NEXTera ENERGY DUANE ARNOLD

December 7, 2016

NG-16-0217
10 CFR 2.202

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Duane Arnold Energy Center
Docket No. 50-331
Renewed Op. License No. DPR-49

NextEra Energy Duane Arnold, LLC's Notification of Full Compliance with Order EA-12-049 Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events and Submittal of Final Integrated Plan

References:
1) Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (ML12056A045)
2) Letter, R. Anderson (NextEra Energy Duane Arnold, LLC) to U. S. NRC, "NextEra Energy Duane Arnold, LLC's Overall Integrated Plan 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)," NG-13-0084, dated February 28, 2013 (ML13063A148)
3) Letter, U.S. NRC to R. Anderson (NextEra Energy Duane Arnold, LLC), "Duane Arnold Energy Center-Interim Staff Evaluation Relating to Overall Integrated Plan In Response To Order EA-12-049 (Mitigation Strategies)" (ML14007A676)

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued an Order (Reference 1) to all licensees including NextEra Energy Duane Arnold, LLC (NextEra Energy Duane Arnold). Reference 1 was immediately effective and directed NextEra Energy Duane Arnold to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event.

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The Order requires all licensees to report to the Commission when full compliance with the requirements of Order EA-12-049 is achieved. This letter, along with the attachments, provides the notification required by Section IV.C.3 of the Order that full compliance has been achieved for the Duane Arnold Energy Center.

This letter contains no new regulatory commitments. If you have any questions, please contact Michael Davis at (319) 851-7032.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on December 7, 2016.

Steven P. Brown
for T. A. Vehec
Vice President, Duane Arnold Energy Center
NextEra Energy Duane Arnold, LLC

Attachment 1: Order EA-12-049 Compliance Summary
Attachment 2: NRC Interim Staff Evaluation Confirmatory Items Summary
Attachment 3: Overall Integrated Plan Pending Items Summary
Attachment 4: Final Integrated Plan in Response to Order EA-12-049

cc: Regional Administrator, USNRC, Region III
Resident Inspector, USNRC, Duane Arnold Energy Center
Project Manager, USNRC, Duane Arnold Energy Center

Attachment 1 to NG-16-0217

NEXTERA ENERGY DUANE ARNOLD, LLC

DUANE ARNOLD ENERGY CENTER

ORDER EA-12-049 COMPLIANCE SUMMARY

4 Pages Follow

NEXTERA ENERGY DUANE ARNOLD, LLC
DUANE ARNOLD ENERGY CENTER
ORDER EA-12-049 COMPLIANCE SUMMARY

Introduction

NextEra Energy Duane Arnold, LLC (NextEra Energy Duane Arnold) developed an Overall Integrated Plan (Reference 1) documenting the diverse and flexible strategies (FLEX) in response to Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Reference 2). The information provided herein documents full compliance for the Duane Arnold Energy Center (DAEC) with Reference 2.

Milestone Schedule

All activities on the Milestone Schedule for the DAEC are now complete.

Milestone	Completion Date
Submit Overall Integrated Implementation Plan	February 2013
Submit 6 Month Status Report	August 2013
Complete Revision to Emergency Operating Procedures to Extend Operation of Steam Driven Pumps	January 2014
Submit 6 Month Status Report	February 2014
Complete Regional Response Center Arrangements	December 2015
Submit 6 Month Status Report	August 2014
First Refueling Outage of Implementation Period	RFO 24 (Fall 2014)
Complete Site Specific Analysis of NEDC-33771P Rev. 1	January 2015
Submit 6 Month Status Report	February 2015
FLEX Storage Buildings Completed	March 2015
Identified Portable Equipment Stored on Site	October 2016
Submit 6 Month Status Report	August 2015
Issue Modification Packages	December 2015
Submit 6 Month Status Report	February 2016
Complete Staffing Study for Flex Implementation	May 2016
Validate that time sensitive actions can be completed consistent with the Flex Strategies	August 2016
Complete Implementing Procedure Development and Validation	October 2016
Submit 6 Month Status Report	August 2016
Complete Required Training	October 2016
Final Implementation Outage for Modifications	RFO 25 (Fall 2016)
Submit Completion Report	December 2016

A declaration of completion of the major elements of the FLEX strategy follows.

Strategies Validation - Complete

The DAEC FLEX implementation strategies are in compliance with Order EA-12-049. The Interim Staff Evaluation (ISE) Confirmatory Items have been addressed and are summarized in Attachment 2.

The DAEC has completed validation and verification activities to ensure the capability to implement the FLEX strategies in accordance with industry developed guidance.

The Phase 2 Staffing Study for the DAEC has been completed in accordance with 10 CFR 50.54(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 3), as documented in a letter dated June 3, 2016 (Reference 11).

Modifications - Complete

The Phase 1, 2 and 3 modifications required to support the FLEX strategies for the DAEC have been fully implemented in accordance with the station design control process.

Equipment Storage - Complete

Two FLEX Storage Facilities have been constructed and are fully functional to house designated portable equipment to implement the FLEX strategies. The FLEX Storage Facilities meet the requirements for protection from the applicable site hazards. The designated portable equipment is properly stored in the designated configuration within the FLEX Storage Facilities or within existing Class 1 structures.

Equipment Procurement - Complete

The equipment required to implement the FLEX strategies for the DAEC has been procured in accordance with NEI 12-06, Section 11.1 and 11.2, received at the DAEC, initially tested or its performance verified as identified in NEI 12-06, Section 11.5, and is available for use.

Maintenance and testing will be conducted through the use of the DAEC Preventative Maintenance program such that equipment reliability is maintained.

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

Procedures- Complete

Severe Accident Management Procedures (SAMPs) for the DAEC have been developed, validated and integrated with existing procedures. The SAMPs and affected existing procedures are effective and issued for use in accordance with the site procedure control program.

A NextEra Fleet FLEX Program Document has been developed in accordance with the requirements of NEI 12-06. The FLEX Program Document is effective and issued in accordance with the site/fleet procedure control program. The document includes, but is not limited to, roles and responsibilities, regulatory requirements, a description of the FLEX strategies and procedure implementation.

Training - Complete

Training for implementation of the FLEX strategies has been completed in accordance with NEI 12-06, Section 11.6.

References

The following references support the DAEC FLEX compliance declaration:

1. NG-13-0084 "NextEra Energy Duane Arnold, LLC's Overall Integrated Plan 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) (ADAMS Accession No. ML13063A148)
2. NRC Order Number EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, dated March 12, 2012 (ML12073A195)
3. 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 (ML 12073A348)

4. NG-13-0328 "NextEra Energy Duane Arnold Energy Center, LLC's 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) (ADAMS Accession No. ML13242A007)
5. NG-14-0061 "NextEra Energy Duane Arnold Energy Center, LLC's 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) (ADAMS Accession No. ML14063A065)
6. NG-14-0200 "NextEra Energy Duane Arnold Energy Center, LLC's 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) (ML14239A493)
7. NG-15-0032 "NextEra Energy Duane Arnold Energy Center, LLC's 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) (ML15054A006)
8. NG-15-0260 "NextEra Energy Duane Arnold Energy Center, LLC's 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) (ML15246A409)
9. NG-16-0049 "NextEra Energy Duane Arnold Energy Center, LLC's 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) (ML16064A023)
10. NG-16-0169 "NextEra Energy Duane Arnold Energy Center, LLC's 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) (ML16246A009)
11. NG-16-0120, "FLEX Strategies Phase 2 Staffing Assessment" dated June 3, 2016 (ML16159A235)

Attachment 2 to NG-16-0217

NEXTERA ENERGY DUANE ARNOLD, LLC

DUANE ARNOLD ENERGY CENTER

NRC INTERIM STAFF EVALUATION CONFIRMATORY ITEMS SUMMARY

6 Pages Follow

DAEC Responses to Interim Staff Evaluation Confirmatory Items

Item Number	Interim Staff Evaluation Confirmatory Item	Response
3.1.1.4.A	Off-Site Resources – Confirm the location of the local staging area for the RRC equipment, and that access routes to the site, the method of transportation, and the drop off area have been properly evaluated for all applicable hazards.	Primary and secondary staging areas and routes to DAEC have been developed and evaluated. Primary and secondary on-site staging areas have been selected. The SAFER Response Plan addresses alternatives for transport of off-site resources to the on-site staging area that include diverse land routes and also includes the option of airlifting equipment. See Final Integrated Plan Section 3.8.
3.1.2.A	Confirm the actual flood hazard level for which reasonable protection and a means to deploy the portable equipment is to be provided.	By letter dated March 31, 2016 (ML16084A788), the NRC Staff provided a summary of their assessment of the re-evaluated flood-causing mechanisms described in the DAEC Flood Hazard Reevaluation Report (ML14072A017) and supplemental information. The letter states the Staff's conclusion that the DAEC's reevaluated flood hazards information, as summarized in the letter, is suitable for the assessment of mitigating strategies developed in response to Order EA-12-049. See Final Integrated Plan Section 3.5.2.
3.1.3.1.A	Confirm that the separation of the two FLEX equipment storage buildings is sufficient to reasonably ensure that one set of equipment will be available, accounting for local tornado data (speed and direction), the actual separation distance of the buildings, and the axis between them.	To minimize the potential for a single tornado to damage all FLEX equipment, the storage buildings are located approximately 3,500 feet apart considering the predominant path of tornados in Iowa (CAL-C14-001, Evaluation for FLEX Building Tornado Wind Hazard). The FLEX storage buildings are located such that the probability of a single tornado striking the two buildings is acceptably low. See Final Integrated Plan Section 3.6.3.

Item Number	Interim Staff Evaluation Confirmatory Item	Response
3.2.1.1.A	From the June 2013, position paper (ADAMS Accession No. ML 13190A201), as discussed in the NRC endorsement letter dated October 3, 2013 (ADAMS Accession No. ML 13275A318), confirm that benchmarks are identified and discussed which demonstrate that the Modular Accident Analysis Program (MAAP) 4 is an appropriate code for the simulation of an ELAP event at Duane Arnold.	DAEC thermal-hydraulic analysis used the Modular Accident Analysis Program (MAAP) 4.0.7 computer code to evaluate the sequence of events, timing of operator actions, equipment requirements, and confirmation of success criteria for the mitigating strategies for an ELAP event (ERIN Engineering Report "Evaluation Report of DAEC Capabilities to Respond to Extended Loss of AC Power(ELAP)" Rev. 2). See Final Integrated Plan Section 3.2.4.3.
3.2.1.1.B	Confirm that the collapsed vessel level in the MAAP4 analysis remains above Top of Active Fuel (TAF) and the cool down rate is within technical specification limits.	The MAAP analysis confirmed that the collapsed level remains above the TAF. The MAAP analysis assumed a cool down rate of less than 100°F per hour, which is within the Technical Specification limit. See Final Integrated Plan Section 3.2.4.3.
3.2.1.1.C	Confirm that MAAP4 is used in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013, position paper.	The MAAP analysis performed for the DAEC was carried out in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper, EPRI Technical Report 3002001785, "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications." See Final Integrated Plan Section 3.2.4.3.

Item Number	Interim Staff Evaluation Confirmatory Item	Response
3.2.1.1.D	Confirm that in using MAAP4, the subset of key modeling parameters cited from Tables 4-1 through 4-6 of the "MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2" (Electric Power Research Institute Report 1020236) is justified. This should include response at a plant-specific level regarding specific modeling options and parameter choices for key models that would be expected to substantially affect the ELAP analysis performed for that licensee's plant. Parameters considered important in the simulation of the ELAP event by the vendor/licensee include nodalization, general two-phase flow modeling, modeling of heat transfer and losses, choked flow, vent line pressure losses, and decay heat.	See Final Integrated Plan Section 3.2.4.3.
3.2.1.1.E	Confirm that the specific MAAP4 analysis case that was used to validate the timing of the mitigating strategies in the Integrated Plan is identified. Alternately, a comparable level of information may be included in the supplemental response.	See Final Integrated Plan Section 3.2.4.3.
3.2.1.3.A	The licensee plans to revise its procedures to be consistent with the BWROG recommendations for extending the availability of steam-driven core cooling systems. Confirm that the technical justification for the recommendations is applicable to DAEC.	The DAEC implementation of BWROG guidance on anticipatory venting was completed in accordance with the provisions of the NRC endorsement letter. Plant-specific considerations (such as capabilities of the installed vent path, net positive suction head for the reactor coolant system injection pumps, and guidance to prevent negative pressure in containment) were included. See Final Integrated Plan Section 3.2.4.6.
3.2.1.8.A	Confirm that the two portable diesel-driven pumps sized in accordance with 10 CFR 50.54(hh)(2) requirements will have sufficient capability to be used as credited in the FLEX strategies implemented pursuant to Order EA-12-049.	The two portable diesel-driven pumps that are sized to 10 CFR 50.54(hh)(2) requirements are capable of supplying water to the reactor and/or the spent fuel pool from the circulating water storage pit as credited in the FLEX strategies. See Final Integrated Plan Sections 3.2.4.7 and 3.3.4.3.

