SRAI-14,15, & 16	SFPI Shock and Vibration analysis. The staff is waiting for AREVA to submit a revised shock and vibration analysis.	McGuire Response: Reference Attachment 5 for response (item 14).

Duke Energy provides the following response to the Interim Staff Evaluation (ISE) open and confirmatory items contained in NRC Letter, "MNS – Interim Staff Evaluation Relating to the Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies), (Agency-wide Documents Access and Management System (ADAMS) Accession No. ML13338A406).

Open Item #	Description	Summary Response
ISE OI 3.2.1.8.A	The PWROG submitted to NRC a position paper, dated August 15, 2013, which provides test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability conditions intended to ensure that boric acid addition and mixing would occur under conditions similar to those for which boric acid mixing data is available. During the audit process, the licensee informed the NRC staff of its intent to abide by the generic approach discussed above. The licensee should address the clarifications in the NRC endorsement letter dated January 8, 2014.	McGuire Response: This item is considered previously closed. The generic approach described in the 8/15/13 PWROG position paper, including the NRC's clarifications, was followed by McGuire when developing the Boration evaluation and FLEX response strategies. The boration calculation is DPC-1552.08-00-0278, revision 2. This calculation, along with further boration evaluation discussion pertinent to this open item, has been placed on the E-Portal for tech staff review.

Confirmatory Item #	Description	Summary Response
ISE CI 3.1.1.2.A	Deployment of FLEX equipment - On page 57 of its Integrated Plan, in the chart identifying Pressurized Water Reactor (PWR) Portable Equipment Phase 2, the licensee lists (9) 9×12 trailers used to store and deploy power equipment, but does not list tow vehicles. Confirm abilities to move FLEX equipment and the level of protection afforded the means to move.	McGuire Response: This item is considered previously closed. Towing capability for stored FLEX equipment will be available in several forms. Not all FLEX components will need the heaviest capability in order to be deployed. McGuire has assigned to the site the following tow-capable vehicles: • 48 ¾-ton trucks • 8 rubber tire tractors These vehicles are normally in use around the site, and Site Services administrative procedures will ensure availability (i.e., fuel, maintenance). In addition to these, McGuire has procured a Dodge short wheelbase 4WD stake body diesel truck, and a Caterpillar 924K Wheel Loader. Both of these vehicles are capable of towing the heaviest FLEX components (i.e., the 500kW FLEX Diesel Generators). The Caterpillar 924K Wheel Loader and the diesel truck will be stored in two of the FLEX Buildings.
ISE CI 3.1.1.3.A	McGuire ISE Confirmatory Item 3.1.1.3.A states: "Procedural interfaces, seismic - Confirm evaluation that shows time is available to deploy ground water sump pumps as needed in critical locations in addition to the vicinity of the TDAFW pump."	McGuire Response: This item is considered previously closed. Initial response to NRC on this item identified the FLEX strategy timeline for the CA Pump Room on AB elevation 716' (28 hours to deploy a FLEX sump pump), and the timeline for the ND/NS Pump Room on AB elevation 695' (18 hours to deploy a FLEX sump pump). This information supported development of FSG-22 ("FLEX Sump Pumps Operation"). Assumptions made for the limiting flood inputs were based on a reasonable evaluation of internal non-seismic pipe breaks, along

Confirmatory Item #	Description	Summary Response
		with the assumption (based on operating experience) that the A & B sumps on AB elevation 716' don't communicate well with C sump in real time, if at all. A further evaluation of the potential real-time interaction of the A, B, and C Auxiliary Building sumps was performed, and concludes that the originally identified deployment times for the FLEX sump pumps are still valid for the breaks assumed. It was confirmed that flooding the 716' elevation of the Aux Bldg. would take a considerable amount of time, and if flooding in this area was observed early in the event, the deployment location of the pumps can be adjusted in order to prevent the 695' elevation from flooding. FSG-22 (FLEX Sump Pumps Operation) contains guidance for this scenario. The FLEX sump pump evaluation has been placed on the E-Portal.
ISE CI 3.1.1.4.A	Off Site Resources, seismic – Confirm development of the MNS playbook as well as identification of the local Assembly Area and routes to the plant.	McGuire Response: By letter dated 9/11/14, NEI submitted a white paper to the NRC regarding the functionality of the National SAFER Response Centers. The white paper provides the programmatic aspects and implementation plans for the SAFER program to be in conformance with the applicable portions of NEI 12-06, rev. 0. On 9/26/14, the NRC issued its staff assessment of the white paper and the SAFER program with regard to conformance with the applicable portions of guidance document NEI 12-06 as endorsed by the NRC in JLD-ISG-2012-01. The NRC staff assessment states, "The NRC staff has concluded that SAFER has procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI

Confirmatory Item #	Description	Summary Response
		12-06 guidance. Therefore, the NRC staff concludes that licensees can reference the SAFER program and implement their SAFER Response Plans to meet the Phase 3 requirements of Order EA-12-049." The McGuire SAFER playbook was issued 9/25/14, and a copy uploaded to the NRC E-Portal. The local RRC deployment sites for McGuire are identified in the playbook.
ISE CI 3.1.3.1.A	Protection of FLEX equipment, high winds – Provide site specific data to justify the assumed tornado width of 1200 feet, which will be needed to confirm the final locations of the FLEX storage facilities conform to NEI 12-06 guidance.	McGuire Response: This item is considered previously closed. The linear distance between McGuire FLEX Building #1 location (the furthest south) and FLEX Building #2 location (the central position) is 1477 feet; linear distance between FLEX Building location #2 and FLEX Building #3 location (the furthest north) is 2571 feet. As these distances exceed the NEI 12-06, revision 0 guidance minimum distance required for separation (i.e., 1200 feet), and the alignment of the McGuire FLEX Buildings accounts for the most applicable reasonable and accurate tornado statistics, the McGuire FLEX Building proposed locations meet the intent of NEI 12-06 and compliance with the guidance is confirmed. Further evaluation and discussion of the FLEX Building design and locations has been placed on the E-Portal.
ISE CI 3.1.5.2.A	Deployment of FLEX equipment, high temperatures - Confirm that the storage facilities will be designed for extreme temperature ranges including concerns for expansion of sheet metal, swollen door seals, etc.	McGuire Response: This item is considered previously closed. The design of the McGuire FLEX Buildings is such that temperature extremes will not pose a hazard to stored FLEX equipment or access to the equipment. The

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		design of the FLEX Buildings combined with the normally temperate climate of the McGuire site location precludes extreme temperature ranges from challenging FLEX equipment stored in the buildings or deployment from the buildings. Further evaluation and discussion of FLEX Building design has been placed on the E-Portal. Evaluation of the FLEX Building passive response to temperature extremes during a temporary loss of retail power condition has also been performed in order to support necessary response actions. This evaluation has been placed on the E-Portal for tech staff review.
ISE CI 3.2.1.A	RCS Cooling and Heat Removal, and RCS Inventory Control Strategies - Justify the use of the analysis from Sections 5.2.1 and 5.2.2 of WCAP-17601-P by identifying and evaluating the important parameters and assumptions demonstrating that they are representative of MNS and appropriate for simulating the [Extended loss of alternating current (ac) power] ELAP transient.	<u>McGuire Response</u>: This item is considered previously closed. The NOTRUMP analysis applicable to McGuire Units 1 and 2 is provided in Section 5.2.1 and Section 5.2.2 of WCAP-17601-P, Revision 1. The generic applicability of this NOTRUMP analysis to McGuire Nuclear Station is provided in Sections 4.1.1 and 5.3.1.4 of the WCAP. McGuire plant-specific parameters are identified in the ELAP mass-energy release calculation (DPC-1552.08-00-279, revision 0) and summarized in the McGuire ELAP Parameters table, both of which have been placed on the E-Portal.
ISE CI 3.2.1.1.A	Computer Code Used for ELAP Analysis – Confirm that reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions prior to reflux condensation initiation. This includes specifying an acceptable definition for reflux condensation cooling.	<u>McGuire Response</u>: This item is considered previously closed. The use of NOTRUMP for the MNS ELAP analysis was limited to the thermal-hydraulic conditions before reflux condensation initiates. The initiation of reflux

Confirmatory Item #	Description	Summary Response
		condensation cooling is defined when the one hour centered moving average (CMA) of the flow quality at the top of the SG U-tube bend exceeds 0.1 in any one loop. MNS plant-specific evaluation using RELAP5 was performed to confirm system response (DPC-1552.08-00-279, revision 0). The current analyses and evaluations supporting the McGuire FLEX response demonstrate that the FLEX Phase 2 RCS makeup pump is being implemented prior to the loop flow rate decreasing below the loop flow rate corresponding to the definition of the onset of reflux condensation. The pertinent analyses and evaluations have been placed on the E-Portal.
ISE CI 3.2.1.2.A	[Reactor Coolant Pump] RCP seals – Confirm that the RCP seal initial maximum leakage rate used in the analysis is greater than or equal to the upper bound expectation for the ELAP event (21 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for Westinghouse plants.	McGuire Response: This item is considered previously closed. In February of 2014, Westinghouse issued a Nuclear Safety Advisory Letter NSAL-14-1 "Impact of Reactor Coolant Pump No. 1 Seal Leakoff Piping on Reactor Coolant Pump Seal Leakage During a Loss of All Seal Cooling". This NSAL (and its subsequent revision 1) describes the potential effect of leak-off piping configuration on RCP #1 seal leak rates during an extended LOSC event. As a result of this NSAL, modifications were made to each MNS RCP #1 seal LO line to add a restriction orifice. In March of 2015, Westinghouse issued another Nuclear Safety Advisory Letter NSAL-15-2 "Impact of a Break in the Reactor Coolant Pump No. 1 Seal Leak-off Line Piping on Seal Leakage During a Loss of Seal Cooling

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		Event". This NSAL describes the potential effect of a large pressure spike causing a rupture of the LO piping on RCP #1 seal leak rates during an extended LOSC event. As a result of this NSAL, MNS evaluated the piping and supports for each #1 seal LO line for a pressure spike as high as 2500 psia (i.e., the maximum RCS pressure following ELAP initiation). Further in-house evaluation with this modified configuration and piping conditions shows that the line remains intact and maximum RCP seal LO flow rates remain below 21 gpm/pump at all times, including during the depressurization and cooldown evolutions performed after ELAP initiation. These evaluations have been placed on the E-Portal; further information can be found in Attachment 7. McGuire is participating in, and continues to follow, industry/NRC efforts to close issues related to RCP seal leakage during an extended LOSC event.
ISE CI 3.2.1.2.B	RCP seals - In some plant designs, such as those with 1200 to 1300 psia [steam generator] SG design pressures and no accumulator backing of the main steam system power-operated relief valve (PORV) actuators, the cold legs could experience temperatures as high as 580 degrees F before cooldown commences. This is beyond the qualification temperature (550 degrees F) of the O-rings used in the RCP seals. For those Westinghouse designs, a discussion of the information (including the applicable analysis and relevant seal leakage testing data) should be provided to justify that (1) the integrity of the associated O-rings will be maintained at the	McGuire Response: This item is considered previously closed. PWROG submitted letter LTR-RES-13-153 ("Documentation of 7228C O-Rings at ELAP Conditions") on November 11, 2013. The letter, which has been placed on the E-Portal for tech staff review, documents a Westinghouse evaluation of compound 7228C RCP O-rings at ELAP conditions up to 582°F (the same O-rings in use at McGuire), and concludes that they will not fail during an 8-hour SBO event w/o seal cooling. The average O-ring failure occurred at 18 hours, with the first failure occurring at 13 hours.

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	temperature conditions experienced during the ELAP event, and (2) the seal leakage rate of 21 gpm/seal used in the ELAP is acceptable.	1, 2-ECA-0.0 directs RCS cooldown during an ELAP event, which initiates cooldown within the first two hours. These procedures have been placed on the E-Portal.
ISE CI 3.2.1.2.C	RCP seals - If the seals are changed to the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals, the acceptability of the use of the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals should be addressed and the RCP seal leakages rates for use in the ELAP analysis should be provided with acceptable justification.	McGuire Response: This item is considered previously closed. McGuire Units 1 and 2 are four-loop Westinghouse Nuclear Steam Supply System (NSSS) design units with model 93A reactor coolant pumps (RCPs) and Westinghouse seals. The ELAP analysis performed in Section 5.2.1 of WCAP-17601-P simulates a model 93A RCP with 21 gpm seal leakage, and is therefore applicable to McGuire Units 1 and 2. McGuire has no current plans to change to low leakage RCP seals or non-Westinghouse seals. If at a future time the seals were to be changed out, the replacement would be performed as a plant modification (Engineering Change). The Engineering Change Program is designed to address all pertinent design inputs and interfaces, which includes the effect on FLEX strategies related to Order EA-12-049 and BDBEEs.
ISE CI 3.2.1.3.A	Decay Heat - Values of the following key parameters used to determine the decay heat should be specified and the adequacy of the values evaluated: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel characteristics, if it's based on the beginning of the cycle, middle of the cycle, or end of the	McGuire Response: This item is considered previously closed. The decay heat curve assumed in the Westinghouse calculations in WCAP-17601, revision 1 is representative of McGuire. Section 5.2.1 of WCAP-17601 modeled a four-loop, 3723 MWt, Model F S/G, HP ECCS, and Model 93A/A-1 RCP. McGuire Units 1 and 2 are

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	cycle.	represented by this 412 T_{cold} reference case. The plant-specific decay heat parameters assumed for the McGuire ELAP mass-energy release evaluation are identified in calculation DPC-1552.08-00-0279, revision 0. This calculation and further discussion have been placed on the E-Portal.
ISE CI 3.2.1.4.A	Initial Values for Key Plant Parameters and Assumptions – Confirm results and appropriate actions subsequent to Westinghouse supplying MNS with additional information regarding the key plant parameters and assumptions.	McGuire Response: This item is considered previously closed. This Confirmatory Item relates to the four NRC Audit Questions dated September 30, 2013. McGuire subsequently requested Westinghouse assistance with: Audit Question McGuire-24; Audit Question McGuire-27(b); McGuire-28; and McGuire-40. These four Audit Questions are responded to in the following previously dispositioned Confirmatory Items: • Confirmatory Item 3.2.1.A: Application of the WCAP-17601 Reference case coping times/AFW requirements to McGuire • Confirmatory Item 3.2.1.1.A: Application of NOTRUMP evaluation to McGuire • Confirmatory Item 3.2.1.2.A: Application of the 21 • gpm/pump RCP seal leakoff rate to McGuire • Confirmatory Item 3.2.1.3.A: Decay heat parameters applicable to McGuire

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ISE CI 3.2.1.7.A	Confirm that MNS will abide by the generic resolution for shutdown and refueling concerns.	McGuire Response: Also see Attachment 2, MNS NRC Audit Report Open and Pending Items McGuire followed the endorsed guidance given for shutdown modes response given in NEI 12-06, revision 0, the NRC-endorsed NEI White paper "Shutdown/Refueling Modes" (ML13273A514 / ML13267A382), and the clarifications provided by FLEX Guidance Inquiry 2013-10. Subsequent discussion with NRC regarding FWST robustness for airborne missiles generated a revision to FLEX procedures 1, 2-FSG-23 to provide additional water sources. The revised plant response procedures are on the E-Portal. MNS expects final guidance (which will incorporate the above) to be in NEI 12-06, Revision 1, which has been sent to NRC by NEI for approval as of October 2015. McGuire's shutdown ELAP response strategy as described in Attachment 6 is in compliance with the current NEI 12-06, Revision 1 pending guidance document, as well as with the endorsed guidance on Shutdown/Refueling Modes.
ISE CI 3.2.3.A	Containment Functions Strategies – Confirm completion of the long term containment analysis and appropriate actions.	McGuire Response: Also see Attachment 2, MNS NRC Audit Report Open and Pending Items Calculation DPC-1552.08-00-0280, revision 2 ("Extended Loss of AC Power (ELAP) - Ice Condenser Containment Response with FLEX Mitigation Strategies") has been placed on the E-Portal. ELAP response actions associated with Containment Functions are primarily contained in 1, 2-FSG-12, which

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		also have been placed on the E-Portal.
ISE CI 3.2.4.4.A	Lighting and Communications - Confirmation will be required that upgrades to the site's communications systems have been completed.	McGuire Response: UHF system enhancements for ELAP events were made during the 1EOC23 refueling outage at McGuire in fall 2014. These modifications are common to both Units 1 and 2. Confirmation of the scope and completion of these modifications has been placed on the E-Portal.
ISE CI 3.2.4.6.A	Ventilation for Equipment Cooling and Personnel Habitability - Room heat up response for specific MNS areas are completed but need to be evaluated by NRC personnel. Confirm completion of evaluation and appropriate actions. Also, confirm ventilation for critical electrical components. Review turbine-driven auxiliary feedwater (TDAFW) Pump, Switchgear, Battery, and Control rooms.	McGuire Response: This item is considered previously closed. Room heat-up response for selected areas of the McGuire Auxiliary Building has been completed (calculation MCC-1240.00-00-0010, revision D2). For the McGuire Fuel Building (evaluated separately), the calculation is MCC-1240.00-00-0011, revision 0. NRC Audit Questions 33, 34, 41, and 50 all requested further information regarding the room heat-up evaluations; the responses to these queries have been placed on the E-Portal, along with the above calculations. Response actions related to equipment cooling and habitability are primarily directed by FSG-5, which has also been placed on the E-Portal.