Item Number	Interim Staff Evaluation Confirmatory Item	Response
3.2.3.A	Confirm that the DAEC implementation of BWROG EPG/ SAG, Revision 3, including any associated plant-specific evaluations, is completed in accordance with the provisions of the NRC endorsement letter dated January 9, 2014.	The DAEC implementation of BWROG guidance on anticipatory venting was completed in accordance with the provisions of the NRC endorsement letter. Revisions to the applicable EOPs and associated documents were made in accordance with DAEC procedures and processes. Plant-specific considerations (such as capabilities of the installed vent path, net positive suction head for the reactor coolant system injection pumps, and guidance to prevent negative pressure in containment) were included. See Final Integrated Plan Section 3.2.4.6.
3.2.4.2.A	Confirm that the updated analyses of room heat-up (and any supporting actions) ensure that adequate cooling is provided to equipment needed during an ELAP event.	Installed plant equipment relied on for FLEX response strategies will remain functional for the temperature conditions anticipated for an ELAP event consistent with NEI 12-06 Section 3.2.2 guideline 10. See Final Integrated Plan Section 3.9.1.
3.2.4.2.B	Confirm that any equipment in the reactor building needed for ELAP mitigation during Phases 2 or 3 will not be compromised by the steam environment caused by SFP boiling.	An evaluation was developed to determine the effects of SFP boiling on plant equipment and personnel access. The evaluation identified the systems, equipment, and instruments required to implement FLEX strategies, and evaluated the temperature/ humidity impacts. All the systems required for FLEX response strategies will remain available and functional. All of the FLEX required instruments are qualified for the environmental conditions. See Final Integrated Plan Section 3.9.1.
3.2.4.4.A	The NRC staff has reviewed the licensee communications assessment (ADAMS Accession No. ML12307A120) and has determined that the assessment and planned upgrades are reasonable (ADAMS Accession No. ML 13142A320). Confirm that the upgrades to the site's communications systems have been completed.	Consistent with the DAEC Communications Assessment, enhancements were completed for DAEC site emergency communications. See Final Integrated Plan Section 3.13.

Item Number	Interim Staff Evaluation Confirmatory Item	Response
3.2.4.6.A	Confirm that DAEC's plan addresses accessibility and habitability of all plant areas requiring personnel access in sufficient detail to determine if the environmental conditions support the needed operator actions.	DAEC has developed guidance to maintain or restore equipment and personnel habitability conditions following a BDBEE. See Final Integrated Plan Section 3.9.3.
3.2.4.7.A	Confirm that the potential effects of using river water, which may contain suspended solids, for reactor/SFP cooling are addressed.	The raw water sources at DAEC are addressed and bounded by BWROG evaluations. Emergency response procedures provide guidance for raising RPV level to inject inside the shroud for potential core inlet blockage. Analysis has shown that heat transfer capability will not be degraded in the first 120 hours following an ELAP. Based on this, sufficient time is available for the emergency response organization to establish long-term alternate core cooling using off site resources. See Final Integrated Plan Section 3.10.2.
3.2.4.9.A	Confirm that a refueling strategy for FLEX equipment has been developed based on a plant-specific analysis. The confirmation should include delivery capabilities, including for an indefinite coping period, and how fuel quality will be assured, if stored for extended periods (including fuel contained in the fuel tanks of Phase 2 equipment).	A site-specific evaluation was performed to determine refueling needs and a refueling strategy was developed. SAMP 719 "Emergency Refueling of Diesel Powered Equipment" provides guidance for refueling the FLEX diesel powered portable equipment with a FLEX transfueler. See Final Integrated Plan Section 3.7.4.
3.2.4.10.A	Confirm that the final load shedding analysis has been completed and that the time constraints assumed in the mitigating strategies have been validated, based on the results of that analysis (DAEC Open Action Item 15).	The load shedding analysis has been completed, and time constraints assumed in the mitigating strategies have been validated. See Final Integrated Plan Section 3.2.4.8.

Item Number	Interim Staff Evaluation Confirmatory Item	Response
3.4.A	Offsite resources - Confirm that NEI 12-06, Section 12.2 guidelines 2 through 10, regarding minimum capabilities for offsite resources, have been adequately addressed.	NEI white paper "National SAFER Response Centers" provides programmatic aspects and implementation plans for the SAFER program (ML14259A222). By letter dated September 26, 2014, the NRC Staff issued their assessment of the white paper and the SAFER program. The assessment documents the NRC Staff's assessment of SAFER's conformance to the NEI 12-06 Section 12.2 guidelines. The assessment states that the NRC Staff concludes that once the NSRCs are declared operational for each site in accordance with the NSRC checklist, licensees can reference the SAFER program and implement their SAFER Response Plans for plant-specific compliance with the final phase requirements of Order EA-12-049. The DAEC SAFER Response Plan has been issued. By letter dated December 2, 2015, Pooled Equipment Inventory Co. (PEICo) provided the completed DAEC "National SAFER Response Centers (NSRC) Checklist to Declare Operational." See Final Integrated Plan Section 3.8.

Attachment 3 to NG-16-0217

NEXTERA ENERGY DUANE ARNOLD, LLC

DUANE ARNOLD ENERGY CENTER

OVERALL INTEGRATED PLAN PENDING ITEMS SUMMARY

3 Pages Follow

All OIP pending actions have been resolved.

	Overall Integrated Plan Pending Actions	Resolution
1	Seismic re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 are not completed and therefore not assumed in this submittal. As the re-evaluations are completed, appropriate issues will be entered into the corrective action process and addressed.	The DAEC seismic re-evaluation is discussed in Final Integrated Plan Section 3.5.1.
2	Flood re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 are not completed and therefore not assumed in this submittal. As the re-evaluations are completed, appropriate issues will be entered into the corrective action process and addressed.	The DAEC flood re-evaluation is discussed in Final Integrated Plan Section 3.5.2.
3	Implement revisions to emergency operating procedures (EOPs) identified by the BWROG to extend operation of steam driven pumps for core cooling during ELAP.	See discussion under Confirmatory Item 3.2.1.3.A in Attachment 2 to this letter. See also Final Integrated Plan Section 3.2.4.6.
4	Validate implementing procedures can be performed in a timely manner.	See Final Integrated Plan Sections 3.12.1 and 3.12.2.
5	Final plant specific analysis for an ELAP will be performed with equivalent acceptance criteria with the exception of Condensate Storage Tank (CST) inventory and suppression pool level which will be altered in recognition of the external hazards and revised duration of the mitigating strategies.	See Final Integrated Plan Section 3.2.4.3.
6	Phase 3 activities will ensure adequate inventory of water can be provided directly from the Cedar River or other sources independent of the normal River Water Supply pumps.	See Final Integrated Plan Section 3.10.3.
7	Implement new and revised plant procedures for FLEX Strategies.	See Final Integrated Plan Section 3.12.1.
8	Implement administrative controls for the FLEX Program.	See Final Integrated Plan Section 3.12.5.
9	Procure FLEX portable equipment.	Portable FLEX equipment has been procured. See Final Integrated Plan Attachment D.
10	Establish preventive maintenance and testing of FLEX portable equipment.	See Final Integrated Plan Section 3.12.4.

	Overall Integrated Plan Pending Actions	Resolution
11	Revise UFSAR and TRM as needed to reflect FLEX program.	The DAEC has determined that no UFSAR or TRM changes are required to reflect the FLEX program. Regulatory treatment of mitigation strategies is discussed in NRC memorandum dated September 12, 2014 (ML14254A467).
12	Complete training of applicable personnel.	See Final Integrated Plan Section 3.12.3.
13	Establish "Playbook" for Regional Response Center interface with the NextEra Energy Duane Arnold.	See Final Integrated Plan Section 3.8.
14	Review generic BWROG analysis of FLEX implementation and perform a detailed review of suppression pool temperature to support FLEX strategies.	See Final Integrated Plan Section 3.2.1.
15	Perform analysis of final load shedding strategy for essential station batteries and implement in plant procedures.	See discussion under Confirmatory Item 3.2.4.10.A in Attachment 2 to this letter. See Final Integrated Plan Section 3.2.4.8.
16	Modify the plant to establish a flood staging area for portable equipment.	See Final Integrated Plan Section 3.5.2.4.
17	Evaluate deployment routes for portable equipment.	See Final Integrated Plan Section 3.5.1.
18	Modify the plant to facilitate connection of portable power supplies. This will include connection points for a 480 volt generator to essential battery chargers and 480 volt distribution panel 1B03. Quick connection points will be established for 120 volt AC power to instrument power supplies.	The plant was modified to facilitate electrical connections of portable power supplies; the final design was revised subsequent to the submittal of the OIP. See Final Integrated Plan Section 3.7.2 and Attachment J.
19	Modify the plant to add suction and injection connection points for portable pump. The portable pump suction will allow access to the circulating water pit (Pump House) from a protected area (Turbine Building) during a design bases flood. The injection point will provide a redundant connection point for RPV makeup located in a protected area (Reactor Building).	The plant was modified to add connection points for the portable pump; the final design was revised subsequent to the submittal of the OIP. See Final Integrated Plan Section 3.7.2 and Attachment J.
20	Construct two FLEX portable equipment storage buildings. The buildings will be separated to minimize the potential for a single tornado path to interact with both buildings.	See discussion under Confirmatory Item 3.1.3.1.A in Attachment 2 to this letter. See Final Integrated Plan Section 3.6.3.

	Overall Integrated Plan Pending Actions	Resolution
21	Phase 3 activities will ensure essential bus can be re-powered using a portable 4160 V Generator. This will include a modification that establishes a transfer panel (disconnect switch) installed in the turbine building that provides a location for connection during a design bases flood and procedures for mobilization.	The planned design was changed subsequent to the submittal of the OIP. Procedures now direct the connection of the 4160 VAC generator to the Standby Transformer secondary or the essential bus feeder lines. This will supply power to one or both essential 4160 VAC buses. See Final Integrated Plan Section 3.2.4.8.
22	Procedures will provide for opening containment vent valves using portable pneumatic supply.	See Final Integrated Plan Section 3.4.4.5.
23	Modify the plant to establish a manual vent capability for the reactor building near the spent fuel pool.	See Final Integrated Plan Section 3.3.1.
24	Update analysis of room heat-up during an ELAP.	See discussion under Confirmatory Items 3.2.4.2.A and 3.2.4.2.B in Attachment 2 to this letter. See Final Integrated Plan Section 3.9.1.
25	Screen BWROG RCIC Durability Study for extending RCIC operation during an ELAP and make applicable improvements.	See Final Integrated Plan Section 3.2.1 and 3.2.4.6.
26	Establish methods to recharge communications equipment.	See discussion under Confirmatory Item 3.2.4.4.A in Attachment 2 to this letter. See Final Integrated Plan Section 3.13.
27	Establish methods to re-fuel portable equipment.	See discussion under Confirmatory Item 3.2.4.9.A in Attachment 2 to this letter. See Final Integrated Plan Section 3.7.4.
28	Review generic BWROG analysis of FLEX implementation and perform a detailed review of limitations on SRV operation to support FLEX strategies.	See Final Integrated Plan Section 3.4.4.1.1.
29	If FLEX transport paths are over previously un-excavated ground, review path for potential soil liquefaction during a seismic event.	See Final Integrated Plan Section 3.5.1.

Attachment 4 to NG-16-0217

NEXTERA ENERGY DUANE ARNOLD, LLC

DUANE ARNOLD ENERGY CENTER

FINAL INTEGRATED PLAN IN RESPONSE TO ORDER EA-12-049

77 Pages Follow

DAEC
FLEX FINAL INTEGRATED PLAN
Revision 0

Prepared: ______________________ Date: 11/10/2016
Kenneth Putnam

Reviewed: ______________________ Date: 11/10/2016
Mike Wood

Reviewed: ______________________ Date: 11/10/16
Mike Matchinis

Approved: ______________________ Date: 11/14/16
Brian Wohlers

FINAL INTEGRATED PLAN FOR NRC ORDER EA-12-049 MITIGATING BEYOND DESIGN BASES EVENTS

Duane Arnold Energy Center

Contents

1.0 INTRODUCTION

The earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in March 2011, highlighted the possibility that extreme natural phenomena could challenge the prevention, mitigation and emergency preparedness defense-in-depth layers already in place in nuclear power plants. At Fukushima, limitations in time and unpredictable conditions associated with the accident significantly challenged attempts by the responders to preclude core damage and containment failure. During the events in Fukushima, the challenges faced by the operators were beyond any faced previously at a commercial nuclear reactor and beyond the anticipated design-basis of the plants. The Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed to mitigate such beyond-design-basis external events (BDBEEs) that are the subject of this Final Integrated Plan.

Accordingly, by letter dated March 12, 2012, the NRC issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Reference 4). This order directed licensees to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities in the event of a BDBEE. Order EA-12-049 applies to all power reactor licensees and all holders of construction permits for power reactors.

By letter dated March 12, 2012, the NRC also issued Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" (Reference 5). This order directed licensees to install reliable SFP level instrumentation with a primary channel and a backup channel, with independent power supplies that are also independent of the plant alternating current (ac) and direct current (dc) power distribution systems. Order EA-12-051 applies to all power reactor licensees and all holders of construction permits for power reactors.

By letter dated June 6, 2013, the NRC issued Order EA-13-109, "Order Modifying Licenses With Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions" (Reference 7). This order required licensees with Boiling Water Reactors with Mark 1 or 2 containments to implement modifications for primary containment vents.

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF was tasked with conducting a systematic and methodical review of the NRC regulations and processes to determine if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 (Reference 1). Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

On February 17, 2012, the NRC staff provided SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," (Reference 2) to the Commission, including the proposed order to implement the enhanced mitigation strategies. As directed by SRM-SECY-12-0025 (Reference 3), the NRC staff issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis

External Events" (Reference 4), and Order EA-12-051, "Order Modifying Licenses With Regard to Reliable Spent Fuel Pool Instrumentation"(Reference 5).

2.1 Order EA-12-049

Order EA-12-049, Attachment 2, (Reference 4) requires that operating power reactor licensees and construction permit holders use a three-phase approach for mitigating BDBEEs. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and SFP cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. Specific requirements of the Order are listed below:

1) Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event.

2) These strategies must be capable of mitigating a simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink (UHS) and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to Order EA-12-049.

3) 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 capabilities at all units on a site subject to Order EA-12-049.

4) Licensees must be capable of implementing the strategies in all modes.

5) Full compliance shall include procedures, guidance, training, and acquisition, staging, or installing of equipment needed for the strategies.

On August 21, 2012, following several submittals and discussions in public meetings with NRC staff, the Nuclear Energy Institute (NEI) submitted document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0 to the NRC to provide specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Mitigation Strategies order. On August 29, 2012, the NRC staff issued its final version of 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", endorsing NEI 12-06, Revision 0, as an acceptable means of meeting the requirements of Order EA-12-049, and published a notice of its availability in the *Federal Register* (77 FR 55230). Subsequently, NEI issued revisions to NEI 12-06 (Reference 39) reflecting additional information. JLD-ISG-2012-01 Revision 1 (Reference 8) was issued by the NRC with an effective date of February 29, 2016 endorsing NEI 12-06 Rev. 2 with exceptions, additions and clarifications. The Duane Arnold Energy Center (DAEC) FLEX program is consistent with NEI 12-06 Rev. 2.

2.2 Order EA-12-051

Order EA-12-051 (Reference 5) required that operating power reactor licensees implement and maintain reliable spent fuel pool water level instrumentation. Order EA-12-051 was implemented at DAEC on a schedule concurrent with Order EA-12-049 (Reference 57). It supports implementation of Order EA-12-049 by providing critical indication for operational decision making on mitigation strategies to protect spent fuel following an ELAP. NEI 12-02 Rev. 1 (Reference 38) provides industry guidance for complying with Order EA-12-051. The NRC endorsed this guidance, with clarifications and exceptions, under JLD-ISG-2012-03 (Reference 9) as an acceptable means of implementing Order EA-12-051. DAEC complies with NEI 12-02 Rev. 1 guidance.

2.3 Order EA-13-109

Order EA-13-109 (Reference 7) required licensees with Boiling Water Reactors with Mark 1 or 2 containments to implement reliable hardened containment vents capable of operation under severe accident conditions. Phase 1 of Order EA-13-109 is implemented at DAEC (Reference 58) on a concurrent schedule with Order EA-12-049. Implementation of Phase 1 of Order EA-13-109 supports implementation of Order EA-12-049 at DAEC by providing hardware to preserve the containment function during an ELAP by venting the torus. NEI 13-02 (Reference 40) provides industry guidance for implementing Order EA-13-109. JLD-ISG-2015-01 (Reference 10) provides NRC endorsement of NEI 13-02, with exceptions, clarifications and additions, as an acceptable means of implementing Order EA-13-109. DAEC complies with NEI 13-02 implementation guidance.

3.0 TECHNICAL EVALUATION OF ORDER EA-12-049

By letter dated February 28, 2013 (Reference 16), NextEra Energy submitted an Overall Integrated Plan for Duane Arnold Energy Center (DAEC) in response to Order EA-12-049. By a series of letters (References 19, 21, and 24-28) DAEC submitted periodic status reports for the Integrated Plan as required by the Order. The Overall Integrated Plan and status updates described the strategies and guidance planned for implementation by DAEC for the maintenance or restoration of core cooling, containment, and SFP cooling capabilities following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-049. By letter dated February 21, 2014 (Reference 29) the NRC issued an Interim Staff Evaluation. An onsite NRC audit of the DAEC progress is documented in a letter dated August 29, 2016 (Reference 30).

3.1 Overall Mitigation Strategy

DAEC is a boiling-water reactor (BWR) with a Mark I containment. Attachment 2 to Order EA-12-049 describes the three-phase approach required for mitigating BDBEEs in order to maintain or restore core cooling, containment and SFP cooling capabilities. The phases consist of an initial phase (Phase 1) using installed equipment and resources, followed by a transition phase (Phase 2) in which portable onsite equipment is placed in service, and a final phase (Phase 3) in which offsite resources may be placed in service. The timing of when to transition to the next phase is determined by plant-specific analyses.

While the initiating event is undefined, it results in an extended loss of ac power (ELAP) with loss of normal access to the ultimate heat sink (LUHS), which is considered a surrogate for a BDBEE. The initial conditions and assumptions for the analyses are stated in NEI 12-06, Section 3.2.1, and include the following:

1. The reactor is assumed to have safely shutdown with all rods inserted (subcritical).
2. The dc power supplied by the plant batteries is initially available, as is the ac power from inverters supplied by those batteries; however, over time the batteries may be depleted.
3. There is no core damage initially.
4. There is no assumption of any concurrent event.
5. Because the loss of ac power presupposes random failures of safety-related equipment (emergency power sources), there is no requirement to consider further random failures.

An ELAP event typically bounds the DAEC plant response for a LUHS as an ELAP event always results in a loss of the DAEC River Water Supply pumps that provide access to the Ultimate Heat Sink (Cedar River) and therefore in this integrated plan ELAP will be the primary discussion unless there is a unique impact of LUHS. Initial plant response is equivalent to that described under the previous plant analysis (Reference 104) required by 10CFR50.63 with the exception that Order EA-12-049 requires use of only equipment protected from external hazards as described in Section 3.5 of this plan. Station procedures (Reference 111) for initial plant response to a loss of AC power were upgraded to include additional load shedding of non-critical loads from the station batteries prior to 2 hours. Battery load shedding is discussed further in Section 3.2.4.8 of this report.

3.2 Reactor Core Cooling Strategies

DAEC FLEX strategies for reactor core cooling are consistent with NEI 12-06 using a combination of installed steam driven systems, DC powered control systems and portable equipment to ensure core cooling can be maintained indefinitely during an ELAP or LUHS.

3.2.1 Phase 1

During Phase 1 core cooling is maintained primarily with the existing Reactor Core Isolation Cooling system (RCIC). The motive force for the system is reactor steam. Reactor pressure is reduced using SRVs and the steam driven systems to between 150 and 200 PSIG (Reference 111). This reactor pressure is maintained sufficient to operate RCIC or HPCI. The cool down rate is limited to within the Technical Specification limit of less than 100° F/hour. Control power for the system is from Division 1 of 125 VDC power. The High Pressure Coolant Injection (HPCI) System provides a reliable backup system but is secondary to RCIC in that it is substantially over-sized for the expected make up requirements after the initial recovery. The Condensate Storage Tanks are the preferred water make-up source during an ELAP or LUHS due to water quality and temperature, however, these tanks are not protected from tornado winds and missiles and therefore a protected source of the suppression pool is credited. The suppression pool provides high quality water but is limited with respect to temperature as decay heat from the reactor will result in increasing water temperature that can reduce reliability of the RCIC system. The temperature of the suppression pool water during an ELAP will exceed the design assumptions for RCIC and HPCI after several hours. While there is substantial operating experience indicating these are robust systems that can tolerate temperatures higher than are expected during the ELAP (Reference 47), for purposes of this plan, it is assumed that suppression pool temperatures greater than 250°F degrees will require transition to Phase 2 for core cooling (Reference 84). See Section 3.2.4.6 for additional discussion of actions to preserve steam driven system availability.

Operators are directed to complete DC load shedding within 2 hours to preserve the availability of station DC power (see Section 3.2.4.8 for additional discussion of electrical).

3.2.2 Phase 2

If the installed systems of RCIC and HPCI are unavailable for core cooling, operators will transition to the use of portable equipment to maintain reactor water above the top of the active fuel ensuring adequate core cooling. DAEC analysis assumes failure of RCIC/HPCI will occur when suppression pool temperature reaches 250° F which is projected to occur at approximately 7.5 hours (Reference 79) after the ELAP. Two portable diesel driven pumps are stored in redundant FLEX storage buildings (one per building). As shown in Attachment K one of these pumps will be utilized to transfer water from the circulating water pit to the reactor via hoses connecting to the RHR system (Reference 120). Procedures for aligning portable equipment have been validated including time constraints to ensure portable equipment will be available for reactor core cooling prior to failure of the installed equipment (Reference 148). The circulating water pit is a robust large volume of water. The water in the pit is normally supplied from the Cedar River via the River Water Supply system. It is rough filtered and fine solids will typically settle out of the water in the pit. The Cedar River is fresh (not salt) water but the quality of the water is lower than would normally be supplied to the reactor. When using raw water for vessel makeup operators will establish a higher control band on reactor water level to ensure any potential blockage of water flow from under the core through the reactor fuel will not result in overheating (Reference 108). The inventory of water available in the circulating water storage pit is sufficient for an extended period of core cooling (Reference 87), however, when depleted a transition to Phase 3 would be required to either transport water from the Cedar River to the circulating water storage pit (Reference 132) or an alternative means of core cooling established. In a flood condition, the portable diesel driven pump is staged in the south Turbine Building rail bay with a suction source from the main condenser hotwell (Reference 55). Water sources are discussed further in section 3.10.

3.2.3 Phase 3

The industry has established two Regional Response Centers (RRCs) capable of supplying substantial support to reactor operators in the event of an emergency. One RRC is located near Memphis Tennessee and one is near Phoenix Arizona. RRC resources including portable equipment will be requested early in the event. While it is highly likely these resources as well as other local community resources would be available within hours, for purposes of this plan it is assumed no off site portable equipment can reach the site in the first 24 hours. Core cooling can be assured indefinitely with Phase 2 equipment provided a water inventory to pump is maintained and the portable equipment is refueled. Under Phase 3, portable equipment from the RRC will be available to maintain long term core cooling by replenishing water inventories (Reference 132), and supplying diesel fuel oil. In addition the RRC will provide defense-in-depth with portable equipment redundant to the DAEC portable equipment used in Phase 2 (Reference 141). The capacity of the RRC portable equipment is listed in Attachment E and bounds the capability of the DAEC portable equipment. Offsite resources are discussed further in Section 3.8 of this plan.

3.2.4 Evaluations Supporting Reactor Core Cooling Strategies

3.2.4.1 Plant SSCs

Attachment A to this plan tabulates the installed plant equipment that is relied on for FLEX strategies. The installed plant equipment listed that performs an active function for FLEX is the same equipment relied upon for compliance with 10 CFR 50.63 described in UFSAR Table 15.3-2, (excluding recovery functions) (Reference 104). The systems are safety related systems housed in Class 1 structures protected from external events, with the exceptions of the CSTs, Main Condenser Hotwell and Circulating Water Storage Pit. The CSTs are not fully protected from external hazards such as tornado missiles; if the CSTs are unavailable, the suppression pool will be the credited source of water inventory. The Circulating Water Storage Pit is a concrete structure built to robust seismic standards. Passive features including the primary and alternate connection points for FLEX portable equipment and water sources for portable pumps were not contemplated under DAEC evaluations for 10 CFR 50.63 but are robust features as described in Attachment A that will remain available for use.