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ISE CI 3.2.4.7.A	Water Sources- Confirm that plant procedures specify that a flow path is promptly established for makeup flow to the steam generators and identify backup water sources in order of intended use; and that plant procedures/guidance should specify clear criteria for transferring to the next preferred source of water.	McGuire Response: This item is considered previously closed. At McGuire, the TDCA pump suction at ELAP onset is automatically aligned to the embedded RC piping inventory if the CAST becomes unavailable due to the BDBEE. FLEX Support Guidelines (FSGs) for McGuire ELAP response contain the appropriate hierarchy of establishing and maintaining feedwater to the SGs beyond this automatic alignment. The following related FSGs are entered from EP/1,2/A/5000/ECA 0.0 (Loss of All AC Power) or other FSGs: FSG-2: Alternate TD CA Pump Suction Source FSG-3: Alternate Low Pressure Feedwater FSG-6: Alternate CA Storage Tank (Water Tower) Makeup FSG-9: Low Decay Heat Temperature Control FSG-21: FLEX Raw Water Distribution All of the above FSGs have been placed on the E-Portal.
ISE CI 3.2.4.8.A	Electrical Power Sources - Confirm completion of Flex Diesel Generator sizing calculation and appropriate actions.	McGuire Response: This item is considered previously closed. The FLEX Diesel Generator sizing calculation is MCC-1381.05-00-0352, revision 2. This calculation has been placed on the E-Portal. McGuire will use one 500kW (625 kva) DG per Unit to

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		supply the power needed for the FLEX Phase 2 strategies. The portable FLEX Alternate AC power system is composed of transformers, power distribution panels, and spider boxes, connected via appropriately sized cables/connectors. Deployment of the FLEX Phase 2 Alternate AC power system is guided by FSG-20 "FLEX Electrical Distribution" and FSG-5 "Initial Assessment and FLEX Equipment Staging". These FSGs have been placed on the E-Portal.
ISE CI 3.2.4.9.A	Portable Equipment Fuel - Confirm completion of evaluation and appropriate actions to assess long-term FLEX equipment fuel oil requirements. Confirm that the licensee's guidance ensures that equipment will operate continuously without interruption.	McGuire Response: Also see Attachment 2, MNS NRC Audit Report Open and Pending Items. There are adequate diesel fuel supplies available during an ELAP response for many days prior to requiring replenishment from outside sources. The non-diesel fuel supplies are more limiting, but still support more than 24 hours of FLEX equipment usage. Beyond 24 hours, additional fuel is available from offsite, as NEI 12-01, revision 0 guidance indicates normal ingress/egress from the plant site is assumed to be restored in Phase 3. As refueling requirements of many of the available vehicles during an ELAP event will be a function of usage and frequency and is therefore not predictable, a refueling timeline for major FLEX components (i.e., diesel generators, diesel pumps, and diesel air compressors) was developed and placed in the FLEX

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		Program Document. The FLEX equipment fuel evaluation and the FLEX Program Document have been placed on the E-Portal.
ISE CI 3.2.4.10.A	Review [direct current] dc load shedding analysis/procedures and walkdown equipment. Perform walk-down of load shedding procedure with an Operator. The battery sizing calculation needs to be verified when revised to show that dc power for 2 of 4 channels can be maintained for 24 hours without a charger in place.	McGuire Response: Also see Attachment 2, MNS NRC Audit Report Open and Pending Items. The Vital Battery I&C SBO Coping Time evaluation is located in calculation MCC-1381.05-00-0351, revision 3. McGuire determined that vital battery coping time post ELAP will be 18 hours and not 24 hours as originally communicated to NRC staff. The new information was included in the Fifth Six Month Status Update for EA 12-049 (ML15253A198) as a change to OIP item 52. This change required a calculation revision and related revisions to 1, 2-ECA-0.0 and FSG-5. The revised plant procedures and calculation have been placed on the E-Portal.
ISE CI 3.2.4.10.B	Load Reduction to Conserve DC Power - Confirm that ELAP procedures/guidance will direct operators to conserve dc power during the event by stripping nonessential loads as soon as practical.	McGuire Response: This item is considered previously closed. The Operations shift manager will have to decide within 2 hours that a single essential bus cannot be recovered within 4 hours of ELAP event onset. When that decision is made, DC bus stripping must be completed within the next hour. Actions have been validated (locally and on simulator) to be completed in less than the required

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		times. Procedure EP/1/A/5000/ECA-0.0, Enclosure 21 "Vital Battery Alignment and Load Stripping" is the operative document for shedding nonessential loads off of the vital busses (both Units). This procedure has been placed on the E-Portal.
ISE CI 3.4.A	Off-Site Resources - Confirm NEI 12-06, Section 12.2 guidelines 2 through 10 are addressed with the RRC.	McGuire Response: By letter dated 9/11/14, NEI submitted a white paper to the NRC regarding the functionality of the National SAFER Response Centers. The white paper provides the programmatic aspects and implementation plans for the SAFER program to be in conformance with the applicable portions of NEI 12-06, rev. 0. On 9/26/14, the NRC issued its staff assessment of the white paper and the SAFER program with regard to conformance with the applicable portions of guidance document NEI 12-06 as endorsed by the NRC in JLD-ISG-2012-01. The NRC staff assessment states, "The NRC staff has concluded that SAFER has procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI 12-06 guidance. Therefore, the NRC staff concludes that licensees can reference the SAFER program and implement their SAFER Response Plans to meet the Phase 3 requirements of Order EA-12-049." The McGuire SAFER playbook was issued 9/25/14, and a copy uploaded to the NRC E-Portal. The local RRC deployment sites for McGuire are identified in the playbook.

MNS RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING THE OVERALL INTEGRATED PLAN FOR IMPLEMENTATION OF ORDER EA-12-051, RELIABLE SPENT FUEL POOL INSTRUMENTATION

The MNS Response to the Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation was provided to the NRC in Duke Energy Letter, Duke Energy Carolinas, LLC, (Duke Energy), Second Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated February 27, 2014 (ADAMS Accession No. ML14073A467).

No further information is required for this attachment.

#	Topic	Parameter Summary	Vendor Design Reference Document #	Additional Comments	Test or Analysis Results	Licensee Evaluation
1	Design Specification	Customer technical requirements specification for SFPLI	Duke Technical Requirements Document DPR-1336.04-00-0001 Rev. 02 , Duke PO 171968, Rev. 003	EA-12-051, NEI-12-02	N/A	The vendor instrumentation design was reviewed and determined to adequately meet the specification requirements.
2	Test Strategy	Qualification is based on a combination of tests and analyses or similarity. Qualification tests and analyses are summarized in qualification analyses report 51-9202556-002.	Qualification analyses Doc. 51-9202556-005	EA-12-051, 1.4 NEI-12-02, 3.4	Test and analyses results meet requirements of EA 12-051, JLD-ISG-2012-03, and NEI 12-02 Rev. 1	The vendor qualification documentation was reviewed and concluded to adequately demonstrate the instrumentation could reliably function in its installed environment(s) during a postulated Beyond Design Bases External Event (BDBEE).
3	Environmental qualification for electronics enclosure with display	Temperature and humidity	Qualification Analyses Doc. 51-9202556-005, Section 2.3	NEI 12-02, 3.4	Temperature rating of Power Control Panel is 149°F allowing for 9°F rise in the panel above ambient. NEMA 4X enclosure prevents moisture intrusion. Radiation withstand analyzed to 1×10^3 rads	The primary channel instrumentation electronics are located outside the SFP area. The vendor instrumentation design temperature, humidity, and dose limits bound the expected environmental conditions during a postulated BDBEE. Refer to RAIs #11 and #12 responses in Duke letter to the NRC dated 2/27/14.
4	Environmental testing for level sensor components in SFP area – Saturated steam & Radiation	Measurement capability through saturated steam and smoke. Testing performed to demonstrate the radar horn cover was effective at preventing moisture intrusion within the horn and wave guide pipe. Radar horn cover (fused silica glass), metal waveguide pipe and horn are not susceptible to radiation degradation. Manufacturer test data supports acceptable radiation degradation resistance for the radar horn cover adhesive.	Qualification Analyses Doc. 51-9202556-005, Section 2.3, 2.4, 2.5, 2.7, Appendix B and supporting references 66-9200846-002 51-9220845-001 51-9221032-000 66-9225632-000	EA-12-051, 1.4 NEI 12-02, 3.4	Initial testing (without horn cover) demonstrated successful measurement capability through steam and smoke. Subsequent testing of the radar horn and cover demonstrated adequate operation during sustained simulated SFP boiling conditions, and that the horn cover was effective in preventing moisture intrusion within the horn and wave guide pipe. The horn cover adhesive is a silicone elastomer manufactured by Down Corning (Sylgard 170). The adhesive manufacturer radiation test data adequately demonstrates the adhesive would not experience unacceptable degradation for exposures up to 1.64×10^8 Rads.	Refer to RAIs #11, #12, and #13 responses in Duke letter to the NRC dated 2/27/14. The radar horn cover qualification testing adequately demonstrated acceptable operation during exposure to simulated SFP boiling conditions. The horn cover adhesive manufacturer radiation test data adequately demonstrated the adhesive would not experience unacceptable degradation for radiation exposure in excess of that expected for the postulated beyond design bases event over the required mission time.

#	Topic	Parameter Summary	Vendor Design Reference Document #	Additional Comments	Test or Analysis Results	Licensee Evaluation
5	Environmental testing for level sensor electronics housing – outside SFP	Temperature and humidity testing and analysis of sensor and indication	Qualification Analyses Doc. 51-9202556-005, Sections 2.3, 2.5, Appendix A and supporting references IEC 60068-2-30, 38-9218218-000, EN 60529:2000, 38-9218214-000, USNRC Bulletin 79-01B Table C-1, NUREG-173, Vol.1, Section 3.11.3.2.1, Reg. Guide 1.209	NEI 12-02, 3.4	Sensor and indication are demonstrated to withstand the manufacturer ratings 80°C (sensor) and 70°C (indication), 100% RH. Radiation withstand analyzed to 1×10^3 rads.	Refer to RAIs #11 and #12 responses in Duke letter to the NRC dated 2/27/14.
6	Thermal & Radiation Aging – organic components in SFP area	Radar horn cover (fused silica glass), metal waveguide pipe and horn are not susceptible to radiation degradation. Horn cover adhesive manufacturer radiation test data and temperature withstand specifications.	Qualification analyses Doc. 51-9202556-005, Section 2.5 51-9221032-000 66-9225632-000	EA-12-051, 1.4 NEI 12-02, 3.4	Thermal and radiation aging not applicable to metal waveguide in SFP area. The horn cover adhesive is a silicone elastomer manufactured by Down Corning (Sylgard 170). The adhesive manufacturer radiation test data adequately demonstrates the adhesive would not experience unacceptable degradation for exposures up to 1.64 $\times10^8$ Rads. The silicone adhesive is rated to withstand temperatures extremes of -45°C to 200°C, which adequately bound the postulated temperatures for sustained SFP boiling conditions.	The glass and metallic instrumentation components located within the SFP area are not susceptible to aging due to thermal and/or radiation effects. The horn cover adhesive manufacturer radiation test data adequately demonstrated the adhesive would not experience unacceptable degradation for radiation exposure in excess of that expected for the postulated beyond design bases event over the required mission time. The horn cover adhesive temperature ratings are acceptable and readily bound the expected conditions for the postulated beyond design bases event.
7	Basis for Dose Requirement	SFPLI remote transmitter and power control panel qualified to 1×10^3 rads based on industry operating experience. Based on engineering judgment, the expected total integrated dose for the radar horn cover adhesive would not exceed 1×10^8 over the required mission time for the instrumentation.	AREVA Document No. 51-9202556-005, Qualification Analysis of VEGAPULS 62 ER Through Air Radar 51-9221032-000 66-9225632-000	NEI 12-02, 3.4	Analyses based on operating experience concludes the electronics are not susceptible to degraded performance up to this dose threshold. The adhesive manufacturer radiation test data adequately demonstrates the adhesive would not experience unacceptable degradation for exposures up to 1.64 $\times10^8$ Rads.	A location specific dose calculation was performed for the remote electronics, which demonstrated the sensor total integrated dose (TID) over its required mission time is enveloped by the vendor instrumentation design limit of 1×10^3 rads. Refer to RAI #13 response in Duke letter to the NRC dated 2/27/14. The horn cover adhesive manufacturer radiation test data adequately demonstrated the adhesive would not experience unacceptable degradation for radiation exposure in excess of that expected for the postulated beyond design bases event over the required mission time.

#	Topic	Parameter Summary	Vendor Design Reference Document #	Additional Comments	Test or Analysis Results	Licensee Evaluation
8	Seismic Qualification	Seismic withstand capability of VEGAPULS 62 ER sensor, indicators, power control panel, mounting brackets, waveguide pipe	Qualification analyses Doc. 51-9202556-005, Section 2.1, Appendix D and supporting references 11-9203036-001, IEEE STD 344-2004, EPRI TR-107330, 174-9213558-006	NEI 12-02, 3.4	VEGAPULS 62 ER sensor, indicators, power control panel, mounting brackets, and waveguide pipe are seismically qualified to RRS levels from EPRI TR-107330	The vendor instrumentation seismic testing adequately demonstrates the equipment is capable of reliably operating during a seismic event. Refer to RAIs #7, #8, and #17 responses in Duke letter to the NRC dated 2/27/14.
9	Sloshing	NRC RAIs indicated a SFP seismic induced sloshing analyses is required. If wave impact is predicted, then the hydrodynamic forces should be included in the mounting design loading combinations.	Sloshing analyses was performed by an alternate vendor than the supplier of the radar level instrumentation (Reference McGuire calculation MCC-1223.20-00-0022).	N/A	Seismic induced sloshing analyses concluded that the available SFP free-board readily enveloped the maximum predicted wave height. The analyses determined wave impact on the radar horn would not occur.	Sloshing analyses determined seismic induced wave would not impact radar horn.
10	Spent Fuel Pool instrumentation system functionality test procedure	Functionality testing was performed during the factory acceptance test. See #16	VEGA Test Procedure AREVA Doc. 38-9219704-000, Factory Acceptance Test Report AREVA Doc. 66-9219739-000	N/A	Testing demonstrated that the SFPLI met the specification functional requirements.	The vendor factory acceptance test demonstrated reliable operation of the SFP level instrumentation under normal conditions and under various simulated test conditions (e.g. steam exposure). The testing demonstrated the instrumentation met design accuracy and repeatability specifications.
11	Boron Build-Up	N/A	Sloshing analyses was performed by an alternate vendor than the vendor whom supplied the radar level instrumentation (Reference McGuire calculation MCC-1223.20-00-0022).	N/A	Waveguide radar horn is not immersed in SFP water and therefore not susceptible to boron accumulation. During postulated SFP boiling, boron is not transported by rising steam/vapor. Seismic induced sloshing analyses concluded that the available SFP free-board readily enveloped the maximum predicted wave height. The analyses determined that a seismic induced wave would not impact the radar horn.	Licensee concludes that the wave guided radar instrumentation located in the SFP area is not susceptible to degradation due to postulated boron build-up. The wave guided radar horn is elevated above the SFP process and would not be susceptible to boron build-up on the horn during postulated SFP boiling conditions, nor is it credible that boron crystal accumulation on the perimeter of the SFP walls would impede the radar signal strength.

#	Topic	Parameter Summary	Vendor Design Reference Document #	Additional Comments	Test or Analysis Results	Licensee Evaluation
12	Pool-side Bracket Seismic Analysis	Seismic Withstand Test and analyses were performed for the horn cover and adhesive to demonstrate adequate seismic withstand capability. Perform seismic induced sloshing analyses to assess hydrodynamic wave force on the radar horn.	Qualification analyses Doc. 51-9202556-005 and supporting reference 174-9213558-006, Calculations 32-9208751-002, 32-9221237-002 51-9221032-000 66-9225632-000 32-9221237-002 66-9225469-000 Sloshing analyses was performed by an alternate vendor than the vendor whom supplied the radar level instrumentation (Reference McGuire calculation MCC-1223.20-00-0022).	NEI 12-02, 3.4	Sensor brackets and electronic enclosure mounting are seismically qualified to EPRI TR-107330 or site-specific RRS. Testing and analyses horn cover and adhesive support the components can tolerate horizontal and vertical accelerations up to 100g and SFP sloshing loads up to 3.37 psi. Seismic induced sloshing analyses concluded that the available SFP free-board readily enveloped the maximum predicted wave height. The analyses determined wave impact on the radar horn would not occur.	Refer to RAIs #7, #8, and #17 responses in Duke letter to the NRC dated 2/27/14. The test and analyses of the horn cover and adhesive demonstrate adequate Seismic Withstand capability. The stress analyses does not need to consider hydrodynamic sloshing forces in the design of the mounting brackets. The sloshing analyses determined seismic induced wave would not impact radar horn.
13	Additional Brackets (Sensor Electronics and Electronic Enclosure)	Seismic withstand of sensor brackets and electronic enclosure mounting	Qualification analyses Doc. 51-9202556-005, Section 2.1, Appendix D and supporting references 11-9203036-001, EPRI TR-107330, 174-9213558-006 Calculations 32-9208751-002, 32-9221237-002	NEI 12-02, 3.4	Sensor brackets and electronic enclosure mounting are seismically qualified to EPRI TR-107330 or site-specific RRS.	Refer to RAIs #7, #8, and #17 responses in Duke letter to the NRC dated 2/27/14.