3.2.4.2 Plant Instrumentation and Control

Attachment I to this plan tabulates critical instruments needed for operational decision making as recommended in NEI 12-06 Section 3.2.1.10 for reactor core cooling as well as maintaining the containment, and spent fuel pool cooling. Required instrument displays are located in the control room and readily accessible to operators throughout the event. These instruments are normally powered by the station batteries via inverters. The station batteries will remain functional as described in Section 3.2.4.8 of this plan and power to these instruments will be maintained. If for any reason this power supply is lost, a contingency has been established to repower either division of instrument power at a location downstream of the instrument AC inverters closer to the installed instruments at either instrument AC distribution panel 1Y11 or 1Y21 (Reference 129). Either division is capable of providing adequate indications for operational decision making. A reference source is available to operators, that provides approaches to obtaining control parameter information including control room and local indication. FLEX guidance on use of portable instruments to take critical readings with no instrument AC power available is contained in FLEX support guidance procedure SAMP 727 (Reference 131).

During an ELAP or LUHS, containment environmental parameters including temperature, humidity, and pressure are elevated but remain within the values specified in the DAEC design bases. Installed instrumentation located within the containment remains within its existing qualifications (Reference 79). As tabulated in Attachment H, locations outside the containment have been reviewed and the environmental conditions for installed instrumentation confirmed to be acceptable (References 64, 89, and 90).

Contingencies to operate RCIC, SRVs, and Containment Vents with a loss of control power have been developed (References 118, 119, and 136) as defense in depth, however, as noted in Section 3.2.4.8 the DAEC FLEX strategy preserves control power to these systems throughout the events and does not rely on these contingencies for successful core cooling, spent fuel pool cooling, or maintaining the primary containment.

3.2.4.3 Thermal-Hydraulic Analyses

DAEC thermal-hydraulic analysis used the Modular Accident Analysis Program (MAAP) 4.07 computer code to evaluate the sequence of events, timing of operator actions, equipment requirements, and confirmation of success criteria for the mitigating strategies for an ELAP event (Reference 79). Industry guidance supports use of the MAAP code as an appropriate tool for performing this type of analysis and provides the technical justification for this use in an EPRI report 3003001785 (Reference 50). The NRC staff has reviewed this guidance and endorsed it by letter dated October 3, 2013 (Reference 13). In this endorsement, the staff placed five limitations on the use of the MAAP code for Boiling Water Reactors. The following summarizes the limitations and DAEC conformance to those limitations.

Comparison of DAEC to NRC Limitations on MAAP Code	
Limitation	**DAEC Use**
From the June 2013 position paper, benchmarks must be identified and discussed which demonstrate that MAAP4 is an appropriate code for the simulation of an ELAP event at the licensee's facility.	Benchmarks were identified and discussed in Reference 79 Table E-1 that demonstrates MAAP4 is an appropriate code for simulation of ELAP at DAEC.
The collapsed RPV level must remain above Top of Active Fuel (TAF) and the cool down rate must be within technical specification limits.	DAEC analysis documented in Reference 79 confirmed that the collapsed RPV water level remains above TAF and the cool down rates are within Technical Specification Limits of <100° F/hour.
MAAP4 must be used in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper.	MAAP4 was used in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper (Reference 50) for DAEC as documented in Appendix E of Reference 79.
In using MAAP4, the licensee must identify and justify the subset of key modeling parameters cited from Tables 4-1 through 4-6 of the "MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2" (Electric Power Research Institute Report 1020236). This should include response at a plant-specific level regarding specific modeling options and parameter choices for key models that would be expected to substantially affect the ELAP analysis performed for that licensee's plant. Although some suggested key phenomena are identified below, other parameters considered important in the simulation of the ELAP event by the vendor / licensee should also be included. a. Nodalization b. General two-phase flow modeling c. Modeling of heat transfer and losses d. Choked flow e. Vent line pressure losses f. Decay heat (fission products / actinides / etc.)	Key modeling parameters specified are identified and justified for DAEC in Annex E.1 of Appendix E to Reference 79.
The specific MAAP4 analysis case that was used to validate the timing of mitigation strategies in the Integrated Plan must be identified and should be available on the ePortal for NRC staff to view. Alternately, a comparable level of information may be included in the supplemental response. In either case, the analysis should include a	DAEC MAAP4 analysis is detailed in Reference 79. Two MAAP case runs have been selected to use as the basis for strategy timelines and system availability. MAAP case run 'K' is selected as the

Comparison of DAEC to NRC Limitations on MAAP Code	
Limitation	**DAEC Use**
plot of the collapsed vessel level to confirm that TAF is not reached (the elevation of the TAF should be provided) and a plot of the temperature cool down to confirm that the cool down is within technical specifications limits.	representative scenario for the non-anticipatory containment vent case. MAAP run 'S2' is selected as the representative scenario for the anticipatory (early) containment vent case. For both of these cases, the collapsed vessel level remains above TAF. Also, the plots for RPV pressure confirm that the cooldown rate is less than the Technical Specification Limit of 100°F/hr. for both cases.

Based on this plant specific response, MAAP 4 is determined to be an appropriate code for the simulation of an ELAP event at Duane Arnold. Plant specific analysis using the MAAP code (Reference 79) has demonstrated that adequate core cooling is maintained throughout Phase 1. Collapsed reactor water level in the reactor always remains above the top of active fuel and cool down rates are less than100° F/hr. Sufficient time is available for portable equipment to be deployed and available for core cooling under Phase 2. The Condensate Storage Tanks (CSTs) are not tornado missile proof and as such are not credited in the base cases of analysis, but are the preferred source of water for RCIC/HPCI and would substantially extend the available time prior to transition to Phase 2 if the CSTs are available. The assumed values for timing studies and procedure validation did not take credit for the slower increase in suppression pool temperature associated with anticipatory venting that would provide additional margin. No credit was taken for HPCI system operation after RCIC failure as a result of high suppression pool temperature or depletion of its associated DC power source (1D1) which would also add additional margin to time available for deployment of the portable pump as well as time available for deployment of the portable generator.

The thermal hydraulic analysis demonstrates that core cooling can be successfully maintained indefinitely for DAEC during a beyond design bases external event resulting in a loss of AC power and a loss of access to the ultimate heat sink using conservative assumptions and with margin from strategies that provide defense-in-depth.

3.2.4.4 Reactor Coolant System Leakage

For purposes of the ELAP hydraulic analysis DAEC assumed leakage from the Reactor Coolant system of 36 GPM at rated pressure. Recirculation pump seal leakage of 18 GPM from each seal at rated pressure is consistent with the assumptions used for evaluation of Station Blackout under 10 CFR 50.63 and documented in UFSAR Section 15.3.2 (Reference 104). This value is considered conservative for currently installed seals based on testing documented in UFSAR Section 5.4.1 (Reference 102). A review of normal unidentified leakage was performed and found to be minimal. A sensitivity review of additional reactor coolant system leakage at the Technical Specification maximum of 25 GPM (61 GPM total) was found to have a negligible effect on the plant response.

3.2.4.5 Shutdown Margin Analyses

DAEC is a Boiling Water Reactor and as such is designed to ensure that control rods alone are sufficient to maintain the reactor subcritical from all plant conditions. No reliance on borated water in the reactor is assumed as documented in UFSAR Section 3.1.2.3.7 (Reference 96).

3.2.4.6 Extending Availability of Steam Driven Systems with Anticipatory Venting

Industry Guidance on procedural changes that could extend the availability of steam driven systems was submitted by NEI on behalf of the Boiling Water Reactor Owners Group by a letter dated November 21, 2013 (Reference 43). By letter dated January 9, 2014 (Reference 20) the NRC endorsed BWROG guidance on anticipatory venting but indicated in the letter that each plant needs to review plant specific information on the topic in association with Order EA-12-049. The letter states that the NRC Staff agrees that the changes to the containment venting strategies as described in the BWROG information report are acceptable for use as part of strategies proposed in response to Order EA-12-049, provided that licensee implementation is in compliance with normal change processes for plant emergency procedures and provided that plant-specific evaluations support the use of the revised strategies. The BWROG paper addresses the venting strategy on a generic basis, but plant-specific implementation relies on such items as the capabilities of the installed vent path, net positive suction head for the reactor coolant system injection pumps, and guidance to prevent negative pressure in containment.

The DAEC implementation of BWROG guidance on anticipatory venting was completed in accordance with the provisions of the NRC endorsement letter. Revisions to the applicable Emergency Operating Procedures and associated documents were made in accordance with DAEC procedures and processes. Plant-specific considerations such as capabilities of the installed vent path, maintaining net positive suction head for the reactor coolant system injection pumps, and guidance to prevent negative pressure in containment were included in the procedures.

Under ELAP conditions, DAEC EOPs provide for bypassing certain isolations and interlocks such as high area temperatures, low reactor pressure and high reactor water level that could limit use of RCIC or HPCI. Reactor water level control range is increased to improve availability of adequate core cooling.

3.2.4.7 FLEX Pumps and Water Supplies

The FLEX portable diesel pumps are capable of supplying water to either the reactor or the spent fuel pool with suction from either the circulating water storage pit or main condenser hotwell at flow rates substantially in excess of that needed to make up for boiling associated with potential decay heat loads (Attachments K and L) and have been evaluated consistent with NEI 12-06 Section 11.2

Decay heat in the reactor will vary based on time after reactor shutdown and make-up requirement will change with the change in decay heat. Phase 2s use of portable pumps is not expected to be required before 7.5 hours. During Phase 2 reactor make-up flow requirements are approximately 115 GPM as documented in the DAEC MAAP Thermal Hydraulic Analysis (Reference 79). Calculations for FLEX pump flow rates when connected to the primary FLEX connection point for reactor injection demonstrate flow rates of approximately 490 GPM can be achieved with adequate NPSH for the limiting configuration of discharge and suction piping/hoses (Reference 66). This substantial margin allows operators the flexibility to utilize the pump intermittently if desired and will also allow diversion of flow to the spent fuel pool if desired. Water sources available for RPV makeup are discussed further in Section 3.10 of this plan. Refueling of the diesel driven portable pumps is discussed further in Section 3.7.4 of this plan.

No additional capabilities are required under Phase 3 other than replenishing water inventory in the circulating water pit and providing additional diesel fuel oil for the portable equipment after 72 hours.

3.2.4.8 Electrical Analyses

DAEC station batteries provide power to critical instruments, RCIC, HPCI, and SRVs required for successful implementation of the FLEX strategies. The station batteries are located in a safety related structure (Control Building) protected from all identified external hazards. Load shedding of non-critical loads is expected to commence after approximately one hour and be completed within two hours of the ELAP event start in accordance with procedures for Station Blackout (Reference 111). The loads selected under the load shedding strategy took into consideration the potential to challenge the ELAP response or the ability to restore AC power. For example, the RCIC barometric condenser condensate pump is a DC load that is preserved to ensure that anytime RCIC is in service, condensate will be returned to the RCIC pump suction to ensure it will not negatively impact the environmental conditions in the general area of the RCIC room. The load shedding procedure has been time validated using station operations personnel. The station batteries will continue to provide adequate power for critical loads as documented in Reference 59 for at least 10 hours on 1D2 (125 VDC Division 2 Battery) and 1D4 (250 VDC Battery) and for at least 8 hours on 1D1 (125 VDC Division 1 Battery). The DAEC evaluation of station batteries is consistent with NEI guidance for battery duty cycles (Reference 45) as endorsed by the NRC letter dated September 16, 2013 (Reference 11). The FLEX strategy battery run-time analysis was calculated in accordance with IEEE-485 methodology using manufacturer discharge test data applicable to the DAEC's FLEX strategy as outlined in the NEI guidance. The DAEC station batteries are manufactured by C&D Technologies, model number LCR-17. Each division of 125 VDC batteries is comprised of 60 cells. The 250 VDC battery is comprised of 116 cells.
Prior to depletion of the station batteries, a FLEX portable 480 Volt diesel generator will supply battery chargers as documented in SAMP 722 (Reference 126) as shown in Attachment M. The FLEX 480 Volt Generators are rated for 480 VAC and 405 kW. The required loads on this generator are two 125 VDC battery chargers each requiring 74 Amps and one 250 VDC charger requiring 97 Amps. The FLEX 480 Volt generators provide substantial margin above the power requirements for station battery chargers as documented in Reference 67. This capacity allows operational flexibility for the operator to use the generators for additional uses.
Charging batteries without normal ventilation can result in hydrogen accumulation in the area of station batteries. No hydrogen accumulation is expected prior to the battery chargers being re-established. Once battery chargers are operating calculations indicate it would take 36 hours before hydrogen concentration would reach 4% in the battery rooms with the doors closed (Reference 70). Maintaining hydrogen concentrations below 4% minimizes the potential for damage to the batteries from hydrogen ignition. Battery room doors will be opened allowing ventilation into the corridor separating the battery room from the turbine building further reducing

the concern of hydrogen accumulation. The large volume of the turbine building and inherent leakage of this structure will preclude significant hydrogen concentration.
The FLEX 480 VAC DGs at DAEC have cabling and connectors that are all 3 phase (in each cable section). The acceptance testing for the installed FLEX connectors verified that they were properly terminated at each connector and that the generator with attached cables will provide the proper phase rotation for the existing plant configuration where they will be connected.
The 220/120 volt FLEX generators are each rated at 6000 VA. The 220/120 volt FLEX generators can be used to provide alternate power to instrumentation via the Instrument AC power system. Power supplied to 1Y11 would total 2293 VA. If power is supplied to instruments via 1Y21 the total load would be 1908 VA.

Installed plant equipment is protected from faults in portable FLEX equipment by the portable generators output breakers. Additionally the equipment being fed have installed breakers that will isolate the generator that is feeding under fault conditions. The FLEX 480 volt generators each have a generator fault detection system that will trip its output breaker under generator fault conditions. The procedural guidance for use of the portable generators ensures the normal supplies to these electrical equipment/buses are isolated prior to supplying the load by emergency FLEX power (References 126, 127, 129 and 134).

A procedure for how to transition to Phase 3 electrical equipment use, including NSRC generators, has been developed (Reference 135). The procedure provides direction for staging locations as well as operational guidance for phase rotation checks required for both 480 VAC and 4160 VAC generator connections to plant equipment. No specific credit is taken for NSRC generators supplying DAEC equipment with respect to coping with ELAP conditions. The NSRC 480 volt generators have larger capacities than the DAEC FLEX generators and could be used as a backup for any loads supplied by the DAEC FLEX generators. The 4160 Volt generators being supplied by the NSRC are rated at approximately 1000 KW each (two will be supplied) with associated switchgear. The procedure directs connection of the 4160 Volt generators to the Standby Transformer secondary or the essential bus feeder lines; this would supply power to one or both essential 4160 VAC busses. The specific use and loads on these 4160 Volt generators are not specifically prescribed. A potential representative case would be the restoration of shutdown cooling. The required loads to establish shutdown cooling would be approximately 1050 kW total for one RHR Pump, one RHRSW Pump, and one ESW Pump.

3.2.5 Flooding Event Strategy

The overall DAEC FLEX strategies for mitigation of an ELAP or LUHS event are the same regardless of the external hazard that led to the ELAP/LUHS. However, for an event caused by external flooding from the Cedar River as a result of a regional precipitation event, both the timing of the event progression and the locations of portable equipment used in the strategy are event specific. See Section 3.5.2 for a detailed discussion of flooding specific considerations and Attachment F, Table F-2 for a timeline related to a flood event.

3.2.6 Conclusions

DAEC has developed guidance that if successfully implemented will maintain or restore core cooling following a BDBEE consistent with NEI 12-06 Rev. 2 guidance as endorsed by JLD-ISG-012-01 and adequately addresses the requirements of Order EA-12-049.

3.3 Spent Fuel Pool Cooling Strategies

The DAEC strategies for maintaining spent fuel pool cooling are consistent with NEI 12-06. The strategies rely initially on the water inventory and thermal mass of the spent fuel pool in Phase 1. If the spent fuel pool temperature increases to where significant evaporation or boiling occur, supplemental ventilation of the reactor building will be initiated by opening reactor building doors in lower elevations and a ventilation damper above the spent fuel pool (Reference 133). Prior to water in the spent fuel pool being depleted to the top of the stored fuel bundles, a portable pump will transfer water from the circulating water pit to the spent fuel pool to ensure the spent fuel is continuously submerged. The water can be added to the pool via hoses directly to the pool, or via a connection on the RHR system that does not require access to the spent fuel pool area.

3.3.1 Phase 1

During normal plant operation, the thermal mass of the spent fuel pool is typically sufficient to accommodate the decay heat from the stored spent fuel for days without a significant loss of inventory (Reference 114) from evaporation or boiling. During the off normal condition of a full core off load, higher decay heat loads would be present in the fuel pool resulting in heat up to at or near boiling within a few hours (Reference 67). To minimize the heat-up of the reactor building and the accumulation of moisture, supplemental ventilation will be established by opening reactor building doors and a vent above the spent fuel pool using SAMP 729 (Reference 133) prior to the onset of boiling. The vent is operated from a manual control station on the Reactor Building 833' elevation (one floor below the refueling floor). The vent control station is installed in the northeast corner, adjacent to the north stairwell. An operator would access this area via the north stairwell, connect the hose on the existing installed pneumatic bottle, and operate two manual valves to open the roof vent.

3.3.2 Phase 2

Prior to evaporation or boiling reducing the inventory of the spent fuel pool water to the top of the stored fuel, a portable diesel pump will transfer water from the circulating water storage pit to spent fuel pool. As directed by EOP 3 (Reference 110) and AOP 435 (Reference 114) make-up to the spent fuel pool can be done directly to the pool per SAMP 712 (Reference 121) or via RHR without accessing the spent fuel pool area per SAMP 718 (Reference 123) as shown in Attachment L.

As a backup to the SFP cooling strategy described above, there is the capability to provide SFP spray of greater than 200 GPM under SAMP 712 (Reference 121) by use of a portable spray nozzle from the refueling floor. This is strictly a contingency and is not required as an active part of the FLEX SFP cooling strategy as the pool is assumed to be intact and makeup to the pool in excess of 53 GPM will maintain the SFP water level above the fuel under all conditions.

3.3.3 Phase 3

No additional capabilities are required under Phase 3 other than replenishing water inventory in the circulating water pit and providing additional diesel fuel oil for the portable equipment for indefinite operation as discussed in Section 3.10 and Section 3.7.4 of this plan.

3.3.4 Evaluations Supporting Spent Fuel Pool Cooling Strategies

3.3.4.1 Availability of Structures, Systems, and Components

3.3.4.1.1 Plant SSCs

For initial response the FLEX strategy relies solely on the inventory of water in the spent fuel pool and the spent fuel pool structure to ensure fuel in the DAEC spent fuel pool is adequately protected. The spent fuel pool is a Class 1 Structure and should not be damaged by external hazards in a manner that adversely affects the stored fuel. A vent has been installed above the spent fuel pool to facilitate natural ventilation of the reactor building with a loss of AC power (Reference 55). The vent can be pneumatically operated from a remote location at the Reactor Building fourth floor using a portable pneumatic supply. To supplement the vent above the spent fuel pool various doors of the reactor building can be opened to allow a chimney effect with warmer air/steam rising to the roof vent to minimize the impact on the reactor building environment. When water makeup to the spent fuel pool is required to maintain an adequate inventory to cover the spent fuel, make up can be provided through multiple paths as defined in AOP 435 (Reference 114). If the makeup path chosen is via RHR, the FLEX portable pump can be connected via either of two connection points. While leakage from the spent fuel pool should not occur by design and is not postulated in the FLEX implementing guidance or in Order EA-12-049, the capability to spray the spent fuel pool is also provided by procedure as defense in depth (Reference 121).

3.3.4.1.2 Plant Instrumentation

To meet the requirements of Order EA-12-051 (Reference 5) redundant channels of instrumentation were installed by modification EC 283472 (Reference 57) to provide a full range of water level indication above the spent fuel for the pool during a BDBEE. In addition, Appendix 2 of AOP 435 (Reference 114) provides direction on alternate spent fuel pool level and temperature indication as defense in depth. The new instrumentation is compatible with the environmental conditions of a boiling spent fuel pool and provides indication available to operators in an accessible location (Control Room).

3.3.4.2 Thermal-Hydraulic Analyses

The make-up flow rate to the spent fuel pool is substantially less limiting than to the reactor. Under typical operating conditions a loss of spent fuel pool cooling would result in a very slow heat up of the spent fuel pool following a loss of spent fuel pool cooling (typically a few degrees per hour) with little resulting loss of inventory (Reference 114). Consistent with NEI 12-06 Section 3.2.16, the thermal hydraulic analysis assumes the SFP boundary is intact, sloshing may occur but does not preclude access to the refuel floor, spent fuel pool cooling system is intact and the SFP heat load is the maximum design bases heat load for the plant. Under the highly unusual circumstance of a full core off load and maximum design bases heat load in the fuel pool, make-up flow rates to the spent fuel pool of 53 GPM would be required to commence within 45 hours of the loss of cooling. This analysis is documented in UFSAR Section 9.1.2.3.2 (Reference 103) and DAEC calculation CAL-M97-019 (Reference 67). It should be noted that under this scenario no reactor vessel make-up is required as all fuel is in the spent fuel pool. Analysis is performed each operating cycle to provide operators with more accurate information on the time available prior to the spent fuel pool temperature reaching 200° F using the actual spent fuel present during the cycle. This cycle specific information is included in plant procedures (Reference 114).

3.3.4.3 FLEX Pumps and Water Supplies

The portable diesel pumps are capable of providing 500 GPM of makeup to the spent fuel pool as documented in calculation CAL-M07-018 (Reference 68) consistent with NEI 12-06 Section 11.2. This is substantially in excess of the worst case required make up rate of 53 GPM. As makeup of water to the spent fuel pool does not need to begin until 45 hours for the worst case spent fuel pool loading with a full core off load and many days later for normal operating conditions, the water supply available in the circulating water storage pit (For Flood events Condenser Hotwell) is sufficient for initial response until long term make up can be assured in Phase 3 (Reference 132). Refueling of diesel driven portable pumps is described in Section 3.7.4 of this plan.

3.3.4.4 Electrical Analyses

The direct mitigating strategies for the spent fuel pool do not rely on AC electrical power. The new Spent Fuel Pool Level Instrumentation installed under NRC Order EA-12-051 (Reference 5) includes local batteries capable of supplying power for 72 hours. The instrument is normally powered from Instrument AC. Instrument AC is supplied by the station 125 VDC batteries via inverters. Therefore, the instruments will be available during Phase 1 by their dedicated batteries, and Phase 2/3 via the FLEX generators as described in Section 3.2.4.2 of this plan.

3.3.5 Conclusions

DAEC FLEX strategies will maintain or restore SFP cooling following a BDBEE consistent with NEI 12-06 guidance (Reference 39) as endorsed by JLD-ISG-2012-01(Reference 8).

3.4 Containment Function Strategies

DAEC FLEX strategies for maintaining the Containment Function are consistent with the guidance provided in NEI 12-06. The DAEC containment structure is a BWR Mark 1 containment. The design of the containment structure is discussed in UFSAR Section 6.2. The drywell and the suppression pool are designed for an internal pressure of 56 PSIG coincident with a temperature of 281° F. The primary containment pressure limit in emergency operating procedures is 53 PSIG and this more limiting value was used as the acceptance criteria for the DAEC FLEX strategies. To meet the requirements of Order EA-13-109 (Reference 7) and the guidance provided in NEI 13-02 (Reference 40), a Hardened Containment Vent System (HCVS) has been installed by modification EC 281991 (Reference 58) to provide a severe accident capable wetwell vent.

3.4.1 Phase 1

The initial plant response to a loss of AC power is for primary containment to isolate. The containment isolation can be completed without AC power (Reference 104). As containment temperatures and pressures slowly increase it will become necessary to open the HCVS suppression pool vent as directed by EOP 2 (Reference 109) and SEP 301.3 (Reference 136). The HCVS does not rely on any AC power in the first 24 hours and has sufficient pneumatic supplies to perform its function for a minimum of 24 hours including purge cycles not required for FLEX strategies. The EOPs have been revised consistent with BWROG generic guidance to include the allowance for anticipatory venting (Reference 43). This guidance has been endorsed by the NRC staff in a letter dated January 9, 2014 (Reference 20). The EOPs include provision to ensure net positive suction head is not adversely impacted for reactor coolant system injection pumps and to ensure that negative pressure in the containment is prevented.

Normally the operation of the hard pipe vent, vent pipe purging operation and rupture disc opening is controlled from the Main Control Room after opening system nitrogen supply valves in the 1A3 Essential Switchgear Room. In the event the control room operation is unavailable, the hard pipe vent isolation valve operation and rupture disc opening can be performed at a remote operating station by the manipulation of manual valves. SEP 301.3 (Reference 136) provides direction for remote or local operation of the hard pipe vent.

The remote operating station is located on the ground floor of the control building in the 1A3 Essential Switchgear Room. The control building is a hardened structure protected from extreme external events. Safe shutdown battery operated lighting provides emergency lighting at the location of the hard pipe vent remote operating station in the 1A3 switchgear room.

The bank of nitrogen bottles providing the normal pneumatic supply to the HCVS is located in the Reactor Building and hence protected from all postulated external events.