#	Topic	Parameter Summary	Vendor Design Reference Document #	Additional Comments	Test or Analysis Results	Licensee Evaluation
14	Shock & Vibration	Shock and vibration withstand testing and analyses for sensor, displays, power control panel Test and analyses were performed for the horn cover and adhesive to demonstrate adequate shock withstand. Additional testing was performed for the power control panel assembly.	Qualification Analysis Doc. 51-9202556-005, Sections 2.2 and supporting references MIL-S-901D, MIL-STD-167-1 38-9193058-000, EN 60068-2-27, 38-9218022-000, EN 60068-2-6, 38-9218023-000, MIL-STD-202 51-9221032-000 66-9225632-000 32-9221237-002 66-9225469-000 38-9228047-000	NEI 12-02, 3.4	Sensor, displays, and power control panel have been tested and/or analyzed for shock and vibration. The test parameter values provided in IEC Standards, IEC 60068-2-6 (vibration) and IEC 60068-2-27 (shock), tables are recommendations and not mandatory testing levels. The test parameter values were selected to be consistent with previous shock and vibration testing performed on the VEGA supplied equipment. The test parameter values specified envelope the expected levels for the equipment installed location, due to the fact that the equipment is mounted to seismic structures within the plant. This approach is consistent with similar technology used in the same application at other installations. The vibration testing deviated from the IEC 60068-2-6 recommended frequency range and displacement magnitude for large power plant equipment (TABLE C.2). In-lieu of the 10-55 Hz and minimum displacement of 0.15 mm recommended in TABLE C.2, the power and control panel vibration testing utilized a narrower frequency band (5-25 Hz) and a more limiting displacement magnitude (1.6 mm). These values were deemed to be acceptable and enveloping for equipment rigidly mounted to a Seismic Category I structure, based on engineering judgment. The shock testing deviated from the IEC 60068-2-27 recommended peak acceleration and duration for land-based permanently installed equipment. In-lieu of the 15g peak acceleration and duration of 11 m-sec recommended in TABLE A.1, the power and control panel vibration testing utilized and acceleration of 10g with a 6 m-sec duration. These values were deemed to be acceptable and enveloping for equipment rigidly mounted to a seismic Category I structure, based on engineering judgment. Testing and analyses horn cover and adhesive support the components can tolerate horizontal and vertical accelerations up to 100g and SFP sloshing loads up to 3.37 psi.	The shock and vibration testing performed for the SFP level instrumentation adequately demonstrates the sensor and power control panel will be reliable in the installed design location. The instrumentation is rigidly mounted to the Seismic Category I Auxiliary Building wall and would not be subjected to any significant shock or vibration during a postulated beyond design bases event, or during normal operation. The instrumentation is located within the Seismic Category I Auxiliary Building and is protected from external wind borne missile threats. The instrumentation installed design location is not susceptible to vibration from surrounding rotating equipment. The radar sensor and power control panel design location provides spatial separation from surrounding SSCs, such that potential seismic interaction with surrounding SSCs is also not a concern. The post modification testing will demonstrate reliable operation of the instrumentation, which confirms no damage occurred during shipping, handling and installation. Similarly, the performance of monthly channel functional comparisons will serve to confirm proper operation of the instrumentation, or provide a means of early detection of potential instrument degradation. Refer to RAIs #14, #15, and #16 responses in Duke letter to the NRC dated 2/27/14. The test and analyses of the horn cover and adhesive demonstrate adequate shock withstand capability.

#	Topic	Parameter Summary	Vendor Design Reference Document #	Additional Comments	Test or Analysis Results	Licensee Evaluation
15	Requirements Traceability	Not required by order	N/A	N/A	N/A	N/A
16	Factory Acceptance Test	Inspection of waveguide, test of functionality of power transfer to battery, sensor measurement accuracy and effects of steam and water in waveguide	VEGA Test Procedure AREVA Doc. 38-9219704-000, Factory Acceptance Test Report AREVA Doc. 66-9219739-000	N/A	Test demonstrates that specification requirements were met.	The vendor factory acceptance test demonstrated reliable operation of the SFP level instrumentation under normal conditions and under various simulated test conditions (e.g., steam exposure). The testing demonstrated the instrumentation met design accuracy and repeatability specifications.
17	Channel Accuracy	Normal and accident conditions SFP level measurement accuracy	AREVA Instruction manual Doc. 01-9221437-001, Section 11.6	EA-12-051, 1.7 NEI 12-02, 3.7	Normal conditions accuracy is ±1 inch, error due to all effects including 212°F saturated steam is ±3 inches. Accuracy verified during factory acceptance testing.	The vendor factory acceptance test demonstrated reliable operation of the SFP level instrumentation under normal conditions and under various simulated test conditions (e.g., steam exposure). The testing demonstrated the instrumentation met design accuracy and repeatability specifications. Refer to RAI #21 response in Duke letter to the NRC dated 2/27/14.
18	Power Consumption	Lifetime of battery backup at full load	Qualification Analysis Doc. 51-9202556-005, Section 2.9, Instruction Manual 01-9221437-001, Section 11.7	EA-12-051, 1.6, NEI 12-02, 3.6	Battery capacity at full load is expected to readily exceed 7 days.	Based on vendor analyses the battery capacity is deemed sufficient to support reliable instrument channel operation until off-site resources can be deployed by the mitigating strategies in response to Order EA-12-049. Refer to RAI #19 response in Duke letter to the NRC dated 2/27/14.
19	Technical Manual	Application-specific information on the installation, operation, and maintenance of the SFPLI	AREVA Doc. 01-9221437-001	N/A	N/A	The vendor technical manual has been reviewed, accepted and incorporated in the engineering change package.

#	Topic	Parameter Summary	Vendor Design Reference Document #	Additional Comments	Test or Analysis Results	Licensee Evaluation
20	Calibration	Periodic indication checks, calibration checks, calibration	EA-12-051, 1.8 AREVA Doc. 01-9221437-001, Sections 7.0 and 9.1.1	EA-12-051, 1.8 NEI 12-02, 3.8 Based on negligible drift rate of VEGA electronics experienced over large user base, periodic calibration is not needed. Functional verification can be achieved using cross channel checks and functional checks per vendor manual.	N/A	Refer to RAIs #19, #23, #24, and #25 responses in Duke letter to the NRC dated 2/27/14. In lieu of horn rotation and use of a portable target, periodic verification of proper radar channel functionality can be achieved by varying SFP water level (minimum 2 points) and verifying proper level indication.
21	Failure Modes and Effects Analysis (FMEA)	N/A	N/A	N/A	N/A	The instrumentation is required to function to provide SFP level indication for a beyond design basis event. Performance of an FMEA is not warranted for this type of an application. Reasonable assurance that both channels are not susceptible to a common mode failure is provided by meeting NEI 12-02 guidance requirements.
22	EMI Testing	Emissions and susceptibility testing for VEGAPULS 62 ER	Qualification Analysis Doc. 51-9202556-005, Section 2.6 and supporting references EN-61000-4 MIL-STD-461E, 58-9214362-000, 38-9219863-000, 38-9218965-000, 38-9218966-000, 38-9219862-000, 38-9218967-000, 38-9218968-000, 38-9218969-000, 38-9218970-000, 38-0218964-000	N/A	VEGAPULS 62 ER has been tested for emissions to both MIL and IEC standards and for susceptibility to IEC standards	The EMI/RFI susceptibility and emissions testing performed for the waveguide radar transmitter provides adequate assurance the instrumentation will be compatible in the design location. The testing was conservatively performed with unshielded interconnecting wiring. The McGuire level channel design included shielded signal cabling, and grounding of the power control panel. During a postulated BDBEE, it is possible that intermittent UHF radio operation could occur in the vicinity of the radar transmitter. Successful long-term SFP monitoring capability during a postulated BDBEE would not be inhibited by potential intermittent radio transmission interference.

NRC Order EA-12-049
FLEX FINAL INTEGRATED PLAN

McGuire Nuclear Station, Units 1 & 2

December 2015

Table of Contents

1. Background

In 2011, an earthquake-induced tsunami caused Beyond-Design-Basis (BDB) flooding at the Fukushima Dai-ichi Nuclear Power Station in Japan. The flooding caused the emergency power supplies and electrical distribution systems to be inoperable, resulting in an extended loss of alternating current (AC) power (ELAP) in five of the six units on the site. The ELAP led to (1) the loss of core cooling, (2) loss of spent fuel pool cooling capabilities, and (3) a significant challenge to maintaining containment integrity. All direct current (DC) power was lost early in the event on Units 1 & 2 and after some period of time at the other units. Core damage occurred in three of the units along with a loss of containment integrity resulting in a release of radioactive material to the surrounding environment.

The U.S. Nuclear Regulatory Commission (NRC) assembled a Near-Term Task Force (NTTF) to advise the Commission on actions the U.S. nuclear industry should take to preclude core damage and a release of radioactive material after a natural disaster such as that seen at Fukushima. The NTTF report (Reference 1) contained many recommendations to fulfill this charter, including assessing extreme external event hazards and strengthening station capabilities for responding to beyond-design-basis external events (BDBEEs).

Based on NTTF Recommendation 4.2, the NRC issued Order EA-12-049 (Reference 2) on March 12, 2012 to implement mitigation strategies for BDBEEs. The order provided the following requirements for diverse flexible coping strategies (FLEX strategies) to mitigate BDBEEs:

- Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and Spent Fuel Pool (SFP) cooling capabilities following a BDBEE.
- These strategies must be capable of mitigating a simultaneous loss of all AC power and loss of normal access to the ultimate heat sink and have adequate capacity to address challenges to core cooling, containment and SFP cooling capabilities at all units on a site subject to the Order.
- Licensees must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to the Order.
- Licensees must be capable of implementing the strategies in all modes.
- Full compliance shall include procedures, guidance, training, and acquisition, staging or installing of equipment needed for the strategies.

The order specifies a three-phase approach for strategies to mitigate BDBEEs:

- Phase 1 - Initially cope relying on installed equipment.
- Phase 2 - Transition from installed plant equipment to on-site FLEX equipment.
- Phase 3 - Obtain additional capability and redundancy from off-site equipment and resources until power, water, and coolant injection systems are restored or commissioned.

NRC Order EA-12-049 (Reference 2) required licensees of operating reactors to submit an overall integrated plan, including a description of how compliance with these requirements would be achieved. The Order also required licensees to complete implementation of the requirements no later than two refueling cycles after submittal of the Overall Integrated Plan (OIP) or December 31, 2016, whichever came first.

Duke Energy (Duke) declared that McGuire Nuclear Station (MNS) Unit 1 was in compliance with Order EA-12-049 on November 18, 2014 following the 1EOC23 refueling outage, which is within two refueling cycles of the submittal of the OIP dated February 28, 2013 (Reference 18). Duke declared that MNS Unit 2 was in compliance with Order EA-12-049 on October 8, 2015 following the 2EOC23 refueling outage, also within two refueling cycles of the OIP submittal (Reference 19).

The Nuclear Energy Institute (NEI) developed NEI 12-06 (Reference 3), which provides guidelines for nuclear stations to assess extreme external event hazards and implement the mitigation strategies specified in NRC Order EA-12-049. The NRC issued Interim Staff Guidance JLD-ISG-2012-01 (Reference 4), dated August 29, 2012, which endorsed NEI 12-06 with clarifications on determining baseline coping capability and equipment quality.

NRC Order EA-12-051 (Reference 5) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level. This order was prompted by NTTF Recommendation 7.1 (Reference 1).

Duke declared that MNS Unit 1 was in compliance with Order EA-12-051 on November 18, 2014 following the 1EOC23 refueling outage, which is within two refueling cycles of the submittal of the OIP dated February 28, 2013 (Reference 18). Duke declared that MNS Unit 2 was in compliance with Order EA-12-051 on October 8, 2015 following the 2EOC23 refueling outage, also within two refueling cycles of the OIP submittal (Reference 19).

NEI 12-02 (Reference 6) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in JLD-ISG-2012-03 (Reference 7), conformance with the guidance in NEI 12-02 is an acceptable method for satisfying the requirements in Order EA-12-051.

2. Order Implementation

2.1. General Elements

The assumptions used for the evaluations of an ELAP/Loss of Ultimate Heat Sink (LUHS) event and the development of FLEX strategies are stated below.

Initial conditions and boundary conditions consistent with NEI 12-06 were established to support development of FLEX strategies, as follows:

- The reactor is initially operating at power, unless there are procedural requirements to shut down due to the impending event. The reactor was operating at 100% power for the past 100 days.
- The reactor is successfully shut down when required (i.e., all rods inserted, no Anticipated Transient Without Scram (ATWS)). Steam release to maintain decay heat removal upon shutdown functions normally, and reactor coolant system overpressure protection valves respond normally, if required by plant conditions, and reseat.
- On-site staff is at site administrative minimum shift staffing levels.
- No independent, concurrent events, e.g., no active security threat.
- All personnel on-site are available to support site response.
- The reactor and supporting plant equipment are either operating within normal ranges for pressure, temperature and water level, or available to operate, at the time of the event consistent with the design and licensing basis.

- No specific initiating event is used. The initial condition is assumed to be a loss of off-site power (LOOP) with installed sources of emergency on-site AC power and station blackout (SBO) alternate AC power sources unavailable with no prospect for recovery.
- Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles are available. Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles, are available. The portion of the fire protection system that is robust with respect to seismic events, floods, and high winds and associated missiles is available as a water source.
- Normal access to the ultimate heat sink (UHS) is lost, but the water inventory in the UHS remains available and robust piping connecting the UHS to plant systems remains intact. The motive force for UHS flow, i.e., pumps, is assumed to be lost with no prospect for recovery.
- Fuel for FLEX equipment stored in structures with designs that are robust with respect to seismic events, floods and high winds and associated missiles, remains available.
- Installed Class 1E electrical distribution systems, including inverters and battery chargers, remain available since they are protected.
- No additional accidents, events, or failures are assumed to occur immediately prior to or during the event, including security events.
- Reactor coolant inventory loss consists of unidentified leakage at the upper limit of Technical Specifications, reactor coolant letdown flow (until isolated), and reactor coolant pump seal leak-off at normal maximum rate.
- For the SFP, all boundaries (e.g., liner, gates) and the SFP cooling system are assumed to be intact. The SFP heat load is assumed to be the maximum design basis heat load. In addition, inventory loss from sloshing during a seismic event does not preclude access to the pool area.

Additional key assumptions associated with implementation of FLEX Strategies are as follows:

- Additional deployment resources are assumed to begin arriving at 6 hours and the site Emergency Response Organization (ERO) will be fully staffed at 24 hours after the event.
- The plant Technical Specifications contain the limiting conditions for normal unit operations to ensure that design safety features are available to respond to a design basis accident and direct the required actions to be taken when the limiting conditions are not met. The result of the BDBEE may place the plant in a condition where it cannot comply with certain Technical Specifications and/or with its Security Plan, and, as such, may warrant invocation of 10 Code of Federal Regulations (CFR) 50.54(x) and/or 10 CFR 73.55(p). (Reference 8)

2.2. Strategies

The objective of the FLEX strategies is to establish indefinite coping capability in order to:

- Prevent damage to the fuel in the reactors
- Maintain the containment function
- Maintain cooling and prevent damage to fuel in the SFP

This indefinite coping capability will address an ELAP – loss of off-site power, emergency diesel generators and any alternate AC source, but not the loss of AC power to buses fed by station batteries through inverters – with a simultaneous LUHS.

The plant indefinite coping capability is attained through the implementation of FLEX strategies that are focused on maintaining or restoring key plant safety functions. The FLEX strategies are not tied to any specific damage state or mechanistic assessment of external events. Rather, the strategies are developed to maintain the key plant safety functions based on the evaluation of plant response to the coincident ELAP/LUHS event. A safety function-based approach provides consistency with, and allows coordination with, existing plant emergency operating procedures (EOPs). FLEX strategies are implemented in support of EOPs using FLEX Support Guidelines (FSGs).

The strategies for coping with the plant conditions that result from an ELAP/LUHS event involve a three-phase approach:

- Phase 1 – Initially cope by relying on installed plant equipment.
- Phase 2 – Transition from installed plant equipment to on-site FLEX equipment.
- Phase 3 – Obtain additional capability and redundancy from off-site equipment and resources until power, water, and coolant injection systems are restored.

The transitions to Phase 2 and Phase 3 will occur at different times for different portions of the FLEX strategies.

The strategies described in this document are capable of mitigating an ELAP/LUHS resulting from a BDBEE by providing adequate capability to maintain or restore core cooling, containment, and SFP cooling capabilities at McGuire Nuclear Station. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies developed to protect public health and safety are integrated into EOPs in accordance with established change processes, and their impact to the design basis capabilities of the Units have been evaluated under 10 CFR 50.59.

2.3. Reactor Core Cooling Strategy

2.3.1. Phase 1: Core Cooling

Upon a loss of AC power due to a BDBEE, each reactor trips and all control rods are inserted. MNS will use the steam generators (SGs) as the heat sink for core cooling, with natural circulation driving flow through the Reactor Coolant (NC) System. The Auxiliary Feedwater (CA) system will provide cooling water to the secondary side of the SGs using the Turbine Driven Auxiliary Feedwater Pump (TDCAP). The TDCAP flow control valves are air-operated and will be available from the Control Room following loss of power. In the absence of the Auxiliary Feedwater Storage Tank (CAST), the credited source of SG feedwater is the raw water inventory remaining in the buried Condenser Circulating Water (RC) System piping, which is protected from all applicable hazards and automatically aligned to the TDCAP suction, if needed. However, the CAST has better water quality and MNS procedures direct preferential use of this water source, if it is available following event initiation.

To remove heat, the MNS FLEX strategy discharges steam from the SGs through the secondary Power Operated Relief Valves (PORVs). MNS will control depressurization to maintain a cooldown rate in the NC System of less than 100°F/hr. Using this cooling method, SG pressure is initially reduced to about 290 psig. Maintaining SG pressure at this level causes NC System pressure to be high enough to prevent injection of nitrogen from the cold leg accumulators (CLAs). SG depressurization to 290 psig using the secondary PORVs results in cooldown of the NC System to about 420°F.

The secondary PORVs and the TDCAP flow control valves will be controlled using air supplied from the Instrument Air (VI) Blackout header and the FLEX Air Tanks.

The vital station batteries provide DC power for essential instrumentation. The MNS FLEX strategy relies on manual load shedding of non-required loads from the essential DC bus in the initial 3 hours following a BDBEE to extend battery life up to 18 hours.

No action is necessary for managing reactor coolant inventory or reactivity during Phase 1. Loss of inventory is limited by restricted leakage from reactor coolant pump (RCP) seals and an engineering evaluation shows that sufficient reactor coolant inventory is available without any NC system pumped make-up after loss of power to the normal charging system/seal cooling to allow coping strategies to be employed through Phase 1. Specifically, MNS determined that action to initiate ELAP boration for reactivity control can be taken as late as 13.85 hours into the event. The latest PWROG evaluation case for stations like MNS indicates that time to core uncovery due to reactor coolant inventory loss is 43.9 hours, with reflux cooling in the SG tubes not beginning until 15.6 hours.

2.3.2. Phase 2: Core Cooling

The Phase 2 core cooling strategy continues to use the SGs as the heat sink. In Phase 2, MNS will ultimately transition from the TDCAPs to portable FLEX pumps, as necessary, to drive the flow of SG feedwater. The credited water source (the UHS) for the portable FLEX pumps is the Standby Nuclear Service Water Pond (SNSWP), although MNS will use higher quality water if such sources are available (e.g., CASTs) to manage SG sedimentation.

Prior to SG pressure no longer supporting TDCAP operation, MNS will establish an alternate water supply using portable equipment. Specifically, MNS will deploy a low-pressure, high volume, diesel-powered FLEX booster pump near the SNSWP and connect this pump to a raw water distribution header (hose). MNS will also deploy a medium pressure, diesel-powered FLEX pump near each Unit to take suction from the raw water distribution header and enable flow to the SGs of up to 300 gpm at 300 psig system pressure. The portable FLEX pump discharge hoses are routed to feedwater system piping FLEX connections either inside or outside the Inner/Outer Doghouses to provide feedwater to all steam generators simultaneously, thereby allowing continued symmetric cooldown.

MNS will provide Phase 2 reactor coolant makeup using portable FLEX high-pressure diesel-powered pumps (≥40 gpm at 1700 psig pump discharge pressure, one per Unit) to deliver water taking suction from a FLEX connection on each Refueling Water Storage Tank (FWST) supply line. Borated water from the FWST will be injected into the RCS primarily through FLEX connections to the Safety Injection (NI) system (one connection on either train), or pump discharge hoses can also be routed to the Decay Heat Removal (ND) system FLEX connection. Boration will be initiated within 13 hours to ensure reactivity control (see also Attachment 7).

MNS will provide electric power to equipment needed to support the Phase 2 core cooling strategy using portable FLEX diesel generators (DGs), power distribution panels (PDPs), and cables. One 500 kW, 600 VAC generator will be deployed for each Unit. MNS will use these portable generators to repower essential battery chargers within 18 hours of ELAP initiation, as well as repowering Containment hydrogen igniters, CLA isolation valves, and portable FLEX sump pumps. The primary connection strategy for the FLEX DGs uses permanently-installed modified motor control center (MCC) buckets with external power connectors to provide power to specific components. The alternate connection strategy uses portable MCC buckets with external power connectors deployed from the FLEX buildings and installed in dedicated spare breaker locations.

After FLEX power is established and prior to NC system cooldown to 350°F, MNS will shut CLA isolation valves to prevent introduction of CLA nitrogen overpressure gas as NC system pressure decreases. SGs may then be depressurized further for longer term cooling.

During an ELAP, the installed sump pumps in below-grade areas of the Auxiliary Building would not be available to mitigate the potential for internal flooding of core cooling equipment that might result from the BDBEE. Upon deployment of FLEX power, MNS will also deploy FLEX sump pumps into one or more of the following areas: Unit 1 CA Pump room at the 716 elevation, Unit 2 CA Pump room at the 716 elevation, Residual Heat Removal (ND)/Containment Spray (NS) Pump room sump at the 695 elevation (common), and the North end of the Auxiliary Building at the 710 elevation (common). The two FLEX sump pumps on 695 and 710 elevations will be deployed within 18 hours of ELAP initiation to ensure that essential components are protected. The two FLEX sump pumps in the CA Pump rooms on 716 elevation will be deployed within 28 hours of ELAP initiation.

2.3.3. Phase 3: Core Cooling

The initial Phase 3 core cooling strategy continues to use the SGs as the heat sink. MNS will receive water purification equipment and a mobile boration skid from the National SAFER Response Center (NSRC) to ensure a long-term source of clean water and the capability for batching RCS makeup (See Section 2.10). MNS will obtain additional diesel fuel from off-site sources for continued operation of diesel-powered equipment, if necessary.

The NSRC will provide two 1 MW diesel generators, which will allow repowering of a 4KV essential bus and required load centers. This increase in electric power capacity will enable the repowering of specific installed plant equipment.

Within approximately six days after ELAP initiation, MNS will transition to Phase 3 core cooling using the Residual Heat Removal (ND) system after NC system temperature is less than 350°F and NC system pressure is less than 385 psig. Transitioning within this timeframe manages excessive Containment conditions (temperature, pressure, and sump level). The NSRC will provide a larger capacity low pressure diesel-powered pump (5000 gpm at 150 psig discharge pressure), which will take suction from the SNSWP and be connected to the service water (RN) system via a check valve bonnet rig to deliver KC (Component Cooling Water system) heat exchanger cooling water. MNS will establish decay heat removal by starting a train of KC pumps and associated KC pump motor coolers, and then start one ND pump train to continue core cooling indefinitely.

The Phase 3 reactor coolant make-up strategy is the same as the Phase 2 strategy. If necessary, MNS can replenish the volume of the FWSTs in several ways including, (1) make-up from the boric acid tank (BAT) by itself or in tandem with another water source (e.g., raw water, the NSRC water purification equipment, the CAST (if available)), (2) the NSRC-supplied mobile boration skid, (3) the opposite Unit's FWST, (4) the Recycle Holdup Tank (RHT) if available, and (5) portable FLEX drop tanks. The preferred option is to use water from existing tanks in the affected Unit. The mobile boration skid enables mixing of powdered boron (also delivered from NSRC) with water.

2.3.4. Availability of Systems, Structures, and Components

The FLEX strategy for core cooling relies on various installed systems, structures, and components (SSCs). These SSCs are protected in regard to the applicable extreme external hazards as discussed below.

2.3.4.1. Structures

The FLEX strategy relies on site structures to provide protection for components, fluid and electrical connections, and deployment paths from applicable extreme external hazards. Specifically, the FLEX strategy relies on the Containment Vessel, along with the Fuel Handling and Auxiliary Buildings, which are all Seismic Category I structures designed to provide protection from the applicable extreme external hazards. The FLEX response strategy also credits the Turbine Building structures for alternate entry points into the Auxiliary Building. MNS performed an evaluation to demonstrate the seismic ruggedness of the turbine buildings.

2.3.4.2. Systems

The FLEX strategy relies on installed piping from various plant systems to deliver water/air for core cooling. Primarily, MNS relies on piping and components from the Reactor Coolant (NC) system, Auxiliary Feedwater (CA) system, Safety Injection (NI) system, Residual Heat Removal (ND) system, the Nuclear Service Water (RN) System, the Component Cooling (KC) system, the Main Steam (SM) System, the Instrument Air (VI) System, and the Condenser Circulating Water (RC) System.

- The portions of the NC, CA, NI, ND, KC, SM, and RN systems required for the FLEX strategy were designed for safety-related service and will be available following the applicable extreme external hazards.
- The Blackout headers in the VI system were evaluated to be seismically rugged and are capable of supporting the FLEX strategies for all applicable hazards.
- MNS completed modifications to portions of the RC system to ensure that the required piping and components would serve their FLEX response function following the applicable extreme external hazards. Subsequent analysis provided reasonable assurance that a seismic event would not compromise the needed RC system piping and associated RN piping.

2.3.4.3. Turbine-Driven Auxiliary Feedwater Pump (TDCAP) and Flow Control Valves (FCVs)

The MNS FLEX response strategy relies on the TDCAP to provide feedwater for the SGs during Phase 1. The TDCAP and its FCVs are safety-related, seismically qualified components that are located in the Auxiliary Building, which is a Seismic Category I structure. These components are therefore protected from the applicable extreme external hazards.

Additionally, the FCVs will be operated with air from the Instrument Air (VI) Blackout header, which is seismically rugged and will remain available via air supplied by the FLEX Air Tanks during an ELAP until a diesel-powered FLEX air compressor is connected within 16 hours of event initiation.

2.3.4.4. Steam Generator Power Operated Relief Valves (PORVs)

The MNS FLEX response strategy relies on the SG PORVs to remove heat during SG cooling, because cooling from the main condenser is not available. The SG PORVs are safety-related, seismically qualified components located inside the Interior and Exterior

Doghouses, which are Seismic Category I structures. The PORVs can be operated with air from the Instrument Air (VI) Blackout header, which is seismically rugged and will remain available via air supplied by the FLEX Air Tanks during an ELAP until a diesel-powered FLEX air compressor is connected within 16 hours of event initiation.

2.3.4.5. Vital Station Batteries

The MNS FLEX strategy relies on station batteries to power vital instrumentation. The station batteries and associated DC distribution systems are located within the Auxiliary Building, which is a Seismic Category I structure. The batteries are therefore protected from the applicable extreme external hazards.

2.3.4.6. Electrical Distribution System

MNS uses selected plant electrical distribution equipment to repower installed components credited for the FLEX response strategy. Electrical distribution components used for the FLEX strategy are located within Seismic Category I structures and will therefore be available following the applicable extreme external hazards.

2.3.4.7. Auxiliary Feedwater Storage Tank (CAST)

The CAST is the primary preferred source of SG feedwater for the FLEX strategy because of its water quality, although it is not protected from all applicable hazards. The CAST contains approximately 300,000 gallons of demineralized water, which will provide approximately 18 hours of cooling water for the TDCA pumps. The CAST may be refilled with raw water from other site sources or with treated water from NSRC water purification equipment.

2.3.4.8. Condenser Circulating Water (RC) Pipe Headers

Although the preferred water source for SG feedwater is a clean source (e.g., the CAST), the MNS FLEX response strategy credits the condenser circulating water headers for cooling water used in the core cooling FLEX strategy, because this piping is protected from all applicable hazards. The captured inventory in this piping provides at least 2 days of SG feedwater.

2.3.4.9. Refueling Water Storage Tank (FWST)

The FWST is the credited source of borated water for reactivity control and NC make-up. The minimum inventory of the intact FWST is 383,146 gallons at a minimum boron concentration of 2,675 ppm. The 40 foot diameter FWST is robust to all applicable hazards at MNS, except that a portion of the FWST (i.e., the portion above the 14 foot-high protective wall) is susceptible to wind-generated missiles. If the FWST is damaged above the wall by a missile, some of the spilled volume would be trapped in the FWST enclosure and will be pumped back into the protected portion of the FWST by a FLEX-deployed portable pump rig as needed.

Additionally, if the FWST is damaged MNS can replenish the protected volume with borated water within 48 hours using FLEX-deployed equipment. If the FWST is not damaged, the FWST inventory will provide sufficient makeup capacity well into Phase 3.

2.3.4.10. Standby Nuclear Service Water Pond (SNSWP)

If auxiliary feedwater from the CAST or other clean source is not available, long-term makeup can be obtained from the SNSWP (the UHS for MNS) using portable pumps and hoses. The SNSWP is nuclear safety related, seismically protected and will provide a sustained water supply with long-term capacity. The total volume of the SNSWP is approximately 578 acre-feet (~188 million gallons). At a continuous flow rate of 1,500 gpm, this SNSWP volume corresponds to 87 days of inventory. For long-term core cooling (i.e., about six days into the ELAP event after transition to RHR), inventory used from the SNSWP is returned to the SNSWP except for water used in the SFP for boil-off make-up. Therefore, the SNSWP inventory provides sufficient water for indefinite coping.

2.3.5. FLEX Connections

Primary and alternate FLEX connections are installed on various plant systems to provide water and power for the FLEX strategies. The combination of primary and alternate connections ensures that the FLEX strategy can be deployed following the applicable extreme external hazards as discussed below.

2.3.5.1. Primary SG Feedwater Connections

The primary SG Feedwater connections are located on the feedwater tempering lines. They are the same connections that were installed pursuant to B.5.b requirements and are located on top of the Diesel Buildings such that they are largely protected from wind generated missiles by surrounding robust structures. These connections provide feedwater to all four SGs and therefore support symmetric cooldown.

2.3.5.2. Alternate SG Feedwater Connections

The alternate auxiliary feedwater connections are located in the Interior and Exterior SG doghouse structures, which are Seismic Category I structures that are protected from all applicable hazards. One connection is provided in each doghouse, and each of the two connections is capable of feeding two SGs. The set of connections provides simultaneous, parallel makeup for all four SGs, thereby supporting symmetric cooldown.

2.3.5.3. Primary Connections for Reactor Coolant Inventory

The primary connections for adding borated water to the NC system are located on the Safety Injection (NI) pump discharge piping on the 750 ft. elevation of the Auxiliary Building. Suction connection is located on the FWST recirculation header, also on the 750 ft. elevation in the Auxiliary Building. These connections are located on safety related piping and are in a Seismic Category I structure. Therefore, these connections are protected from the applicable extreme external hazards.

2.3.5.4. Alternate Connections for Reactor Coolant Inventory

The alternate connections for adding borated water to the NC system are located on the Safety Injection (NI) pump discharge piping on the 733 elevation of the Auxiliary Building. These connections are located on safety related piping and are in a Seismic Category I structure. Therefore, these connections are protected from the applicable extreme external hazards.

2.3.5.5. Primary Connections for Instrument Air (Blackout Header)

The primary FLEX Phase 2 connections for supplying compressed air to the SG PORVs and the TDCAP FCVs are located on the VI system Blackout header in the Exterior Doghouses. These connections are located on seismically rugged piping and are in a Seismic Category I structure. Therefore, these connections are protected from the applicable extreme external hazards. FLEX Phase 1 VI system response is via the FLEX Air Tanks.

2.3.5.6. Alternate Connections for Instrument Air (Blackout Header)

The alternate FLEX Phase 2 connections for supplying compressed air to the SG PORVs and the TDCAP FCVs are located on the VI system Blackout header in the Interior Doghouses. These connections are located on seismically rugged piping and are in a Seismic Category I structure. Therefore, these connections are protected from the applicable extreme external hazards. FLEX Phase 1 VI system response is via the FLEX Air Tanks.

2.3.5.7. Electrical Connections

The MNS FLEX strategy relies on FLEX power to charge batteries, maintain vital instrumentation, and repower plant equipment. The primary connections for FLEX power are permanently installed 600V MCC buckets for various electrical loads used in the FLEX strategy. The alternate connections use portable MCC buckets deployed from the FLEX Buildings. All connections are located in the Auxiliary Building, which is a Seismic Category I structure. Therefore, the connection locations are protected from the applicable extreme external hazards.

2.3.6. Plant Instrumentation

MNS will monitor the following parameters to support deployment of the FLEX core cooling strategy. Associated instruments are initially powered using vital station batteries and the primary monitoring strategy is to obtain readings from the main control room (MCR).

- SG Narrow Range Level Indication
- SG Pressure
- Auxiliary Feedwater Flow to SGs
- NC Wide Range Pressure
- NC Wide Range Hot Leg Temperature
- Pressurizer Level
- Wide Range Neutron Flux or Source Range
- Core Exit Thermocouples
- Reactor Vessel Level Indication System

MNS will ensure longer term power for essential instrumentation during Phase 2 by establishing FLEX power with a portable 500kW, 600 VAC diesel generator (see Section 2.3.2), which will enable re-charging station batteries. As an alternative, MNS can also directly re-establish power to the applicable cabinets for the instrumentation loops using smaller portable generators and cabling.

If instrumentation required for the FLEX response strategies cannot be obtained from the control room, MNS has alternate methods for monitoring these parameters. MNS can dispatch operators to monitor parameters locally (e.g., SG pressure and CA flow may be monitored from the interior and exterior doghouses) or portable test equipment may be used to monitor parameters from inside the Process Control System 7300 cabinet located in the Control Room.

2.3.7. Thermal-Hydraulic Analysis

MNS developed a FATHOM model to evaluate delivery of cooling water to various loads to support the FLEX response strategies. Key conclusions from this analysis are as follows:

- The combination of the FLEX Low Pressure Pumps at the SNSWP and the FLEX Medium Pressure Pumps in the station yard has sufficient capacity to deliver over 300 gpm of flow (per unit) from the SNSWP to the SGs. The MNS model demonstrated satisfactory make-up capacity for both the primary SG connection alignment and the alternate SG connection alignment, including the planned hose arrangements for each. This analysis included water demands on the FLEX Low Pressure Pumps for other FLEX functions (e.g., SFP make-up), to confirm that the pump capacity is satisfactory.

- The NSRC-supplied high capacity pump has sufficient capacity to enable cooling via the KC heat exchangers while in residual heat removal alignment. The NSRC pump is rated for 5,000 gpm flow at 150 psig. The hydraulic model shows that the NSRC pump will supply about 3,700 gpm to the KC heat exchanger for core cooling and enough flow to each pump motor cooler and room air handling unit for the KC and ND pumps to assure safe operation using maximum hose lengths.
- The FLEX High Pressure Pump can provide at least 40 gpm of borated water makeup at 1600 psig system pressure (1700 psig discharge pressure) using the primary or alternate connections in the NI piping.
- The FLEX water distribution system can supply cooling water for various HVAC loads using a pressure regulating control valve, fire hose, garden hose, and prefabricated header pipes.

Using raw water for SG feedwater for greater than 290 continuous hours (~12 days) may result in significant SG heat transfer degradation due to sedimentation. MNS will deploy water treatment equipment as part of the Phase 3 FLEX response strategy to provide a higher purity water source, if long term SG feedwater is needed.

MNS performed analyses of potential internal flooding in the Auxiliary Building and its effect on components needed for the FLEX response strategy:

- ND pumps and related components will not be affected by internal flooding for at least 18 hours.
- TDCA pumps will not be affected by internal flooding for at least 28 hours.

The TDCA pump can deliver adequate flow rate when SG pressure is above approximately 95 psig. Accounting for uncertainty in pressure readings, MNS procedures permit SG cool down to 160 psig after establishing FLEX power and isolating the CLAs, which is well into Phase 2. Therefore, SG pressure will be sufficient to power the TDCA pump at least until the FLEX pumps are deployed for raw water distribution.

MNS has sump pumps in the FLEX buildings that will be deployed in time to protect the ND pumps and the TDCA pumps from internal flooding. Hydraulic analysis demonstrated that four FLEX sump pumps, with the planned hose arrangements for discharge to ground level, are capable of mitigating internal flooding in the Auxiliary Building.

2.3.8. Reactor Coolant Pump Seal Leakage (ELAP)

MNS performed a modification to each of the RCP #1 seal leak-off lines involving addition of a restriction orifice just downstream of the seal exit. Third-party and OEM analyses of this modified piping configuration show that initial leak-off flow rates, and those experienced during subsequent NC system cooldown, stay within the maximum limits of current WCAP-17601-P, revision 1 assumptions (i.e., 21 gpm / seal). Reference Attachment 7 "McGuire

Nuclear Station Reactor Coolant Pump Seal Leakage Margin Assessment - ELAP" for further details.