3.4.2 Phase 2

No additional strategies are required for Phase 2 to maintain the primary containment other than replenishing the electrical supply after 24 hours. After 24 hours, the FLEX portable generator will be relied on to repower the HCVS uninterruptable power supply (Reference 134). The pneumatic supply of the HCVS is sized to accommodate significant purging of the HCVS from hydrogen generated by fuel failure. Use of the HCVS for FLEX strategies would not include fuel failure and therefore no purging is required resulting in the normal pneumatic supply being substantially oversized for FLEX applications. No supplemental pneumatic supply is required, however, contingencies for replacing the pneumatic supply using portable nitrogen bottles are provided for defense in depth (Reference 136).

3.4.3 Phase 3

No additional strategies beyond those described in Phase 1 and 2 are needed to maintain the containment function indefinitely with the exception of long term refueling of portable equipment (Reference 124).

3.4.4 Evaluations Supporting Containment Functions

3.4.4.1 Availability of Structures, Systems, and Components

3.4.4.1.1 Plant SSCs

The plant equipment relied on to maintain the containment function is primarily the existing safety related structure and the robust components installed as part of the HCVS. DAEC has completed analysis demonstrating the HCVS has the capacity to vent the steam/energy equivalent to one percent of licensed thermal power and that the suppression pool and HCVS together are able to absorb and reject decay heat such that following a reactor shutdown from full power containment pressure will be maintained below the lower of the primary containment design pressure and the primary containment pressure limit (53 PSIG). The expected suppression pool maximum temperature is less than 255 degrees and the expected maximum drywell temperature is approximately 270 degrees (Reference 79). The environmental qualification testing for the Safety Relief Valves demonstrated operability up to temperature of 355 degrees so the SRVs are not impaired by the projected drywell temperature during the FLEX strategies (Reference 82). SRV operation has been evaluated to the requirements specified by the BWROG (NEDC-33771P), which concludes that the capabilities of the installed SRVs are appropriate for the expected containment conditions (Reference 149). The HCVS equipment design assumes the temperature of vented steam to be 350 degrees and therefore is not adversely affected by the suppression pool temperatures projected during the FLEX strategies. No water source other than the suppression pool itself along with water injected to the reactor vessel for reactor core cooling as discussed in Section 3.2 of this plan are relied upon to maintain the containment function.

3.4.4.1.2 Plant Instrumentation

Section 3.2.4.2 and Attachment I to this plan discuss critical instruments needed for operational decision making as recommended in NEI 12-06 Section 3.2.1.10. These instruments are normally powered by the station batteries via inverters. The station batteries will remain functional as described in Section 3.2.4.8 of this plan and power to these instruments will not be load shed. If for any reason this power supply is lost, a contingency has been established to repower either division of instrument power at a location downstream of the inverters closer to the installed instruments at either instrument AC distribution panel 1Y11 or 1Y21 (Reference 129). Either division is capable of providing adequate indications for operational decision making. For defense in depth, procedures are in place for operators to use either local indications or portable instruments to take readings on applicable critical instruments with no AC power available to the instruments (Reference 131). The environmental conditions within the drywell during an ELAP are bounded by the peak temperatures specified for design bases accident conditions for electrical equipment inside the containment (Reference 61) therefore the qualification of instruments for use is unchanged from the existing design.

3.4.4.2 Thermal-Hydraulic Analyses

The Thermal-Hydraulic Analysis of the containment was performed concurrent with the analysis of core cooling discussed above in Section 3.2.4.3 of this report due to the close interaction of BWR core and containment functions. The analysis confirmed that the containment pressure and temperature could be controlled within the design limits. The sizing analysis of the HCVS piping (Reference 72) demonstrated the HCVS has the capacity to vent the steam/energy equivalent to one percent of licensed thermal power and that the suppression pool and HCVS together are able to absorb and reject decay heat such that following a reactor shutdown from full power containment pressure will be maintained below the lower of the primary containment design pressure and the primary containment pressure limit (53 PSIG). The use of anticipatory venting limits peak containment temperature to approximately 270 degrees and peak containment pressure to approximately 22 PSIG (Reference 79 Case S2). The expected suppression pool maximum temperature is less than 255 degrees and the expected maximum drywell temperature is approximately 270 degrees (Reference 79) thus ensuring margin to the containment pressure and temperature design limits.

3.4.4.3 FLEX Pumps and Water Supplies

The FLEX mitigation strategies for preserving the containment do not rely on portable pumps or water supplies other than the suppression pool.

3.4.4.4 Electrical Analyses

The FLEX containment strategies rely on the HCVS components installed under NRC Order EA-13-109 which have dedicated battery backed uninterruptable power supplies (UPS) for the first 24 hours that power the HCVS control valve solenoids and instrumentation on the HCVS that monitor system operation (Reference 134). After 24 hours the FLEX generator may be used to repower these components. The FLEX generator has sufficient capacity to re-power the UPS (Reference 58). Instrumentation used for plant decision making on containment parameters are discussed in Attachment I.

3.4.4.5 Pneumatic Supply Analyses

The FLEX containment strategies rely on the HCVS components installed under NRC Order EA-13-109 which have pneumatic supplies sufficient for a minimum of 24 hours. The HCVS pneumatic design assumes the need for periodic purging of the vent line to mitigate the presence of hydrogen from fuel failures. For FLEX strategies no fuel failures occur and operating procedures would not utilize the purge function. As a result, the pneumatic supply is substantially oversized to maintain system operation without purging. If replenishment of the nitrogen supply is needed, procedural guidance is provided for use of portable nitrogen bottles (Reference 136) as defense in depth for the containment function.

3.4.5 Conclusions

DAEC has established guidance that if implemented successfully will maintain or restore containment functions following a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01 and addresses the requirements of Order EA-12-049 for mitigating strategies to preserve the primary containment.

3.5 Characterization of External Hazards

DAEC is located in eastern Iowa and has been evaluated for external hazards consistent with NEI 12-06 (Reference 39). Each of the hazards described in NEI 12-06 that potentially contribute to ELAP or LUHS are applicable to DAEC at least in part.

3.5.1 Seismic

The DAEC is located in a region of comparatively low seismic activity with no noteworthy seismic events occurring at the station in the initial 40 years of operation. UFSAR Section 2.5 (Reference 95) describes the geology of the area and the potential for seismic events. UFSAR Section 3.7 (Reference 99) describes the design of DAEC structures and equipment to account for potential seismic stress. The peak ground accelerations for structures on bedrock is listed as 0.12 g and for structures supported on soil is listed as 0.18 g for use in the response spectra. By letter dated March 12, 2012, (Reference 6) the NRC requested Licensees to submit updated information related to the potential seismic hazards for the site. By letter dated March 28, 2014 (Reference 23) DAEC submitted the requested information which concluded the updated seismic hazard for the DAEC site was bounded by the original design with the exception of frequencies above 10 Hertz. By letter dated August 21, 2014 (Reference 31) the NRC staff concurred with the DAEC seismic screening indicating DAEC screened "out" with respect to the need to perform an expedited seismic evaluation for FLEX equipment and screened out with respect to needing to perform additional seismic risk evaluations. The DAEC did screen in for a limited scope review of high frequencies. By letter dated February 18, 2016 the NRC staff concluded that with respect to high frequency exceedance, DAEC met low spectral acceleration screening criteria and did not warrant additional evaluations for functionality of control devices (Reference 32). In Reference 35, DAEC documented these seismic reanalysis results consistent with Mitigating Strategies Assessment (MSA) in NEI 12-06, Appendix H, Revision 2, H.4.2 Path 2: GMRS < SSE with High Frequency Exceedances.

An evaluation was performed pertaining to the foundation design and equipment access routes for the FLEX storage buildings (Reference 76). Calculations performed determined the allowable bearing pressure for the foundations at the storage building locations. Estimates of settlement were developed for foundations based on the allowable bearing pressure. The modulus of subgrade reaction is estimated based on the calculated magnitude of settlement. A minimum foundation embedment was established for protection against frost penetration and bearing foundations on suitable material, lateral earth pressure coefficients are calculated and coefficients of friction for sliding on dissimilar materials are provided. Aggregate roadway sections were evaluated against a design section at each of the six (6) roadway borings. Approximately 300 feet of roadway adjacent to Boring RB-3 did not meet the minimum design road section and was remediated (Reference 105).

3.5.2 Flooding

3.5.2.1 Characterization of Flood Hazard

The DAEC is located on the Cedar River in Iowa. As such the DAEC is susceptible to flooding hazards from the Cedar River. Flooding due to hurricane storm surge, seiche, or tsunamis are not applicable to the DAEC site due to its inland location far from large bodies of water. The potential for flooding is described in UFSAR Section 2.4 (Reference 94). As noted in Table 2.4-1 of Reference 94, floods that would approach plant grade are expected to be extremely rare. Floods with a 500 year return frequency would have a flood height approximately 8 feet below plant grade and would not have a significant impact on FLEX strategies. However, the maximum possible flood is postulated to be substantially higher than a 500 year flood. The maximum possible flood height is approximately 7 feet above plant grade. The design of the DAEC to mitigate a flood of this height is described in UFSAR Section 3.4 (Reference 98).

By letter dated March 12, 2012, (Reference 6) the NRC requested licensees to submit updated information related to the potential flood hazards for the site. DAEC performed an updated assessment of the flooding hazard and submitted a summary of that analysis by letter dated March 10, 2014 (Reference 22). The updated analysis included evaluations of dam failures, local intense precipitation, and combined events. The NRC Staff completed an interim review of the DAEC flood hazard analysis and documented their conclusions in Reference 33. The conclusion of that review was that the existing design bases flood did not fully bound the potential hazard using current standards and therefore a Mitigating Strategies Assessment is required. The slight exceedance identified in this review would not exceed the physical capability of current flood protection features required by the CLB at DAEC in Reference 98 and procedurally controlled under Reference 116. The DAEC FLEX design assumed flood condition including wind wave run-up of at least 769 feet MSL exceeding the reevaluated flood hazard height of 767.8 specified by the NRC in Reference 33. The updated assessment of flood hazards also identified the potential for Local Intense Precipitation to cause temporary water accumulations on site adjacent to buildings. The small depth and short duration of this water accumulation are judged to not delay planned actions for FLEX equipment deployment described in the 100 percent power timeline as commencing two hours after the loss of all AC power.

The DAEC FLEX strategies reviewed the impact of flooding consistent with Table 6-1 of NEI 12-06, for a regional precipitation driven flood event (PMF) with respect to the warning time and persistence of the hazard. Several days of warning time are available from the time of an extreme rainfall event upstream of the plant site prior to flood waters reaching plant grade. For purpose of this evaluation it is assumed the ELAP event starts at the time flood waters reach plant grade. The maximum duration of time the flood waters are projected to be above plant grade is three days (Reference 22). Additional details on the flood related event timeline are provided in Attachment F.

3.5.2.2 Protection of FLEX Equipment from Flood Hazard

The North Emergency Response Storage Building is located substantially above the maximum postulated flood height (Reference 105). One full set of FLEX equipment is housed in this location and fully protected from all flood events consistent with NEI 12-06 Section 6.2.3.1a. The South Emergency Response Storage Building is below the postulated maximum flood height. Equipment normally stored in the South Emergency Response Storage Building will be relocated to an area protected from flooding in the warning period prior to flood waters reaching plant grade consistent with NEI 12-06 Section 6.2.3.1.c.

3.5.2.3 Deployment of FLEX Equipment for Flood Event

During this warning period the DAEC performs flood preparation activities under Abnormal Operating Procedure 902 (Reference 116). Appropriate FLEX portable equipment will be moved inside flood protected areas. To ensure the FLEX portable pump has reliable access to a controlled water source, a plant modification has been made to provide a connection point inside the flood protected area of the turbine building to the main turbine condenser system hot well. A water tight door was installed on the Turbine Building in place of the previously existing portable stop logs to allow more efficient access point for portable equipment during flood preparations (Reference 55). The flood mitigation actions taken by DAEC are intended to minimize the potential for significant in-leakage to flood protected structures and as such DAEC design does not include any safety related dewatering features. Below grade structures are designed to include water proofing and sealed penetrations (Reference 98). Minor in leakage is possible but it would be expected to flow to lower elevations of the protected buildings and would not directly impact FLEX strategies.