2.3.9. Shutdown Reactivity Analysis

MNS performed a shutdown reactivity analysis that incorporated the guidance provided in the Westinghouse position paper entitled "Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Boron Mixing in Support of the Pressurized Water Reactor Owners Group (PWROG)" (ADAMS Accession Number ML13235A135) with the clarifications specified in the NRC endorsement of this approach (Reference 15). The MNS analysis included a one-hour mixing delay, in accordance with those clarifications.

The MNS analysis concluded that a FLEX high pressure make-up pump, delivering FWST water at 40 gpm, must be started by 13.85 hours into the ELAP event to provide and maintain the necessary 1% shutdown margin and prevent a potential re-criticality from occurring during cooldown. MNS will deploy the FLEX High Pressure Pump within 13 hours of ELAP initiation to meet this requirement. MNS currently requires delivery of 14,970 gallons of FWST water into the NC system for boration, which is well within the nominal FWST inventory of 383,146 gallons, even if damaged above the protective wall.

For the latest PWROG evaluation case, the PWROG-14027-P, Revision 3 report indicates that reflux cooling may begin in four-loop plants like MNS after 15.6 hours. Addition of borated NC system make-up must occur before reflux cooling to ensure adequate mixing. Deployment of the FLEX High Pressure Pump within 13 hours of ELAP initiation satisfies this requirement. Further details can be found in Attachment 7.

2.3.10. FLEX Pumps

2.3.10.1. FLEX Low Pressure Pumps

After the TDCA pump is secured, the MNS FLEX response strategy relies on a portable low pressure diesel-powered booster pump to provide cooling water from the SNSWP to the station yard (for subsequent delivery to the SGs by the FLEX Medium Pressure pump).

MNS has three portable FLEX Low Pressure Pumps, stored in the FLEX Buildings, to satisfy the N+1 inventory requirement. The #1 and #2 pumps can each supply a design flow of 1,500 gpm when taking suction on the SNSWP. The #3 pump can supply a design flow of 3,000 gpm (potentially supplying both Units) when taking suction on the SNSWP. Hoses from the FLEX Low Pressure Pump can be routed through either the North or South Vehicle Access Portals for connection to tanks or other site components. As discussed in Section 2.3.7, hydraulic analysis shows that these pumps have sufficient capacity to support the MNS FLEX response strategies.

The credited water supply for the FLEX Low Pressure Pumps is the SNSWP (UHS).

2.3.10.2. FLEX Medium Pressure Pumps

After the TDCA pump is secured, the MNS FLEX response strategy relies on a portable medium pressure diesel-powered pump to deliver feedwater from the SNSWP (via the portable low pressure FLEX booster pump) to the SGs. Each FLEX Medium Pressure Pump is a 300 gpm centrifugal pump with a maximum discharge pressure of 400 psig. Suction for the FLEX Medium Pressure Pump may be from the CAST (preferred, if available) or from the FLEX low pressure pump at the SNSWP.

MNS has three portable FLEX Medium Pressure Pumps, stored in the FLEX Buildings, to satisfy the N+1 inventory requirement.

The FLEX Medium Pressure pumps discharge water at a pressure of up to 400 psig (will be controlled to 360 psig to 380 psig to protect hoses). MNS will control pump flow as necessary, but will not need more than 300 gpm. As discussed in Section 2.3.7, hydraulic analysis shows that these pumps have sufficient capacity to support the MNS FLEX response strategies.

2.3.10.3. FLEX High Pressure Pumps

For an ELAP event initiating in Modes 1 - 4, the MNS FLEX response strategy relies on a FLEX High Pressure Pump to provide NC system boration and make-up. The FLEX High Pressure Pump is a diesel-powered, centrifugal pump that can deliver at least 40 gpm at 1700 psig pump discharge pressure, which is adequate to support the reactivity control and NC system make-up requirements for the FLEX response strategy. With diesel drivers, these pumps can also provide up to 50% more flow if necessary (see also Attachment 7).

MNS has three portable FLEX High Pressure Pumps, stored in the FLEX Buildings, to satisfy the N+1 inventory requirement.

The credited water supply for the FLEX High Pressure Pump is the FWST.

2.3.10.4. FLEX Sump Pumps

To mitigate potential internal flooding of areas in the Auxiliary Building containing equipment needed for the FLEX response strategies, MNS will use portable FLEX sump pumps if the installed station sump pumps are not available. MNS has six submersible FLEX sump pumps to address this concern, with each of the three FLEX Buildings containing two pumps. One of the sump pumps is diesel-powered. The other five pumps are electrically powered and require that FLEX power be established to enable use of the pumps. As discussed previously, no Auxiliary Building area needed for FLEX response is expected to require a sump pump prior to 18 hours; the FLEX Electrical Distribution system will be deployed within 12 hours.

As discussed in Section 2.3.7, hydraulic analysis shows that four of these pumps have sufficient capacity to support the MNS FLEX response strategies.

2.3.11. Electrical Analysis

2.3.11.1. FLEX Diesel Generators

MNS relies on DC systems for necessary electrical coping power during Phase 1 of the ELAP. To extend the coping capability of the vital station batteries, MNS will complete load shedding within 3 hours of ELAP initiation to reduce battery discharge to only essential loads (e.g., vital instrumentation). This action will extend the functional capability of the vital station batteries to at least 18 hours.

For longer term electrical power, MNS will deploy portable FLEX DGs (one for each Unit), PDPs, and associated cabling to establish the FLEX Electrical Distribution system. MNS has three 500 kW, 600VAC FLEX DGs to satisfy the N+1 requirement. The three FLEX DGs are stored in the FLEX Buildings.

MNS performed an analysis to ensure that the FLEX DGs had sufficient capacity to support Phase 2 FLEX response strategies. The analysis included electrical loads specific to core cooling, such as battery chargers, CLAs, TDCA pump room sump pumps and the ND/NS pump room sump pump. The analysis also considered the cable size and length of cable routing to evaluate voltage drop. MNS concluded that the FLEX DGs and planned/alternate cable routing arrangement were adequate to support the required loads.

2.3.11.2. Lighting

Plant emergency lighting and portable lighting for personnel (e.g., headlamps, flashlights) are available for limited durations. Primary response equipment controls are illuminated by light systems incorporated into the equipment skids. Lighting strings powered from the FLEX Electrical Distribution system are also included in FLEX response equipment for general area lighting in the Control Room, CA pump rooms, and Auxiliary Building at elevations 760 ft., 750 ft., 733 ft., 716 ft., and 695 ft.

Portable lighting in other plant areas that lose power can be supplied by FLEX utility power, which is provided by 120 VAC transformers and spider boxes powered from the FLEX DGs. During response to an ELAP, MNS will evaluate establishing temporary lighting in the Control Room, the MG Set Rooms, the Battery Room, the Interior and Exterior Doghouses, the Technical Support Center (TSC), and the Electrical Penetration Rooms.

2.4. SFP Cooling/Inventory Strategy

2.4.1. Phase 1: SFP Cooling

No actions are required during ELAP Phase 1 for SFP make-up because the time to boil is sufficient to enable deployment of Phase 2 equipment. Using conservative maximum design basis heat loads (i.e. one-third recently discharged core offload at 150 hours) and the maximum allowable initial pool temperature (140°F), the minimum time to boiling is 8.2 hours. Using best estimate (~20 day) heat loads and the maximum pool temperature, this minimum time is 17 hours. Assuming a more realistic initial pool temperature of 90°F immediately following a typical 21-day refueling outage, the minimum time to boil is extended to about 35 hours. Adequate SFP inventory exists to provide personnel shielding well beyond the time of boiling. MNS will monitor SFP water level using reliable SFP level instrumentation installed per Order EA-12-051.

If necessary in Phase 1, MNS can provide SFP makeup via gravity drain from the FWST.

To vent boil-off steam from the SFP Building, the FLEX response strategy directs the opening of the exterior roll-up door in the SFP Building early in the ELAP event.

2.4.2. Phase 2: SFP Cooling

To compensate for SFP boil-off, MNS will provide makeup water by pumping raw water from the SNSWP directly to the SFP deck through hoses. The hoses will be connected early in the ELAP event to a spray header (Boggs Box) while access to the SFP deck is less challenging. The alternate strategy is to connect hoses from the SNSWP to the Spent Fuel Cooling (KF) system suction lines. This connection will allow makeup to the SFP without access to the SFP deck. Borated water may be added to the SFP through existing piping from the FWST though this is not expected to be necessary since pool boron is retained during boil-off.

MNS can also connect hoses for SFP makeup to fire protection piping or directly from fire protection piping if it is pressurized. This approach, which also requires SFP deck access, is simpler than running hose from the SNSWP, but it is not credited since the fire protection piping is not hardened for all external hazards.

2.4.3. Phase 3: SFP Cooling

MNS will receive water purification equipment from the NSRC to ensure a long-term source of clean water for SFP cooling. Additional diesel fuel (e.g., for diesel-powered pumps) may be required to ensure that Phase 2 SFP cooling/make-up strategies can be maintained.

2.4.4. Availability of Structures, Systems, and Components

2.4.4.1. SFP Building

The FLEX response strategy relies on site structures to provide protection for components, fluid and electrical connections, and deployment paths from applicable extreme external hazards. Specifically, the FLEX strategy for SFP cooling relies on the SFP Building. The majority of the SFP Building is a Seismic Category I structure that is designed to provide protection from the applicable extreme external hazards. Portions of the north end of the SFP Building are not robust to all applicable hazards. MNS has evaluated these locations and determined that the lack of protection from all applicable hazards does not affect the FLEX response strategy for SFP cooling.

2.4.4.2. Primary Connection for SFP Makeup

The primary strategy for delivering makeup flow to the SFPs is to deploy hose to the SFP deck for delivering water directly to the SFP. Hose can be connected to a Boggs Box, which is a portable unit that sprays water into the SFP. Boggs Boxes are stored in the FLEX Storage Buildings and would be deployed early for an ELAP event. MNS has three Boggs Boxes, which satisfies the N + 1 requirement for equipment redundancy.

2.4.4.3. Alternate Connection for SFP Makeup

The alternate connection for delivering SFP makeup flow is at the SFP cooling pump suction piping in each Unit. This piping connection is located in the Auxiliary Building, which is a Seismic Category I structure. The SFP cooling pump suction piping proceeds to the SFP through the SFP Building, and is protected from all applicable hazards.

2.4.4.4. Ventilation

MNS will open the SFP exterior roll-up door to establish a steam vent path from the SFP Building during an ELAP event. This action will minimize the impact of condensed steam from the SFP on Auxiliary Building habitability. MNS will monitor radiation levels outside the SFP roll-up door.

2.4.5. Plant Instrumentation

The key parameter for the SFP cooling/inventory function is SFP wide range level. The reliable SFP level transmitters, installed per NRC Order EA-12-051, are capable of measuring SFP level from approximately the top of the fuel racks to a level above normal SFP water level. The primary channel consists of a through-air wave guided radar system, which consists of a wave-guide pipe assembly located within the SFP building and remote electronics located within the Auxiliary Building. All components are seismically mounted. The instrument is equipped with a backup battery power system to enable continued long-term (~7 days) use during an ELAP event. The instrument channels are electrically and spatially separated.

The primary channel radar components are designed to reliably operate in the installed locations during postulated BDBEE conditions. Qualification testing was performed to demonstrate reliable operation of the primary level channel under simulated SFP boiling conditions. The transmitter and power control panel are not directly exposed to the potentially harsh SFP environment. A location-specific dose calculation demonstrated that the Total Integrated Dose over the required mission time would not exceed the design limit of the electronic components.

The backup reliable SFP level instrument is a bourdon tube pressure gauge which monitors SFP level from a fuel transfer tube process connection. The instrument loop provides a local readout on the 733 elevation (Electrical Penetration Room) of the Auxiliary Building. This instrument is a purely mechanical device that is not exposed to adverse high temperature, humidity, or radiation during a postulated BDBEE. The metallic bourdon tube pressure gauge is not susceptible to degradation due to exposure to humidity, temperature or radiation.

2.4.6. Thermal-Hydraulic Analysis

MNS determined that either the primary (SFP pool deck/Boggs Box) or alternate (KF piping) connection approaches for the Phase 2 FLEX strategy can provide makeup flow that is greater than the SFP boil-off rate.

MNS performed thermal-hydraulic analysis to address the SFP cooling/inventory function under the most limiting conditions and configuration. Key conclusions from the analysis include the following:

- The boil-off rate assuming the maximum heat load in the SFP is 91gpm.
- Assuming normal plant operation and an initial pool temperature of 90°F, the SFP will not reach the boiling point after ELAP initiation until approximately 35 hours.
- Assuming a maximum heat load and an initial pool temperature of 140°F, the pool could begin boiling as early as 8.2 hours.
- For direct feed to the SFP using the large (3,000 gpm) FLEX Low Pressure Pump staged at the SNSWP and hose deployed to the SFPs, a FATHOM model determined that over 400 gpm can be supplied to both Unit 1 and Unit 2 SFPs at the same time. In practice, flow will be governed by make-up requirements for each pool and may be adjusted, as necessary. This analysis included water demands for other FLEX response functions (e.g., core cooling), confirming that the capacity of the FLEX Low Pressure Pumps is satisfactory for meeting all water demands. If the large FLEX Low Pressure Pump does not survive the BDBEE, the two FLEX Low Pressure Pumps (1,500 gpm, one per Unit) will be staged at the SNSWP.
- For the alternate SFP makeup approach using the KF piping, the FATHOM analysis shows that a make-up flow of at least 300 gpm is achievable.

MNS determined that the maximum flow from the Boggs Box is 500 gpm - 700 gpm. This flow rate exceeds the 250 gpm specified in NEI 12-06, Revision 0 guidance.

2.4.7. FLEX Pump and Water Supplies

The MNS FLEX response strategies rely on FLEX Low Pressure Pumps to supply raw water from the SNSWP. The FWST has higher quality water and can supply make-up water to the SFP, if desired. (See Sections 2.3.4 and 2.3.10.)

One of the FLEX Low Pressure Pumps is rated for 3,000 gpm flow and the other two are rated for 1,500 gpm flow. Two of the 1,500 gpm flow pumps may be deployed if necessary. As discussed in Section 2.3.7, the flow rate from the low pressure, high capacity pump(s) exceeds the requirements for SFP makeup and other potentially concurrent demand (e.g., SG feedwater).

During Phase 3, water from the SNSWP can be processed by NSRC water treatment equipment to supply higher purity makeup water.

2.4.8. Electrical Analysis

SFP level will be monitored during an ELAP event by reliable instrumentation installed to satisfy Order EA-12-051. The primary level instrumentation system has replaceable batteries with sufficient capacity to maintain the level indication function for at least 7 days. This duration will be sufficient for other resources to become available. If necessary, MNS will replace the batteries in the SFPLI, or the instrumentation can also be energized using a 24 VDC power supply. The alternate SFP level instrumentation system is analog (bourdon tube) and requires no electrical power.

2.5. Containment Function Strategy

2.5.1. Phase 1: Containment

MNS performed analyses to determine the temperature and pressure increase in the Containment vessels resulting from an ELAP during a BDBEE. Containment pressure and temperature remain at or below acceptable values during the initial 24 hours after the event. Containment penetrations for the RCP seal return line and ventilation unit condensate drain tank (VUCDT) are isolated manually within several hours of ELAP initiation, as are instrument air (VI system) lines supplying containment. MNS will monitor containment pressure using the Containment Wide Range Pressure Instrumentation. No other actions are required during Phase 1. The ice condenser containment design helps maintain containment conditions in all phases of the ELAP event, until the ice bed inventory is depleted.

2.5.2. Phase 2: Containment

In Phase 2, MNS will use the FLEX Electrical Distribution System and the FLEX DGs to repower Hydrogen Skimmer fans, which help limit the temperature increase in the SG and Pressurizer enclosures. This step will be completed within 24 hours of the start of the ELAP event.

Per NEI 12-06, revision 0 guidance, plants with Ice Condenser Containment designs such as MNS are required to repower hydrogen igniters to prevent buildup of hydrogen in case the ELAP event degrades to core damage. MNS will repower the hydrogen igniters using FLEX power, which will be established with portable diesel generators as part of Phase 2. (See Section 2.3.2.)

MNS analyses show that containment pressure/temperature will remain at or below acceptable values during the initial 48 hours after the event; however, Phase 3 FLEX strategies (described in Section 2.5.3 following) are currently required to be implemented within 48 hours of ELAP initiation in order to mitigate adverse containment conditions. MNS will continue to monitor containment pressure using the Containment Wide Range Pressure Instrumentation.

2.5.3. Phase 3: Containment

MNS will provide long-term Containment cooling by repowering a Lower Containment Ventilation (VL system) fan within 48 hours of ELAP initiation to ventilate the hotter air within the SG and Pressurizer enclosures. MNS will also repower a Containment Air Return fan (CARF) to mix the colder air in the ice condenser with the rest of Containment within 52 hours. These components will be powered using the large 4160V diesel generator equipment provided by the NSRC.

MNS will complete transition to ND system (Residual Heat Removal) cooling and cooldown to Mode 5 within 6 days of ELAP initiation to prevent challenging containment temperature and pressure limits following ice bed inventory depletion.

2.5.4. Availability of Structures, Systems, Components

2.5.4.1. Reactor Building/Containment

The FLEX response strategy relies on site structures to provide protection for components, fluid and electrical connections, and deployment paths from applicable extreme external hazards. Specifically, the FLEX strategy for maintaining Containment integrity relies on the Reactor Building/Containment Vessel, along with MCCs located in the Auxiliary Building. The Reactor Building and Containment Vessel are Seismic Category I structures that are designed to provide protection from the applicable extreme external hazards.

2.5.4.2. Components Inside Containment

MNS relies on repowering a set of fans (Hydrogen Skimmer fans, VL system fans, and CARFs) to maintain Containment temperature and pressure below acceptable limits. Hydrogen igniters are available to maintain hydrogen concentration below acceptable limits as defense in depth if the ELAP event degrades to core damage. All of these components are located inside the Reactor Building/Containment vessel, which is a Seismic Category I structure that protects equipment from external hazards. Additionally, these components are qualified to perform their design functions at the limiting environmental conditions of containment, which bound the calculated pressure and temperature conditions resulting from the ELAP event.

2.5.4.3. Spray Strategy

Containment spray functionality is not required to support MNS FLEX response strategies.

2.5.5. Plant Instrumentation

The key parameter for the Containment integrity function is containment wide range pressure, which can be monitored from the Control Room. Instrumentation will be powered by station batteries. If vital instrumentation and controls are lost subsequent to ELAP initiation, the alternate strategy is to read containment pressure inside the Process Control System 7300 cabinet using portable FLEX test equipment.

Additionally, MNS will maintain available the instrumentation for wide range Containment Sump level and Containment area radiation level.

2.5.6. Thermal-Hydraulic Analysis

To ensure functionality of the SG and Pressurizer level instrumentation during an ELAP event, MNS concluded that temperatures in the SG and Pressurizer enclosures should be maintained at less than saturated to prevent reference leg flashing during NC system cooldown evolutions. The design pressure limit of the MNS steel Containment Vessel is 15 psig.

MNS performed a thermal-hydraulic analysis to assess containment integrity using a GOTHIC model. Considering planned MNS actions to repower Hydrogen Skimmer fans within 24 hours and provide Containment cooling by repowering a VL system fan and a CARF within 48 hours and 52 hours, respectively, the GOTHIC analysis shows that Pressurizer enclosure temperatures and Containment pressure briefly peak at 294°F (for approximately 17 hours) and 16.13 psig (for approximately 8 hours). MNS evaluation concluded that temporary exposure to these elevated conditions is acceptable. For the temporary Containment pressure case, the faulted nature of the ELAP event permits the use of higher allowable stresses (i.e., up to and including yield). Approaching these stress limits would occur only at a significantly higher pressure than that experienced during the evaluated ELAP transient. For the temporary Pressurizer enclosure temperature case, there is more than sufficient NC system pressure available (i.e., above 0 psig) during this period to preclude reference leg flashing. Pressurizer level indication is adjusted appropriately for adverse containment conditions.

2.5.7. Electrical Analysis

Containment pressure instrumentation will initially be powered by safety-related vital batteries. The FLEX Electrical Distribution System will recharge the batteries to maintain availability of this instrumentation.

Hydrogen Skimmer fans used for containment ventilation and hydrogen igniters will be powered by the FLEX Electrical Distribution System. The Lower Containment (VL system) fans and Containment Air Return fans (CARF) will be powered from NSRC equipment. The primary connections for FLEX power are permanently-installed modified motor control center (MCC) buckets with external power connectors to provide power to specific components. The alternate connection strategy uses portable MCC buckets with external power connectors deployed from the FLEX buildings and installed in dedicated spare breaker locations. All MCC connections are located in the Auxiliary Building, which is a Seismic Category I structure. Therefore, the connection locations are protected from the applicable extreme external hazards.

MNS performed an analysis to ensure that the FLEX DGs had sufficient capacity to support the Phase 2 FLEX response strategies. The analysis included electrical loads relevant for maintaining Containment integrity, such as battery chargers, hydrogen igniters, and the Hydrogen Skimmer fans. The analysis also considered the cable routing to individual loads. MNS concluded that the DGs and planned/alternate cable routing arrangement were adequate to support operation of the required loads.

For FLEX response equipment utilized later in the event for long-term Containment cooling (i.e., > 24 hours after ELAP initiation), portable MCC buckets will be deployed from the FLEX buildings.

2.6. Characterization of External Hazards

The following extreme external hazards were assessed for applicability for MNS:

- Seismic events
- External flooding
- Storms such as hurricanes, high winds, and tornadoes
- Extreme snow, ice, and cold
- Extreme heat

2.6.1. Seismic events

The seismic hazard is applicable for MNS.

The MNS Updated Final Safety Analysis Report (FSAR) states that the safe shutdown earthquake (SSE) has a ground acceleration design value of 0.15g acting horizontally and 0.10g acting vertically, and the operating basis earthquake (OBE) has a ground acceleration design value of 0.08g acting horizontally and 0.0533g acting vertically (FSAR, Section 3.1). Per NEI 12-06, Revision 0, Table 4-2, all sites will consider seismic events.

2.6.2. External flooding

The external flooding hazard is applicable for MNS.

The limiting site flooding event for MNS is the Probable Maximum Precipitation event, which is of limited duration and water level. As described in UFSAR Sections 2.4, 2.4.10, and 3.4, MNS Seismic Category I structures are not susceptible to external flooding from the Probable Maximum Precipitation or Probable Maximum Flood Events. MNS is considered a dry site.

2.6.3. Storms such as hurricanes, high winds, and tornadoes

The high wind hazard is applicable for MNS.

As described in UFSAR Section 2.1.1, the MNS site is located at latitude 35°25'59" north and longitude 80°56'55". According to NEI 12-06, Revision 0 the location of MNS has a peak gust wind speed of 150 mph and a recommended tornado wind design speed of 172 mph. Based on the potential for winds in excess of 130 mph, the MNS site is susceptible to damage from severe winds from a hurricane or tornado.

2.6.4. Extreme snow, ice and cold

The extreme cold (including snow and ice) hazard is applicable for MNS.

MNS is located above the 35th parallel and is therefore subject to low-to-significant snowfall accumulation and extreme low temperatures per NEI 12-06, Revision 0. Based on NEI 12-06, the MNS site is also subject to the existence of large amounts of ice, and thus the potential for severe power line damage.

2.6.5. Extreme heat

The extreme heat hazard is applicable for MNS.

NEI 12-06, Revision 0 states that virtually every state in the lower 48 contiguous United States has experienced temperatures in excess of 110°F and many in excess of 120°F. In accordance with NEI 12-06, all sites will address high temperatures. Therefore, the extreme high temperature hazard is applicable for MNS.

2.7. Planned Protection of FLEX Equipment

Storage and protection of FLEX equipment is discussed in this section. MNS evaluated the applicability of external hazards and addressed implementation considerations associated with each including:

- protection of FLEX equipment
- deployment of FLEX equipment
- procedural interfaces
- utilization of off-site resources

MNS has three buildings for storage of FLEX response equipment that are 60 feet by 120 feet with multiple access doors. Design requirements for each building include the following:

- Conforms to ASCE 7-10 for seismic ruggedness (>2 × SSE)
- Rated to withstand wind loads to greater than 200 mph, which conforms to ASCE 7-10
- Located to provide protection from the design basis flood hazard

- Separated from the other FLEX Buildings by more than 1,200 feet to minimize the potential for multiple buildings to be damaged by tornados
- Includes power for FLEX equipment block heaters and FLEX equipment battery chargers
- Provides severe temperature protection for FLEX equipment

Redundant equipment is stored in the three FLEX Buildings such that if any single building were destroyed by the BDBEE (e.g., a tornado), sufficient FLEX equipment would remain intact and available for deployment from the remaining two buildings.

2.8. Planned Deployment of Flex Equipment

2.8.1. Haul Paths and Accessibility

The MNS FLEX response strategies plan for deployment of pumps, DGs, and other equipment from the FLEX Buildings to locations at the power block to support the various FLEX capabilities.

MNS has a Caterpillar 924K front end loader and a Dodge RAM 5500 diesel truck with stake body and pintle hitch for towing of FLEX equipment. These vehicles will be stored in separate FLEX Buildings.

In addition to the CAT 924K and the diesel truck, MNS Site Services also has other heavy equipment (e.g., tractors, backhoes, skid steers) in diverse locations that can support debris removal and deployment of FLEX response equipment. These vehicles are capable of clearing storm debris or ice/snow following a severe weather event, or rubble blocking vehicle access to the needed equipment staging locations following a seismic event. The equipment also supports maintaining vehicle access to the site following a BDBEE.

As discussed in UFSAR Section 2.5.4.8, soils beneath MNS are not considered susceptible to seismic liquefaction. Therefore, deployment routes will not be affected by seismic liquefaction.

MNS is considered a dry site, so flooding does not impact deployment paths from the FLEX Buildings to the power block.

Periodic walkdowns by plant personnel provide assurance that deployment paths for FLEX response equipment remain clear.

2.8.2. Deployment of Strategies

2.8.2.1. Raw Water Distribution

The MNS FLEX response strategies rely on distribution of raw water from the SNSWP when other sources of water are no longer available. MNS has one FLEX Low Pressure Pump with 3,000 gpm capacity and two other FLEX Low Pressure Pumps with 1,500 gpm capacity each. If the 3,000 gpm pump is available following the BDBEE, MNS will preferentially deploy that pump rather than the two 1,500 gpm pumps.

MNS will connect the FLEX Low Pressure Pump(s) to the Fire Protection system if that system is available following the BDBEE. If this option is not available, MNS can establish raw water distribution from the SNSWP to the station yard using hoses only. Hoses would be routed through the North Vehicle Access Portal (VAP) or the South VAP. If both VAPs are available, Unit 1 may use the South VAP and Unit 2 may use the North VAP to minimize the length of hose runs. MNS will install Y-connectors on the deployed hose at pre-determined locations to provide access to the various water demands of the FLEX response strategies.

MNS concluded that ice in the SNSWP will not affect the ability to provide water for FLEX response strategies. The normal intake from the SNSWP is approximately 40 feet under water and there are two independent, safety-related water sources. Implementation of the Phase 2 strategy requires placing suction hoses into the SNSWP. The debris removal equipment will be able to remove any ice at the SNSWP to enable deployment.

2.8.2.2. Core Cooling Strategy

The FLEX core cooling strategy may use the FLEX Medium Pressure Pumps to deliver feedwater to the SGs as a contingency to the TDCA pump, and will eventually use it to allow cooldown in order to transition to use of the ND system (Residual Heat Removal).

One FLEX Medium Pressure Pump is stored in each of the FLEX Buildings. One FLEX Medium Pressure Pump is needed for each Unit, which will be staged outside near the stairs of the EDG roof and Exterior Doghouse. MNS will deploy hoses from that location to tie into an appropriate water supply (e.g., 5-inch hose deployed from the FLEX Low Pressure booster pump / SNSWP). MNS will also deploy hoses from the FLEX Medium Pressure Pump discharge to one of the FLEX connections for SG make-up.

A description of availability of water sources and connection points is provided in the Reactor Core Cooling Strategy discussion (Section 2.3) of this Final Integrated Plan (FIP). For all applicable extreme external hazards, sufficient water is available and the redundant connection points ensure that auxiliary feedwater flow will be available to all SGs.

2.8.2.3. Reactor Coolant Boration and Make-up Strategy

The FLEX core cooling strategy relies on FLEX High Pressure Pumps to deliver water to the NC system.

One FLEX High Pressure Pump is stored in each of the FLEX Equipment Storage Buildings. One FLEX High Pressure Pump will be deployed for each Unit. The two pumps may be staged in one of three locations outside the Auxiliary Building. MNS will deploy hoses from the selected location to the FLEX piping connection on the FWST supply line to provide a suction source for the pump. MNS will deploy hoses from the pump discharge to one of the FLEX connections for NC system make-up.

Evaluation of availability of water sources and connection points is provided in the Reactor Core Cooling Strategy discussion (Section 2.3) of this FIP. Sufficient water is available and the redundant connection points ensure that borated water make-up will be available to the NC system for all applicable extreme external hazards.

2.8.2.4. Electrical Strategy

Each of the three FLEX Buildings at MNS contains a 600VAC FLEX DG, and associated power distribution panels (PDPs) and cabling. Two of the three FLEX DGs are needed for a dual-unit ELAP event. MNS has identified six candidate locations around the power block for potentially staging the FLEX DGs. After the DGs are positioned in the selected locations, MNS will set up PDPs and deploy cabling to align the DGs to in-plant MCCs. Four PDPs will be set up per FLEX DG, with two of the PDPs connected directly to the DG and two other PDPs jumpered to the directly-connected PDPs. Each Unit has several permanent modified FLEX electrical connections and several other locations that can use portable FLEX MCC buckets deployed from the FLEX Buildings.

During Phase 3, two NSRC-delivered 4160V 1MW DGs per Unit will connect to a 4160V distribution center to re-energize one 4KV essential bus. The NSRC distribution center will be connected to the MNS 4KV switchgear. For Unit 1, the preferred deployment location for the two NSRC DGs is the northwest corner of the Auxiliary Building, just north of the Unit 1 SFP roll-up door. For Unit 2, the preferred location is the northeast corner of the Auxiliary Building near the entrance to the Hot Tool Room.

Evaluation of availability of electrical connection points is provided in the Reactor Core Cooling Strategy discussion (Section 2.3) of this FIP. For all applicable extreme external hazards, connections will be available for the FLEX electrical strategy.

2.8.3. Fueling of Equipment

MNS has two sources of diesel fuel oil (DFO) for the FLEX response strategies: (1) the MNS garage underground diesel fuel tank, and (2) the four safety-related 50,000 gallon Diesel Fuel Oil Storage Tanks (DFOSTs) for the Emergency Diesel Generators (EDGs). MNS also has a portable diesel-powered fuel oil transfer skid, which is attached to the DFOST recirculation pump suction line to pump oil from the DFOSTs. In addition, at least one station fuel oil truck with underground tank draft capability is staged for emergency response in the event of severe weather.

MNS analysis shows that the total estimated DFO consumption is 3,600 gallons per day, so the DFOST inventory would be sufficient for several weeks. MNS could obtain additional fuel from off-site sources during Phase 3, if necessary.

2.9. Sequence of Events and Staffing

2.9.1. Sequence of Events

The Table below presents a Sequence of Events (SOE) Timeline for an ELAP/LUHS event at MNS. Validation of each of the FLEX time constraint actions was completed in accordance with the FLEX Validation Process document issued by NEI and includes consideration for staffing. Times listed are approximate.

Sequence of Events Timeline			
Action	**Start Time (hours)**	**Completion Time (hours)**	**Remarks / Applicability**
Event Starts	0	NA	Plant @100% power.
Take Control of TDCAP	0.5	1	
Diagnose / Declare Event	1	1	
Open MCR Doors	1	2	Cooling strategy.
De-energize EDG Sequencer	1	2	DC Load Shedding.
Align FLEX Pump to SGs	1 - 72	72	Secondary strategy to TDCA Pumps. Prior to Residual Heat Removal alignment and cooldown below 350°F.
Isolate RCP Seal Return, VUCDT containment isolation	2	3	No required time limit.
Disconnect Non-critical DC Loads	2	3	DC Load Shedding.
Cooldown of NC system	2	4	First cooldown to ~420°F.
Purge Main Generator	2	4	Hydrogen mitigation.
Begin Containment Isolation	2	N/A	VUCDT and RCP Seal Return line listed above. No specified time limit for others.
Bypass SG PORV solenoid valves	3	4	Prior to loss of Aux. Control Power.
Open RC Vents	3	6	If loss of Lake Norman occurs (dam failure).
Isolate/mitigate plant internal flooding	4	12	Continuous action as sources are identified. No isolation credit taken. Sump pumps credited for CA Pump Rooms and ND/NS Pump Room sump.
Debris Removal for Access	4	24	Site access by 8 hrs. maximum.
Secure inputs to Ground Water Sump	6	7	RN vents, other inputs as found. No time limit.
Install portable antenna if installed antenna is damaged	6	7	Ensure radio communication from Control Room to operators at FLEX equipment.
Refueling of small (6 kW) FLEX diesel generators	6	continuous	Used for 120VAC service prior to FLEX Electrical Distribution set-up.
Deploy FLEX Electrical Distribution	8	14	

Sequence of Events Timeline			
Action	**Start Time (hours)**	**Completion Time (hours)**	**Remarks / Applicability**
Align FLEX pumps from FWST supply to NC system	9	13	Earliest possible start time is ~7-8 hours if minimal debris removal. Required by 13 hours.
Provide recharge for radio repeaters	10	13	
Install portable FLEX Instrument Air and recharge BO header	12	16	
FLEX Raw Water Distribution	12	17	
Deploy FLEX sump pumps	14	18 or 28	18 or 28 hour time limit depending on location.
Recharge Vital Batteries	14	18	
Install FLEX portable lighting	14	24	No time limit.
Power Hydrogen Igniters	>14	N/A	NEI 12-06, rev. 0 contingency. Performed after FLEX Electric Power Distribution set-up. No specified time limit.
Make-up to CAST if needed	15	18	
Stage Make-up to SFP	18	20	
Open SFP doors	18	20	Steam vent path.
Start Hydrogen Skimmer Fans	20	24	Containment cooling strategy.
Install Portable AC and fans	20	40	After installation of FLEX Electric Power Distribution. No time limit except for Battery Room fans installed within 24 hours of charger repowering.
Initiate FWST Make-up for Tornado Event	24	N/A	Continuous.
Supply SFP make-up	>24	continuous	Dependent on pool history and Monitoring Pool Level.
Isolate CLAs	42	48	Before NC system cooldown to approximately 350°F.
Align TDCAP suction from RC piping to UHS (SNSWP)	45	48	Prior to depleting captured volume in RC piping.
Start Lower Containment Ventilation (VL system) fan	46	48	Containment cooling strategy.
Cooldown to ~350°F	48	49	After CLA Isolation. Second cooldown.

Sequence of Events Timeline			
Action	**Start Time (hours)**	**Completion Time (hours)**	**Remarks / Applicability**
Start Containment Air Return Fan	50	52	Containment cooling strategy to engage ice condenser.
Align RHR cooling and initiate final Cooldown to stop NC system leakage and heat input to Containment	72	144	Prior to 6 days.

2.9.2. Staffing

Using the methodology of (Nuclear Energy Institute) NEI 12-01, Revision 0 *Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities* (Reference 16), an assessment of the capability of the on-shift staff and augmented Emergency Response Organization (ERO) to respond to a BDBEE was performed.

The assumptions for the NEI 12-01 Phase 2 scenario postulate that the BDBEE involves a large-scale external event that results in:

- An ELAP
- An extended LUHS
- Impact on Units (all Units are in operation at the time of the event)
- Impeded access to the Units by off-site responders as follows:
  - 0 to 6 Hours Post Event – No site access.
  - 6 to 24 Hours Post Event – Limited site access. Individuals may access the site by walking, personal vehicle or via alternate transportation capabilities (e.g., private resource providers or public sector support).
  - 24+ Hours Post Event – Improved site access. Site access is restored to a near-normal status and/or augmented transportation resources are available to deliver equipment, supplies and large numbers of personnel.