3.5.2.4 Procedural Interfaces for Flood Event

Abnormal Operating Procedure (AOP) 902 (Reference 116) directs plant response to flood related events. AOP 902 provides direction to plant operators with respect to responding to flood warnings, monitoring flood projections, and deploying flood protection features. If flood water elevations are projected to reach plant grade AOP 902 directs operators to shut down the reactor prior to water elevations reaching plant grade. AOP 902 also provides direction for relocating FLEX equipment in coordination with flood preparations to ensure the required FLEX equipment required for Phase 2 is pre-staged inside the Turbine Building prior to flood water reaching plant grade. The FLEX procedures (SAMPs) provide guidance that supports hose connections and electrical connections as well as hose and cable routing fully inside the flood protected buildings. Diesel engines will be exhausted through portable exhaust piping outside if required. The Transfueler will also be staged inside the building providing a quantity of diesel fuel as needed to support FLEX strategies during the period water is projected to be above plant grade. If necessary, FLEX procedures also provide methods to access fuel oil from the diesel generator day tanks or the main fuel oil storage tank. For a flooding event the Condensate Storage Tanks remain available for RCIC suction providing a cool water source such that RCIC should remain available throughout the period of inundation, but the FLEX portable pump will be available with connection points fully within the flood protected area to provide defense-in-depth for RPV makeup as well as Spent Fuel Pool makeup if needed. The FLEX 480 volt generator and associated cables will be located inside the flood protected area and be available to re-charge station batteries when required. AOP 902 would direct plant shutdown prior to flood waters reaching plant grade. As a result substantially lower decay heat is present in the reactor and consequently the expected progression of the event is slower as reflected in the timeline shown in Attachment F, Table F-2. Consumption of water and fuel oil would also be at substantially slower rates than an ELAP event occurring from 100% power and therefore would not be challenged during the period of surrounding site inundation.

3.5.2.5 Utilization of Off-site Resources for Flood Event

Station personnel would be activated during the warning period for a flood event, so limitations on staffing would not apply. Since the warning period is greater than 4 days NSRC resources could be delivered to the site in advance, but for purposes of this evaluation, no credit is taken for off-site resources being available for use during the period when flood waters are above plant grade (approximately 3 days per Reference 22). Once flood waters have receded below plant grade, off-site resources would be available for utilization consistent with other hazards as described in Section 3.8 of this plan. In the event surrounding community infrastructure is substantially impaired such that vehicle access to the site is unavailable for equipment delivery, the NSRC has the capability of delivering support equipment via helicopters (Reference 142).

3.5.3 Hurricane

The DAEC is located in eastern Iowa substantially inland from any oceans; therefore hurricane influences are not applicable consistent with Figure 7-1 of NEI 12-06.

3.5.4 Tornado and High Winds

The DAEC is located (Latitude 42° 6' 02" N and Longitude 91° 46' 36" W) in a region susceptible to tornados as documented in UFSAR Section 2.3 (Reference 93) and Figure 7-2 of NEI 12-06. UFSAR Section 3.3 (Reference 97) describes wind and tornado loadings for the design of structures. Safety related features at DAEC are protected from tornado winds up to 300 MPH with transverse velocity of 60 MPH and associated wind driven missiles. This exceeds the recommended tornado design wind speeds shown in Figure 7-2 of NEI 12-06. The design of the FLEX equipment storage buildings utilizes separation as described in Reference 39 to protect from tornado missiles and ensures at least one set of portable equipment remains available. Protection of equipment is discussed further in Section 3.6 of this report. Tornados may occur with limited warning time but the duration is expected to be relatively short allowing deployment of FLEX portable equipment without significant delay. Portable equipment deployment paths and debris removal following a tornado are discussed further in Section 3.7 of this report.

3.5.5 Snow, Ice, and Extreme Cold

The DAEC site location in eastern Iowa (Latitude 42° 6' 02" N and Longitude 91° 46' 36" W) does experience the hazards of snow, ice and extreme cold as noted in Figure 8-1 and Figure 8-2 of NEI 12-06. The licensing basis for the site for these hazards is described in UFSAR Section 2.3 (Reference 93). Temperatures as low as -36 degrees Fahrenheit, snowfall events as large as 16.7 inches, and heavy freezing rain have occurred. Most winters include multiple days of extreme cold, heavy snow or freezing rain and site personnel routinely successfully manage these adverse conditions. Winter weather events typically have one or more days warning period. AOP 903 (Reference 117) provides direction for managing potential winter weather events. Section 3.7 of this report discusses deployment of FLEX equipment during severe winter weather.

3.5.6 Extreme Heat

Regional experience with high temperatures exists for the DAEC site. UFSAR Section 2.3 (Reference 93) describes an observed temperature maximum extreme of 110° F. UFSAR Section 3.11 (Reference 101) describes the environmental design for electrical equipment. Expected environmental service conditions for areas containing safety related equipment are described in a controlled design document, QUAL-SC101 (Reference 61). AOP 903 (Reference 117) provides guidance to operators on managing severe weather conditions such as high temperature.

3.5.7 Conclusions

Each of the hazards discussed in NEI 12-06 (Reference 39) Section 4.1 apply to the DAEC site. For storm events with high winds, the subset of events related to hurricanes do not apply to the DAEC site due to the in land location. For flooding events storm surge, seiche and tsunami do not apply to the DAEC site as it is not located on a large body of water.

3.6 Protection of FLEX Equipment

DAEC has constructed two dedicated buildings for storage of FLEX portable equipment (Attachment B). Each building contains one complete set of FLEX portable equipment essential to executing the FLEX strategies. The DAEC is a single reactor site and therefore two sets of portable equipment (one in each storage structure) fully satisfies the "N+1" criteria defined in NEI 12-06 (Reference 39) Section 3.2 to have sufficient equipment for each reactor on the site plus one spare set of equipment. Each building contains a Tow Vehicle and Debris Removal equipment to support deployment. Doors on the storage buildings can be opened manually in the event of a loss of AC power.

3.6.1 Building Structural Loads

The DAEC storage buildings were constructed to meet ASCE 7-10 standards (References 62 and 105) for seismic, wind and snow/ice. Load requirements as established by the ASCE 7-10, "Minimum Design Loads for Buildings and Other Structures", was the selected option. This option is consistent with the guidance provided in NEI 12-06 Section 7.3.1.1.c. for DAEC's specific geographical area. Due to the low seismic loads in this geographical location, the wind loads are larger and therefore the controlling factor in the design of the DAEC FLEX Storage Facilities. The DAEC FLEX Storage Facilities are designed to meet the most severe conditions of load combinations as set by the ASCE 7-10 for DAEC's specific area. The DAEC FLEX Storage Facilities are designed to meet the following wind design basis:
Wind Load (W)

- Exposure (Surface Roughness) Category = C
- 115 mph Ultimate Design Wind Speed (3-second gust)
- 76 mph Serviceability Design Wind Speed (3-second gust)
- Enclosure Classification = Partially Enclosed Buildings

Based on the above information it is concluded that the DAEC FLEX Storage Facilities can protect FLEX equipment with loads associated with either a high wind event or a seismic event as required by ASCE 7-10. This will allow station personnel to successfully deploy the equipment necessary to implement FLEX strategies under the conditions of Order EA-12-049.

3.6.2 Interaction of Stored Equipment

The equipment stored in the buildings is tied-down or adequately spaced to avoid interaction during a seismic event and to minimize the potential for wind damage in the event the building is damaged consistent with NEI 12-06. The storage buildings were inspected (Reference 88) in accordance with EPRI methods (Reference 51) for potential seismic interactions due to unsecured and/or non-seismic components to confirm that interaction that would damage FLEX equipment would be unlikely.

3.6.3 Tornado Separation

Tornado impacts were addressed in the design by physical separation of the two storage buildings consistent with NEI 12-06 Section 7.3.1.1.c. To minimize the potential for a single tornado to damage all FLEX equipment, the storage buildings are located approximately 3500 feet apart. An evaluation of the DAEC site tornado hazard (Reference 60) confirmed that the probability of a single tornado striking both storage buildings was acceptably low to ensure that at least one set of FLEX equipment would remain deployable. The evaluation utilized data from NUREG/CR-4461 for tornado strike frequencies as well as path, width and length data for the DAEC geographic location (Latitude 42° 6' 02" N and Longitude 91° 46' 36" W). The building separation substantially exceeds the minimum separation of 1200 feet defined for reasonable protection in NEI FAQ 2013-01 (Reference 41).

3.6.4 Protection from Temperature Extremes

The heating and ventilation design of the storage building ensures normal storage temperature conditions suitable for long term equipment reliability. Temperatures internal to building will be maintained between 50°F and 100°F.

3.6.5 Protection from Flooding

The north equipment storage building location is substantially above the elevation where a flooding potential would exist. The south equipment storage building is located below the elevation where flooding could affect the building but sufficient warning time (several days) is available to relocate FLEX equipment to a flood protected location inside the turbine building in the event it was needed after flood water reached plant grade in accordance with Abnormal Operating Procedure for flooding (Reference 116).

3.7 Deployment of FLEX Equipment

3.7.1 Haul Paths and Accessibility

Provisions are made for removal of potential debris generated by a tornado or other external event including snow under Reference 128. At least two paths are available from each FLEX storage building to the deployment location to minimize the potential challenge from debris sources (Reference 105). FLEX response calls for an initial assessment of damage caused by the external hazard to allow the selection of which set of FLEX equipment to utilize and the most readily available transport path.

Soil conditions for the storage buildings and transport paths were evaluated (Reference 76) and improvements to the transport path were completed to ensure a seismic event would be unlikely to impair the transport path. Access to the FLEX equipment and transport to the deployment locations do not require AC power. Where necessary doors and gates can be unlocked using keys available to response personnel and manually opened for personnel and equipment access. Portable lighting and lighting on FLEX tow vehicles are provided in each FLEX Emergency Response Storage building (Reference 130).

3.7.2 FLEX Equipment Transport and Connection

Vehicles equipped with four wheel drive, tire chain options, and snow blades will ensure reliable towing/transport of the FLEX equipment from the storage location to the deployment areas. Flooding events have significant warning time (Section 3.5.2) and appropriate FLEX equipment will be deployed prior to water reaching plant grade. The connection points (Electrical and Mechanical) for FLEX equipment are located in robust structures protected from the specified external hazards consistent with NEI 3.2.2.17 and are tabulated in Attachment J. The staging location of the large pumps and generators will be selected based on the damage assessment (Reference 128) to ensure hoses and cables can reach connection points and in the case of flooding events that the portable equipment is protected from impending flood waters. Access to FLEX connection points is entirely through seismic Class 1 structures with the exception of the Turbine building which is seismically robust as discussed in UFSAR Section 3.8.4.3.3. Electrical power is not required for deployment. A tow vehicle will be maintained in each FLEX Emergency Response Storage Building to ensure a means to move the FLEX equipment is reasonably protected from external events. Backup lighting options for FLEX deployment are included in SAMP 724 (Reference 128).

Long-term replenishment of the water inventory from the Cedar River or other sources is addressed by SAMP 728 (Reference 132) during Phase 3 including provisions for handling water makeup when the surface of the Cedar River is frozen. The procedure includes multiple options and flow paths for replenishing water inventories. Access to offsite resources is discussed further in Section 3.8.

3.7.3 Staffing and Communications

To support deployment of FLEX portable equipment, assessment of the damage caused by the external event, selection of the preferred transport path, transport and connection of portable equipment will be completed by the site Fire Brigade which is included in the minimum shift staffing (Reference 34). Portable radios are available to the Fire Brigade in accordance with the site communications assessment to assist in remote communication with the plant operating staff (Reference 15). No FLEX strategies rely on continuous remote communications for successful completion.

3.7.4 Refueling Portable Equipment

Portable equipment can be refueled as necessary under SAMP 719 (Reference 124). Fuel consumption rates for portable equipment have been evaluated (Reference 81) with the summary results shown in Table 3.7-1. Intermittent use or partial loading of equipment may reduce actual total fuel consumption. The FLEX portable equipment will normally be stored with fuel in the integral tanks. The portable Transfueler will be stored with approximately 900 gallons of fuel. Refueling of equipment will start as resources are available prior to depletion of integral tanks on the portable equipment. DAEC staffing studies assumed refueling activities would start after 16 hours. Refueling will be accomplished with a FLEX Transfueler that has a storage capacity of approximately 900 gallons of diesel fuel. The FLEX Transfueler has a gasoline powered and a DC Powered (powered by FLEX Tow Vehicle) onboard transfer pumps, and fuel transfer hoses and nozzles to accomplish the refueling of diesel powered portable FLEX equipment. Each pumps capacity substantially exceeds the required flow rate to maintain FLEX equipment. There is a FLEX Transfueler stored in each Emergency Storage Building to ensure one Transfueler will be available after a beyond design basis event. Each FLEX Transfueler has the capability and equipment to refill its storage tank from the DAEC Standby Diesel Generator underground storage tank.