The on-shift staffing analysis concluded that the number of on-shift personnel is sufficient to perform those transition phase tasks identified as being implemented during the 0 to 6 hours post-event period.

The expanded ERO analysis concluded that sufficient personnel resources exist in the current MNS augmented ERO to fill positions for all of the expanded ERO functions. Thus, ERO resources and capabilities necessary to implement Transition Phase coping strategies performed after the end of the 0 to 6 Hours Post Event period exist in the current program.

To conduct the assessment, a team of subject matter experts from Operations, Maintenance, Radiation Protection, Chemistry, Security, Engineering, Corporate Fukushima Response and industry consultants conducted tabletop evaluations. The participants reviewed the assumptions and existing procedural guidance, including applicable draft FLEX Support Guidelines (FSGs) for coping with a BDBEE using minimum on-shift staffing. Particular attention was given to the sequence and timing of each procedural step, its duration, and the on-shift individual performing the step to account for both the task and time motion analyses of NEI 10-05, Revision 0, *Assessment of On-Shift Emergency Response Organization Staffing and Capabilities* (Reference 17).

2.10. Offsite Resources

The Strategic Alliance for FLEX Emergency Response (SAFER) team is contracted by the nuclear industry through Pooled Equipment Inventory Corporation (PEICo) to establish NSRCs operated by Pooled Inventory Management (PIM) and in collaboration with AREVA to purchase, store, and deliver emergency response equipment in the case of a major nuclear accident or BDBEE in the United States.

MNS relies on equipment stored off-site for Phase 3 of the FLEX response strategy. (See Sections 2.3, 2.4, and 2.5.)

The NRC letter dated September 26, 2014 (ADAMS Accession No. ML14265A107) titled "Staff Assessment of National SAFER Response Centers Established in Response to Order EA-12-049" (Reference 12) endorsed Nuclear Energy Institute's (NEI) White Paper titled "National SAFER Response Centers" (Reference 13). NRC concluded that SAFER procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI 12-06, Revision 0 guidance and the SRP to meet Phase 3 requirements of Order EA-12-049.

2.10.1. National SAFER Response Center (NSRC)

The SAFER Response Plan for MNS, (Reference 9) contains (1) SAFER control center procedures, (2) National SAFER Response Center procedures, (3) logistics and transportation procedures, (4) staging area procedures, which includes travel routes between staging areas to the site, (5) guidance for site interface procedure development, and (6) a listing of site-specific equipment (generic and non-generic) to be deployed for FLEX Phase 3.

Two NSRC's are strategically located across the country in Memphis, TN and Phoenix, AZ. The primary location for MNS is Memphis.

If possible, SAFER equipment will be delivered to Staging Area C, which is the Kings Mountain Training Center (43 miles away from the MNS site by driving). When MNS is ready, SAFER equipment will then be delivered to Staging Area B, which is an overflow parking lot at the MNS site near FLEX Building #2. MNS has identified primary and alternate driving routes from Staging Area C to Staging Area B. MNS will coordinate with the state of North Carolina to determine the condition of bridges along the travel path. If road travel from Staging Area C to Staging Area B cannot be accomplished, then Staging Area B will receive SAFER equipment directly via helicopter airlift. MNS identified two access routes from Staging Area B into the protected area with the primary access being through the normal Vehicle Access Portal (VAP) on the eastern side of the site, and the secondary access point being on the south west side of the site.

The SAFER Response Plan for MNS does not include a Staging Area D.

The first arriving equipment will be delivered to the site within 24 hours from initial contact and remaining equipment will be delivered within 72 hours from initial contact.

2.10.2. Equipment

The NSRC will provide equipment as listed in the response plan. The NSRC will deliver the first pieces of equipment within 24 hours from initial contact. Such priority equipment includes Medium Voltage Generators (4160 VAC), a water purification skid, a mobile boration unit, and other support function equipment. The generic set of NSRC equipment as identified in the plan provides back up to on-site FLEX equipment (e.g., pumps, DGs) and will be provided as lower priority items to arrive within 72 hours from initial contact. NSRC equipment connections to applicable hoses and/or plant equipment are compatible or necessary adapters are available.

Other offsite resources may be obtained as needed to support the event which may include diesel fuel oil, equipment from other nuclear plants, and equipment from vendors.

2.11. Habitability and Operations

2.11.1. Equipment Cooling and Personnel Habitability

The loss of all AC power limits the areas of the plant where heat sources are present and plant heat-up will occur. MNS performed a GOTHIC analysis to evaluate temperatures in relevant portions of the Auxiliary Building (including the MCR), the Service Building, and the Interior Doghouse during an ELAP event. MNS will open Control Room doors within 3 hours of the start of the event to maintain temperature at an acceptable level during Phase 1. Other areas of concern did not reach excessive temperature during Phase 1.

As necessary, MNS will deploy spot coolers in the Control Room and portable fans in the Battery Room and CA pump rooms to lower temperatures as part of Phase 2. MNS evaluation suggests that at least four coolers should be deployed in the Control Room. MNS plans to deploy eight FLEX HVAC units to the Control Room, which will maintain temperature below 80°F. This equipment is powered by small portable FLEX diesel generators located in the MG Set Rooms and discharges heat through the FLEX Raw Water Distribution system. Water is supplied to the FLEX HVAC units from a portable raw water distribution header and return water is routed to the station yard area. Condensate from the coolers is drained to plant drains in the Service or Turbine Building.

During Phase 3, MNS may use normal (installed) cooling equipment that can be re-powered from the DG provided by the NSRC.

2.11.2. Hydrogen Ventilation

The minimum concentration of hydrogen gas to result in an explosive mixture is 4%. A conservative MNS analysis determined that hydrogen generation and build-up in an individual battery room enclosure will remain below 2% for at least 13 hours of battery charging. The individual battery room enclosures are part of an overall battery compartment, which will remain below 2% for at least 15 days. As part of the Phase 2 FLEX response strategy, MNS will deploy small portable fans within 12 hours of commencing battery charging to circulate air in the battery rooms and prevent excessive hydrogen gas accumulation.

MNS analysis also determined that the ventilation capacity required to maintain acceptable hydrogen concentration is 1.1 ft^3/min. Fans used in the FLEX strategy will provide ventilation flow far in excess of this minimum requirement.

2.12. Water Sources

Discussion of credited water sources for the FLEX response strategies is included in the previous sections for each individual strategy.

As part of initial assessment of plant systems following a BDBEE, MNS will determine the condition of the following water sources:

- FWST
- CAST
- Auxiliary Feedwater Condensate Storage Tanks (CACST)
- SNSWP
- Lake Norman

Other water sources (e.g., Reactor Makeup Water Storage Tanks (RMWSTs), Recycle Holdup Tanks (RHTs)) will be assessed as necessary during event response.

2.12.1. SG Make-up

For SG make-up, MNS will provide water from any of the following sources:

- CASTs (default)
- Auxiliary Feedwater Condensate Storage Tanks (CACST)
- RC system piping embedded volume
- Lake Norman (via Nuclear Service Water (RN) and RC piping)
- SNSWP (via RN and RC piping)

The embedded RC system captured volume and the SNSWP are the credited sources of water because of their robustness to the applicable hazards. Lake Norman may not be available as a water source (e.g., if there is a dam failure). The CAST and CACST are not protected from external hazards. These tanks are normally aligned as a TDCAP suction source, but automatic realignment of TDCAP suction to embedded RC system captured volume is provided if the CAST and CACST are lost.

The CAST and CACST have condensate grade water that will not foul the SGs. If MNS switches to Lake Norman or the SNSWP, raw water is acceptable for use for a limited duration. In this case, water purification equipment from the NSRC will be deployed to establish a clean water source.

2.12.2. Reactor Coolant System Make-up

For NC system boration during Phase 2, MNS will provide borated water from both of the following sources:

- FWSTs
- CLAs

For NC system inventory control during Phase 2, the FWST is the source of borated make-up water. The FWST inventory can be replenished using one or more of the following options:

- BATs
- Blended make-up from the BAT and another source (e.g., NSRC-supplied water purification unit, CAST, raw water)
- NSRC-supplied mobile boration skid
- Opposite Unit's FWST
- RHTs
- Portable FLEX drop tanks mixing boron and RMWST inventory or raw water

The SNSWP provides a robust water source that can be credited for long-term FWST make-up for all applicable hazards. However, a clean water source is the preferred option for mixing borated water and refilling the FWST. Tanks containing clean water or the

NSRC-supplied water purification equipment would be used rather than raw water, if available.

2.12.3. SFP Inventory Control

For inventory control of the SFP, MNS uses raw water via the Fire Protection system or from hoses, both of which ultimately are pressurized with raw water. The credited source of this water is the SNSWP. The SNSWP will be available following the applicable extreme external hazards.

During Phase 3, MNS may transition to a clean water source (e.g., NSRC-supplied water purification unit) when available.

2.13. Shutdown and Refueling Analysis

Order EA-12-049 requires that licensees must be capable of implementing the FLEX response strategies in all Modes. In general, the previous Sections focus on a BDBEE occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. If the BDBEE occurs with the plant at power, the mitigation strategy initially focuses on the use of a pump coupled to a steam-powered turbine to provide the water initially needed for decay heat removal. If all or most of the fuel has been placed in the SFP, there is a shorter timeline to implement the FLEX response strategy for providing SFP make-up water. However, this is balanced by the fact that if immediate cooling is not required for the fuel in the reactor vessel, the operators can concentrate on providing make-up to the SFP and the number of personnel on-site is much greater during an outage. MNS analysis shows that following a full core offload to the SFP, at least 63 hours are available to implement makeup before boil-off results in the water level in the SFP dropping far enough to uncover fuel assemblies. As previously discussed, MNS can provide sufficient SFP make-up in advance of this timeline.

When a plant is in a shutdown mode and steam is not available to operate the steam-powered pump, another strategy must be used for decay heat removal while fuel is still in the reactor vessel. On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown Refueling Modes" (Reference 10), which described methods to ensure plant safety in shutdown modes. By letter dated September 30, 2013 (Reference 11), the NRC staff endorsed this position paper as a means of meeting the requirements of the Order. In the third six-month update (Reference 14) dated August 27, 2014, MNS committed to follow the guidance in this position paper.

MNS's FLEX response strategy for core cooling during Modes 5 and 6 includes use of medium pressure pumps to supply water to the NC System. The same water supply path from the FWST is used as for the Modes 1 - 4 strategy. A FLEX Medium Pressure Pump (300 gpm at 400 psig discharge pressure) is used to supply water to primary FLEX connections in the ND system. Alternate connections are those used for the Modes 1-4 strategy (NI system connections). Cooling occurs by steaming of the reactor coolant through NC system vent paths used during the outage. The FWST inventory, if the tank is intact, will provide at least two days of feed and bleed core cooling. Diverse options exist for borated water make-up to the FWST if it is damaged above the protective wall by a wind-generated missile.

If the reactor vessel head is removed, core cooling can be provided by maintaining the refueling canal level. If the NC system is intact and can be pressurized, core cooling can be maintained using SGs in a similar manner to the Modes 1-4 scenario.

Provided that core cooling is expected to be maintained, MNS will open the Containment Upper Personnel Airlock to establish an emergency vent path and prevent excessive pressure buildup.

This vent path will direct steam into the Fuel Building and then outside through the open Fuel Building roll-up door.

2.14. Procedures and Training

2.14.1. Procedural Guidance

The inability to predict actual plant conditions that require the use of BDBEE equipment makes it impossible to provide specific procedural guidance. As such, the FSGs provide guidance that can be employed for a variety of conditions. FSGs, to the extent possible, provide pre-planned FLEX response strategies for accomplishing specific tasks in support of EOPs and Abnormal Operating Procedures (AOPs). FSGs are used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

Procedural interfaces were incorporated into ECA-0.0, "Loss of All AC Power" to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP.

2.14.2. Training

Programs and controls have been established to assure personnel proficiency in the mitigation of BDBEE is developed and maintained. The Systematic Approach to Training (SAT) process was utilized to evaluate, develop and implement training for applicable personnel.

Initial training has been provided and continuing periodic training will be provided to site emergency response leaders on BDBEEs emergency response strategies and implementing guidelines. Personnel assigned to direct the execution of mitigation strategies for BDBEEs have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints.

Care has been taken to not give undue weight (in comparison with other training requirements) for Operator training for BDBEE accident mitigation. The testing/evaluation of Operator knowledge and skills in this area was similarly weighted.

3 Acronyms

ATWS - Anticipated Transient Without Scram
BAT - Boric Acid Tank
BDB - Beyond-Design-Basis
BDBEE - Beyond Design Basis External Event
CA - Auxiliary Feedwater System
CACST - Auxiliary Feedwater Condensate Storage Tank
CARF - Containment Air Return Fan
CAST - Auxiliary Feedwater Storage Tank
CFR - Code of Federal Regulations
CLA - Cold Leg Accumulator
DFOST - Diesel Fuel Oil Storage Tank
DG - Diesel Generator
EFPD - Effective Full Power Days
ELAP - Extended Loss of AC Power
EOC - End of Cycle
EOP - Emergency Operating Procedure
ERO - Emergency Response Organization
FCV - Flow Control Valve
FIP - Final Integrated Plan
FLEX - Diverse Flexible Coping Strategies
FSG - FLEX Support Guideline
FWST - Refueling Water Storage Tank
KC - Component Cooling Water System
KF- Spent Fuel Pool Cooling System
LOOP - Loss of Offsite Power
LUHS - Loss of Access to Ultimate Heat Sink
MCC - Motor Control Center
MCR - Main Control Room
MNS - McGuire Nuclear Station
NC - Reactor Coolant System
ND - Residual Heat Removal System
NI - Safety Injection System
NEI - Nuclear Energy Institute
NRC - Nuclear Regulatory Commission
NS - Containment Spray System
NSRC - National SAFER Response Center
NTTF - Near-Term Task Force
OEM - Original Equipment Manufacturer
PDP - Power Distribution Panel
PEICo - Pooled Equipment Inventory Corporation
PIM – Pooled Inventory Management
PORV - Power-Operated Relief Valve

RC - Condenser Cooling Water System
RCP - Reactor Coolant Pump
RCS - Reactor Coolant System
RFO - Refueling Outage
RHT - Recycle Holdup Tank
RMWST - Reactor Makeup Water Storage Tank
RN - Nuclear Service Water System
RVLIS - Reactor Vessel Level Indication System
SAFER - Strategic Alliance for FLEX Emergency Response
SAT - Systematic Approach to Training
SBO - Station Blackout
SFP - Spent Fuel Pool
SG - Steam Generator
SNSWP - Standby Nuclear Service Water Pond
SSE - Safe Shutdown Earthquake
TDCAP - Turbine-Driven Auxiliary Feedwater Pump
TIA - Task Interface Agreement
TS - Technical Specifications
TSC - Technical Support Center
UHS - Ultimate Heat Sink
VAP - Vehicle Access Portal
VI - Instrument Air System
VL - Containment Ventilation System
VUCDT - Ventilation Unit Condensate Drain Tank
WZ - Groundwater Drainage System

4 References

1. Recommendations for Enhancing Reactor Safety in the 21st Century; The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, July 12, 2011

2. NRC Order EA-12-049, Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, March 12, 2012. (ML12054A735)

3. NEI 12-06, Rev. 0, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, August 2012.

4. NRC 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. (ML12229A174)

5. NRC Order EA-12-051, Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation.

6. NEI 12-02, Rev. 1, Industry Guidance for Compliance with NRC Order EA-12-051 to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, August 2012.

7. NRC Interim Staff Guidance JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation.

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9. Areva, Inc., "SAFER Response Plan for McGuire Nuclear Station," Revision 000, dated August 26, 2014.

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11. NRC (Davis) letter to NEI (Pollock), dated September 30, 2013. (ML13267A382 in NRC ADAMS Database)

12. NRC (Davis) letter to NEI (Pollock), dated September 26, 2014, "Staff Assessment of National SAFER Response Centers Established in Response to Order EA-12-049." (ML14265A107 in NRC ADAMS Database)

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14. Duke Energy letter MNS-14-066, dated August 27, 2014, "Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)." (ML14253A188 in NRC ADAMS Database)
15. NRC (Davis) letter to PWROG (Stringfellow), dated January 8, 2014. (ML13276A183 in NRC ADAMS database)
16. NEI 12-01, Rev. 0, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities, May 2012.
17. NEI 10-05, Rev. 0, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities, June 2011. (ML111751698 in NRC ADAMS database)
18. Duke Energy letter MNS-14-086, dated November 18, 2014, "Notification of Full Compliance with Order EA-12-049, 'Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events' and with Order EA-12-051, "Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" - McGuire Nuclear Station Unit 1." (ML14335A322 in NRC ADAMS Database)
19. Duke Energy letter MNS-15-096, dated December 07, 2015, "Final Notification of Full Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events and with Order EA-12-051, Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation for McGuire Nuclear Station."

1. Background and Purpose

NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," required licensees to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment and spent fuel pool cooling capabilities following a beyond-design-basis external event. To develop strategies for maintaining/restoring core cooling, licensees evaluated reactor coolant system (RCS) leakage from reactor coolant pump (RCP) seals during an extended loss of all AC power (ELAP).

NSAL-14-1, Revision 1 was issued by Westinghouse on September 9, 2014 and it documents that the nominal RCP seal leakage rate of 21 gallons per minute (gpm), as documented in WCAP-10541, Revision 2, may be not be applicable for all plants using Westinghouse RCPs with standard seal designs because of the various thermal-hydraulic conditions set up by plant-specific seal leak-off piping designs.

PWROG-14015-P, Revision 2 was issued by the PWR Owner's Group in April 2015 to determine revised no. 1 RCP seal leak-off flow rates following an ELAP.

PWROG-14027-P, Revision 3 was issued by the PWR Owner's Group in April 2015 to evaluate the time to enter reflux cooling and the time at which the core uncovers based on the revised seal leak-off flow rates during an ELAP.

Following issuance of the Watts Bar Mitigating Strategies Safety Evaluation dated March 27, 2015, via e-mail dated March 31, 2015 NRC requested that licensees with standard Westinghouse RCP seal packages review the technical content therein and provide information addressing similar issues. This information would be documented in a Margin Assessment. Specifically, the NRC communication stated (as similarly noted in the Watts Bar Safety Evaluation):

"At the present time the NRC staff is unable to conclude that Westinghouse's analytical modeling of RCP seal leakage is acceptable on its own merits. However, for the purposes of mitigating strategies, the staff can balance the modeling uncertainties and deficiencies of the model with the unique aspect of FLEX. To expedite individual plant resolution, licensees could provide a brief discussion about the margin for RCS makeup time, based on the favorable aspects of individual site mitigating strategies."

The purpose of this Margin Assessment is to provide a discussion regarding the margin for RCS makeup time, specifically addressing the examples of pertinent information regarding seal leakage as provided by NRC.

2. RCP Seal Leak-Off Line Configuration

McGuire is a four-loop Westinghouse PWR utilizing Model 93A reactor coolant pumps, using standard Westinghouse seal packages. The McGuire RCS loops utilize BWI inverted U-tube type steam generators. McGuire's Mitigating Strategies (FLEX) response is based on the established RCP seal leakage profile as identified in WCAP-17601-P, revision 1 "Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs".

In early 2014, as a result of Westinghouse NSAL-14-1, McGuire (an early implementer of the Fukushima Orders) contracted with MPR Associates to have the existing RCP no. 1 and no. 2 seals and the associated no. 1 seal leak-off piping evaluated for an extended loss of seal cooling event, such as an ELAP. Due to time constraints this effort was performed in parallel with the follow-on PWROG initiative to resolve issues associated with the established RCP seal leak-off rates during a LOSC event. The MPR RCP seal model is different from the Westinghouse seal model being used in the PWROG work, in that the MPR model accommodates a transient analysis for evaluation of known pressure spikes during the early stages of the LOSC event. The Westinghouse RCP seal model does not currently allow for evaluation of transient behavior.

As a result of the MPR seal analyses McGuire determined that a modification to the no. 1 RCP seal leak-off piping configuration, in the form of a 0.254-inch bore restriction orifice (in series with the original 0.359-inch bore flow metering orifice) positioned downstream of the seal exit but in relatively close proximity to it, was required. This modification limits seal leakage after an extended LOSC event and also serves to protect the downstream seal leak-off piping/components from the adverse pressure conditions associated with the transient. In terms of the categorization of plants by leak-off configuration given in the PWROG-14015-P, revision 2 report dated April 2015, upon implementation of this modification McGuire is classified in the first generic leakage category (i.e., Category 1).

McGuire is not officially crediting the MPR analysis for ELAP response or compliance with Order EA-12-049, and as of fall 2015 the officially credited PWROG work to resolve remaining open issues is not yet complete. However, the MPR analysis results for both seal leak rate and the attendant leak-off piping pressure-temperature conditions during an ELAP/LOSC event show McGuire seal leak rates (post-restriction orifice modification) are bounded by the documented Westinghouse leakage results as identified in the PWROG-14027-P revision 3 report, dated April 2015. Additionally, in-house piping stress evaluation of the RCP no. 1 seal leak-off piping/components shows the modified system retains its integrity throughout the transient predicted by the MPR seal model, as well as at more extreme conditions.

During the August 2014 NRC FLEX Audit, most of the above information was discussed with the NRC audit team and with ONRR, and subsequently an information package was placed on the McGuire E-Portal for technical staff information/use. McGuire installed additional 0.254-inch bore restriction orifices in all four Unit 1 RCP no.1 seal leak-off lines and declared Unit 1 in compliance with Order EA-12-049 in November 2014. Subsequently, McGuire installed the additional 0.254-inch bore restriction orifices in all four Unit 2 RCP no.1 seal leak-off lines and declared Unit 2 in compliance with Order EA-12-049 in October 2015. The status of the McGuire response to NSAL-14-1, revision 1 was updated in the EA-12-049 Fourth Six-month Status Report dated February 28, 2015.

In March 2015, specific transient conditions potentially requiring further evaluation of the RCP no. 1 seal leak-off piping were identified by PWROG via Westinghouse NSAL-15-2. This NSAL formally identifies the existence of a potential 2045 psia pressure spike that occurs at the no. 1 seal exit early in the LOSC transient and its potential effect on the seal leak-off line, a transient the Westinghouse seal model cannot specifically evaluate as noted previously. As a result of this model limitation, the NSAL recommends Licensees assume a conservatively high seal exit pressure and temperature in the leak-off piping to account for the pressure spike for evaluation of system response to an ELAP. While the current McGuire MPR ELAP transient analysis predicts lower pressure and temperature conditions than those recommended by NSAL-15-2, an additional analysis case was run by MPR with a 2045 psia pressure (the NSAL-15-2 recommendation) as a forced input at the seal exit. This analytical approach removes reliance on the MPR seal model entirely and allows for independent thermal-hydraulic evaluation of the RCP no. 1 seal leak-off line. Similar to the position taken at Watts Bar, an analysis case was also run at the maximum possible #1 seal exit conditions (i.e., 2500 psia at the associated RCS T_{cold} value of 568°F).

Results from these evaluations, coupled with in-house piping/hanger stress analysis reviews, show the RCP no.1 seal leak-off piping remains adequately protected by the newly-installed restriction orifice from both of these extreme pressure transients and as such the published PWROG Category 1 ELAP leak-off rates still apply for McGuire.

3. Margin Assessment

The margin assessment was performed using the examples of pertinent information regarding seal leakage provided by NRC via e-mail dated March 31, 2015. This assessment highlights the favorable aspects of the McGuire FLEX strategy and identifies areas with margin.

3.1. Early RCS Cooldown

Per ECA-0.0 response, symmetric RCS cooldown/depressurization at McGuire is started within 1-2 hours of ELAP onset to minimize RCS inventory loss and protect the RCP seal packages. Post-event initiation, RCS conditions at McGuire will peak at 2485 psig and 568°F until cooldown commences. The McGuire RCP Model 93A seal packages contain O-rings made from 7228C elastomer material, which has been evaluated to withstand up to 582°F for eight hours. Early initiation of RCS cooldown therefore provides further assurance the RCP seals will continue their function to limit leak-off flow and RCS inventory loss.

- **Additional Favorable Cooldown Information**

The behavior of the RCP no. 2 seal has been evaluated by both Westinghouse and MPR, and the seal is shown to remain closed as designed during an ELAP event, even for extended durations at elevated pressures and temperatures. The current McGuire ECA-0.0 cooldown strategy (RCS conditions of at or below ~420°F four hours into the event, followed by a further cooldown to at or below ~350°F 48 hours into the event) provides further assurance the no. 2 seal will remain closed as well as facilitating RCS conditions favorable for passive injection of highly borated water from the Cold Leg Accumulators.

Though their analysis demonstrates the no. 2 seal remains closed with the RCS at the SG O.08 setpoint, Westinghouse guidance (Technical Bulletin TB-15-1) recently recommended an accelerated cooldown profile within the first 24 hours of ELAP initiation as a prudent action. The OEM has indicated that an upcoming revision to this guidance will relax some of the limitations in the original version; McGuire will evaluate an alternative accelerated cooldown profile when the guidance is finalized.

3.2. Early RCS Makeup

In order to identify margin associated with the RCS makeup strategy, two characteristics related to RCS behavior are addressed: adequate boration capability/ mixing during two-phase natural circulation in the RCS to prevent a return to criticality, and the predicted time to reflux cooling in the steam generators.

- **Adequate Boration Capability and Boron Mixing**

For an ELAP scenario initiating while in Modes 1-4, the McGuire RCS boration start setpoint (from 7 to 13 hours into the event) is based on preventing a potential return to criticality calculated to occur at 13.85 hours after plant trip rather than the predicted onset of reflux cooling in the SG tubes, which occurs later.

As noted previously, after the initiation of an ELAP event, the operators will cool down the RCS to approximately 420°F within the first several hours in order to minimize RCP seal leakage and inventory loss. Operators will then maintain the plant at those conditions until sufficient boration has been completed before continuing to cool down further. The McGuire high pressure diesel-driven FLEX makeup pump has sufficient performance (40 gpm at 1700 psig discharge pressure) to ensure injection flow is greater than RCP seal leakoff flow at the time of pump alignment to the RCS (predicted as 6-8 gpm/seal). Should conditions warrant (e.g., unexpectedly greater RCP seal leak rates), the pump has a variable speed control for flow and pressure which provides the ability to increase injection flowrates by up to 50% if needed, a benefit of having a diesel driver.

Endorsed NEI 12-06 guidance allows for plant operational parameters in their normal ranges prior to onset of an ELAP, in lieu of the more restrictive limits of a design basis analysis. In performing the in-house RELAP5 McGuire ELAP boration evaluation however, credit for parameters in their normally expected ranges was not generally taken (i.e., more limiting assumptions were made), which provides for a qualitative margin assessment as noted following:

- For the boration capability evaluation all four RCP seal packages are assumed not to leak during the ELAP event (i.e., they seal perfectly), minimizing RCS letdown and maximizing the boron injection requirement

- Boration requirements for McGuire RCS cooldown are based on an ELAP event occurring after a >500-day EFPD reactor run (EOC; RCS at 6 ppm), with the most limiting equilibrium Xenon characteristics

- The assumed required final RCS boron concentration after FLEX makeup pump injection is conservatively high (475 ppm), which increases the amount of borated water volume injection to meet shutdown requirements at 350°F (about 150 ppm is the minimum required boron concentration to remain 1% shutdown)

- Assumed decay heat is representative of EOC

- Minimum boron concentration allowed by TS is assumed in the Refueling Water Storage Tank

- An hour is subtracted from the actual time to re-criticality (and hence the response time) to ensure adequate boron mixing occurs during FLEX pump makeup

- The time to start the FLEX make-up pump is calculated based on the required boron curve at an RCS temperature of 350°F; during boration activities operators would maintain the plant near 420°F which conservatively requires the FLEX makeup pump to start earlier than necessary

- The Pressurizer is assumed to only be filled to 60% level prior to requiring RCS letdown through the RV head vents; controlling the injection pump to RCS pressure in lieu of Pressurizer level would reduce the total boration time (and delay the boration start setpoint) by allowing additional RCS injection

The margin inherent in the boration calculation assumptions/inputs therefore shows that any return to criticality during an ELAP event would reasonably be expected to occur well beyond the maximum 13 hour RCS make-up setpoint in the documented McGuire FLEX response.

- **<u>Time to Reflux Cooling</u>**

For the latest NOTRUMP reference case, the PWROG-14027-P, revision 3 report dated April 2015 for 4-loop T_{cold} plants identifies that Category 1 stations such as McGuire will enter reflux cooling at 15.6 hours, with the time to uncover the core at 43.9 hours, during an ELAP event. Initiating RCS boration by no later than 13 hours after event initiation at McGuire therefore ensures that boration would occur with acceptable loop flow conditions.

McGuire performed a site-specific in-house analysis of the time to reflux cooling using the RELAP5 code to establish a setpoint for RCS boration during ELAP, using the original seal leakage profile from WCAP-17601-P, revision 1. Subsequent to that analysis, RELAP5 sensitivity cases were also run in-house to evaluate the new seal leakage rates identified in PWROG-14015-P. Margin in the calculation of the predicted time to reflux cooling in the steam generator U-tubes is qualitatively identified in these RELAP5 analyses, as noted following:

- For this evaluation all four RCP seals are assumed to leak at their maximum flow rate, minimizing the time to reflux cooling in the steam generators

- Assumed decay heat is representative of EOC

- McGuire-specific mass-energy release evaluation (RELAP5) assuming the original RCP seal leak-off profile as given in WCAP-17601-P, revision 1 (i.e., no leak-off line orifice modification) shows a predicted time to reflux cooling well beyond the NOTRUMP reference case

- McGuire has installed new restriction orifices in the RCP #1 seal leak-off lines in close proximity to the seal exit, which serve to limit maximum downstream leak-off line pressure and the peak leak-off flowrates (McGuire is in PWROG Category 1)

- McGuire-specific ELAP mass-energy release sensitivity cases (RELAP5) adjusted for the revised PWROG Category 1 RCP seal leak-off profile show that the predicted time to reflux cooling in the steam generator tubes is still considerably delayed as compared to the NOTRUMP reference case

- MPR analysis of no. 1 seal leakage flowrates for the modified McGuire leak-off piping configuration (MPR site-specific models) show peak values less than those in the WCAP-17601-P, revision 1 or the PWROG-14015-P, revision 2 reference cases; therefore cumulative RCP seal leakage will likely be lower than identified for PWROG Category 1 plants

Note that, for the purposes of this evaluation (NOTRUMP or RELAP5), the definition of reflux cooling is as identified in PWROG-14027-P, revision 3: "...'reflux cooling' is considered to exist when the one hour centered moving average flow quality of the steam generator U-bend flow quality has increased to a value of 0.1 in any one loop."

3.3. Possessing the Capability to Initiate RCS Makeup within "X" Hours (Shorter than Planned Time)

RCS makeup during an ELAP event is a prioritized action per ECA-0.0, and relies on diesel-driven injection pumps that do not require FLEX electrical distribution to be set up first. McGuire also has three distinct FLEX Buildings in diverse locations to protect FLEX response capability. The longest RCS injection time start setpoint (13 hours) is determined based on the FLEX Building furthest from the pump deployment location, and assumes maximum event diagnosis times, debris removal times and pump deployment times. The existence of three FLEX Buildings provides reasonable assurance that FLEX makeup pumps will be accessible in a shorter timeframe than 13 hours; current guidance located in McGuire's FSG-05 "Initial Assessment and FLEX Equipment Staging" directs responding Operators to identify availability of FLEX resources early in the event and prioritize accordingly. This serves to minimize deployment times of prioritized actions such as RCS injection, so the timeframe for initiating FLEX RCS boration following an ELAP initiation can be stated as occurring between 7 and 13 hours post trip.

Additionally, McGuire site was re-evaluated for potential flooding concerns as an aspect of NTTF Recommendation 2.1. The conclusion reached in the Flood Hazard Reevaluation Report (McGuire Yard Combined Effects evaluation) is that the station does not experience significant floodwaters, and the predicted floodwaters that do result are short-lived. This provides further assurance of FLEX Building accessibility and prompt equipment deployment.

3.4. Having an Abundant Supply of Borated Coolant Onsite and/or Having a Relatively Large Capacity for Injecting Coolant

McGuire has adequate onsite borated makeup capacity for at least 72 hours following the onset of an ELAP event in Modes 1-4. McGuire's FSG-08 "Alternate NC System Boration" directs responding Operators to utilize the borated inventory available in the FWST for RCS makeup (approximately 6 days' worth if FWST undamaged). Should the FWST be damaged by a wind-borne missile above the protective wall, further boration capability beyond 48 hours is afforded by aligning the Boric Acid Tanks, which are protected, and mixing that borated inventory with water from an unborated source (e.g., Standby Nuclear Service Water Pond or other available clean water supply) as needed. Beyond 72 hours, the NSRC equipment (i.e., mobile boration skid) is available.

McGuire's Standby Nuclear Service Water Pond remains available as a clean (i.e., ≤ 5 ppm TSS) unborated water source, and its use is proceduralized later in the ELAP event.

Use of the 40 gpm makeup pump and the FWST/BATs provides sufficient boration to reach the reactivity objective. The supply of borated coolant and/or mixing capability onsite provides several (≥ 3) days of boration capacity.

3.5. Having a High Capacity and/or High Pressure RCS FLEX Makeup Pump

The McGuire FLEX High Pressure Pump (diesel driven) has a rated capacity of 40 gpm at 1700 psig discharge pressure, and has a variable speed control for flow and pressure. As noted previously the diesel driver provides the ability to increase injection flowrates by up to 50% if needed without changing to a different pump.

3.6. Having the Ability to Monitor RCS Inventory during the Event and Attempting to Implement Makeup More Rapidly If Signs of Increased Leakage Were Detected

FSG-4 lists the critical instruments required to be maintained during the ELAP transient. Available instrumentation related to monitoring RCS inventory includes:

- RCS wide range pressure
- RCS wide range hot leg temperature
- Core exit thermocouples
- RVLIS
- Pressurizer level
- Neutron flux

Current guidance located in ECA-0.0 "Loss of All AC Power" and FSG-8 "Alternate NC System Boration" instructs responding Operators to prioritize RCS injection and respond more quickly if high RCS leakage is suspected.

3.7. Restricting Leakage (i.e. Installation of a Flow Restricting Orifice Not Already Accounted for in the Plan)

McGuire has installed restriction orifices in all four Unit 1 #1 RCP seal leak-off lines and in all four Unit 2 #1 RCP seal leak-off lines. While site-specific thermal-hydraulic analysis indicates lower peak seal leakage as a result of this modification, current McGuire FLEX response assumes seal leakage per WCAP-17601-P, revision 1.

3.8. NSAL-15-2 Leakoff Line Break

As noted previously, McGuire has evaluated the leak-off piping/components for a transient pressure spike at the #1 seal exit up to 2045 psia (at 568°F) per the NSAL-15-2 recommendation to ensure system integrity is maintained. A further case was run at a more extreme condition (2500 psia and 568°F) as well. Evaluation of the results show the RCP no.1 seal leak-off piping remains adequately protected by the newly-installed restriction orifice from either of these transients, and as such the published PWROG Category 1 ELAP leak-off rates still apply for McGuire.

3.9. Additional Considerations

The following additional observations are made to assist NRC staff in balancing the RCP seal modeling uncertainties and potential deficiencies:

- The Westinghouse generic ITCHSEAL calculations contain known conservatisms as observed in the comparison of the results of the reference case to the Montereau test data, and also in the application of the reference case leak-off line configuration assumptions for each leakage Category to the plant-specific leak-off line configuration.

- Although reflux cooling in the SG tubes is undesirable and has not been fully analyzed in the context of the ELAP event for the reference case, the use of timing associated with entry into reflux cooling as an acceptance criterion provides significant margin with respect to entry into core uncovery.