Table 3.7-1 Fuel Oil Consumption

Hours 0-7.5	Hours 7.5-24	Day 2+ (N sets of key onsite portable equipment operating)	Maximum Regional Response Center Equipment if all were in service
None-Phase 1-no portable equipment required other than deployment activities	Minimal-Integral tanks on portable equipment support minimum required operation	38.3 gallons/hour at full load	273 gallons/hour

Adequate quantities of fuel oil are available on site for refueling on-site portable equipment to allow continuous operation until off site resources are available and can access the site. Table 3.7-2 reflects the quantities of fuel oil in robust protected locations. SAMP 719 (Reference 124) provides direction to allow refueling portable equipment under flood conditions from sources protected from flood water. Substantial additional storage of fuel oil is located on site that is not fully protected but may be used preferentially if available. Fuel that is stored in the onboard portable equipment and in the FLEX Transfuelers will be tested periodically to verify fuel quality. The fuel in the Transfueler will utilize additives that help maintain fuel quality. The fuel that is stored in the underground tank is currently tested both on delivery and periodically during storage to ensure adequate quality is maintained in accordance with DAEC Technical Specifications.

Table 3.7-2 Fuel Oil Storage		
Storage Tank	Nominal Capacity	Location
Transfueler Portable Tanks	900 Gallons	One in each FLEX Emergency Response Building
1T-35 Main Fuel Oil Storage Tank	40,000 Gallons	Underground Safety Related
1T-37A EDG A Day Tank	850 Gallons	Turbine Building Safety Related
1T-37B EDG B Day Tank	850 Gallons	Turbine Building Safety Related

3.8 Offsite Resource Utilization

DAEC is a participant in the industry National SAFER Response Centers (NSRC) which will provide support for Phase 3 response equipment. A site specific response plan has been developed (Reference 142). The NSRC Regional Response Centers (RRC) are described in an NEI white paper (Reference 44) including an assessment of how they fulfill NEI 12-06 Section 12.2 minimum capabilities. The NRC Staff found the NSRC to be an acceptable means to meet Phase 3 requirements for Order EA-12-049 in an assessment dated September 26, 2014 (Reference 14). The NSRC generic portable equipment (Reference 86) is shown in Attachment E. DAEC has established procedures for requesting deployment of SAFER equipment to the site and for coordination of SAFER Support (Reference 141). For DAEC, an offsite staging area (Staging Area C) has been defined at the Eastern Iowa airport (See Attachment C) which is approximately 15 miles (20 miles driving) from the DAEC site (Reference 91). Both Staging Area C and the DAEC plant site are located west of the Cedar River to reduce the potential for flooding or seismic events impacting bridges across the river to impede site access. An alternate offsite staging area (Staging Area D) has been defined at the Iowa City Airport (Reference 92) which is approximately 35 miles from the station. For flooding events on the Cedar River significant warning time is available (see Section 3.5.2). If flood projections are expected to exceed plant grade, sufficient time would be available to deploy equipment from the RRC prior to river level impeding access, however, for purposes of this plan, no credit is taken for NSRC equipment prior to flood levels receding below plant grade. Equipment will be delivered on site to the North FLEX Storage Building (Staging Area B) where site ERO personnel can coordinate final deployment of the RRC equipment. The primary on-site staging area is adjacent to the North FLEX storage building and an alternate on-site staging area is adjacent to the south FLEX storage building. Transport paths from these locations to final deployment areas have been evaluated consistent with Phase 2 equipment deployment. The SAFER Response Plan addresses alternatives for transport of off-site resources to the on-site staging areas that include diverse land routes and also includes the option of airlifting equipment to the on-site staging area. Appendix 4B "Abnormal Conditions Checklist" of Reference 142 addresses actions to be taken for logistics and transportation of off-site resources in the event the transport path is blocked for any reason (seismic, flood etc.) or inclement weather impacts the delivery of off-site resources to the site. Appendix 4C "Fly or Drive Decision Checklist" provides guidance regarding the choice of transport method. Once SAFER equipment is onsite, SAMP 728 (Reference 132) and SAMP 733 (Reference 135) provide tactical guidance for use of the SAFER equipment including connection point compatibility between portable equipment and plant equipment. Attachment J tabulates the deployment locations and connection points for portable equipment.

Based on this DAEC has developed guidance that allows utilization of offsite resources following a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01.

3.9 Habitability and Operations

3.9.1 Equipment Operating Conditions

Installed plant equipment relied on for FLEX response strategies will remain functional for the temperature conditions anticipated for an ELAP event consistent with NEI 12-06, Section 3.2.2 guideline 10. Attachment H to this plan tabulates the key areas and expected high temperature conditions. For cold external conditions, equipment located inside the reactor building is not expected to be adversely affected due to the large thermal mass and presence of decay heat. For the limited equipment in areas external to the reactor building such as the control building and the circulating water storage pit, the thermal mass is expected to limit impacts and operator guidance is provided on tools available to minimize the impact of adverse environmental conditions (Reference 130). The FLEX portable equipment was purchased with specifications for use in a wide range of environmental conditions (-25°F to 109°F), and is stored in buildings where normal temperatures are maintained between 50° and 100° F. Engines for portable equipment are self-cooled via air cooling and do not rely on external sources of cooling.

Duane Arnold Calculation CAL- M06-007, "Room Heatup Analysis for DAEC During Station Blackout" (Reference 64) was developed to determine temperatures in select areas during a Station Blackout (SBO). The areas of concern evaluated in the calculation are the RCIC room, the HPCI room, and the Control Room. The calculation was performed using the GOTHIC computer model. This analysis models the SBO event for a 24 hour period; therefore it was used as the basis of analysis for FLEX response discussed below:

RCIC Pump Room
The analysis indicates peak temperature in the RCIC room reaches 125°F after 24 hours, and assumes the RCIC room door remains closed throughout the run. This peak temperature is conservative as the DAEC FLEX strategy assumes the RCIC pump operates only for the first 7.5 hours of the ELAP event. RCIC is designed to operate satisfactorily in accident mode with ambient temperatures up to 148°F. Therefore, the RCIC pump room temperature is acceptable for the DAEC FLEX strategy mission time.

No temperature monitoring actions or ventilation actions are required to maintain acceptable temperatures in this area.

HPCI Pump Room
The analysis indicates the peak temperature in the HPCI room is 138°F after 60 minutes, at which time the HPCI room doors are opened in accordance with Reference 111. After an initial temperature drop resulting from opening the doors, the room temperature continued to increase gradually, reaching a maximum of 137°F in 24 hours. This is acceptable based on the specified HPCI room maximum allowed temperature of 148°F and because the HPCI pump is not credited as primary DAEC FLEX strategy.

No additional temperature monitoring actions or ventilation actions are required to maintain acceptable temperatures in this area.

Main Control Room
Temperature conditions in the main control room following a Station Blackout (SBO) event were analyzed for scenarios including an assessment of the control room conditions following an

extended loss of AC power (ELAP) event. For the DAEC ELAP event, the existing analysis conservatively assumes SBO heat loads and operator actions to open control room doors within 60 minutes following the start of the event in accordance with Reference 111. No supplemental forced cooling is assumed for the representative case. The analysis concludes that the peak temperature in the Control Room is 120°F after 24 hours (this is for the case with doors open and natural circulation established). This peak temperature is within the qualification limits for control room equipment.

For extended periods, temperature conditions in the control room are more limiting for plant operators than for control room equipment. The recommended upper temperature limit for the control room is 110°F for operator comfort. FLEX procedures (References 111, 128, and 130) identify this temperature limit and compensatory ventilation actions (restart normal system ventilation fans in Phase 2 or stage temporary fans) to maintain control room temperatures below 110°F if necessary. These actions provide acceptable environmental conditions for electrical equipment in the control room as well as plant operators.

Primary Containment

A plant specific evaluation of FLEX strategies has been completed and is documented in Reference 79, including Primary Containment temperatures. This report documents that the containment environmental conditions are acceptable when FLEX strategies are successfully implemented. Acceptance criteria defined include confirmation that Drywell temperatures remain below 340° F. The results of the analysis indicate maximum temperatures in the Drywell of approximately 270° F during the ELAP event. The qualification for the safety relief valve solenoids documents that they are qualified to operate in an environment with a temperature of 355 degrees at 62 PSIG for 155 days.

No additional temperature monitoring actions or ventilation actions are required to maintain acceptable temperatures in this area.

Battery Rooms and Switchgear Rooms

Temperature conditions in the DAEC Control Building following a Station Blackout (SBO) event are included in the calculation of Reference 64. The battery room and switchgear room control volumes are included in the calculation. To manage temperature conditions in the rooms following a SBO event, Abnormal Operating Procedure (AOP) 301.1 (Reference 111) requires the battery room and switchgear room doors to be open within 60 minutes following the onset of an SBO/ELAP.

Following an ELAP event, heat loads in the battery and switchgear rooms are reduced due to the loss of AC power. Inverters supplying Instrument AC power from the batteries are located in the switchgear rooms and would contribute to the heat load though as a result of DC load shed activities would be operating at a substantially reduced load (22.7% of maximum). Due to the design of the control building and initial room temperatures, it is reasonable to assume the room temperature profiles would be similar to that of the control room. As stated above, the Control Room temperature following an SBO/ELAP is approximately 120°F after 24 hours. A peak temperature of 120°F in the battery and switchgear rooms is within the qualification temperature of the required electrical equipment.

The DAEC 250 VDC and 125 VDC safety-related batteries were manufactured by C&D Technologies. Specifications for these batteries established a maximum normal design operating temperature of 104°F. Qualification testing was not performed at higher temperatures. These batteries have a specified life expectancy of 20 years. C&D Technologies provides methods to calculate expected battery life at elevated temperatures. Operation at 120°F would de-rate the battery life to approximately 10% of rated. Even if the battery was near the end of rated life when the event occurred, several days of operation would be expected. Elevated ambient temperature also has an impact by increasing the charging current required to maintain the float charging voltage set by the charger. The elevated charging current will in turn increase cell water loss through an increase in gassing and water addition to the cell could be required. If battery cell plate uncovery were to occur, failure issues associated with plates being exposed would involve the potential development of sulfation and a subsequent reduction in capacity. For either case described above (loss of battery life or cell failure) the battery charger has the capability to carry the anticipated DC loads indefinitely provided AC power remains available to power the charger.

FLEX procedures (References 111, 128 and 130) identify this upper temperature limit for the battery and switchgear rooms and compensatory ventilation actions (restart normal system ventilation fans in Phase 2 or stage temporary fans) will be prescribed to maintain these room temperatures below 120°F. These actions provide the acceptable environmental conditions for electrical equipment in the battery and switchgear rooms.

FLEX Instrumentation
Analysis of Reactor Building general area environmental conditions during an ELAP including spent fuel pool conditions was performed under Reference 89. Installed instrumentation located in these areas was reviewed to confirm instrument performance would be acceptable for the environmental conditions expected during an ELAP with the following results:

Torus Room –Torus room maximum temperature reaches approximately 195°F at 24 hours. Instruments located in the Torus room relied on for FLEX include the Torus Level transmitters (qualified for environmental conditions up to 320°F) and Torus Water Temperature elements (qualified for environmental conditions up to 373°F). Based on this, instruments located in the Torus room remain within their qualified temperature range.

RB Elevation 757 –Reactor Building Elevation 757 maximum temperature reaches approximately 125°F at 24 hours. The temperature rise from 20 hours to 24 hours is essentially constant at 1°F/hr. Instrumentation relied on for FLEX strategies located in this area including RPV Level, Torus Temperature, and RPV Pressure are all qualified for temperatures substantially above 125°F (150°F for Torus Temperature Indicator TI4325 and 176°F or higher for other instruments). Redundant instrumentation is available for TI4325 in a low temperature location. Based on this, temperatures in the Reactor Building at elevation 757 are considered acceptable.

RB Elevation 786 – Reactor Building at Elevation 786 maximum temperature reaches approximately 115°F at 24 hours. Instrumentation located in this area includes Drywell Pressure, RPV Pressure, and RPV Level. Each of these instruments is qualified for temperatures of 185°F or higher. Based on a steady state temperature in Elevation 786 of 115°F, all instruments located in this area are considered acceptable.

3.9.2 Heat Tracing and Low Ambient Temperatures

Installed plant systems credited for FLEX are listed in Attachment A. Only the Condensate Storage Tanks (CSTs) system has heat tracing. None of the other systems have installed heat tracing for the purpose of freeze protection.

The piping connected to the CSTs (suction and return) does have heat tracing. This function would be unavailable in certain events, i.e. station blackout or extended loss of AC power. As stated in Attachment A, the CSTs provide the preferred initial water inventory for RCIC and HPCI make-up to the RPV. The CSTs are not fully protected from external hazards such as tornado missiles. If the CSTs are unavailable, the suppression pool will be the credited source of water inventory. Consequently, no detailed evaluation of the effect of CSTs on coping duration was performed as part of FLEX implementation. Therefore, there will be no impact if CSTs lose heat tracing during an event.

The Phase 2 on-site portable equipment required to mitigate events is listed in Attachment D. The equipment is stored in the climate controlled FLEX Storage Buildings. The buildings are designed to maintain the storage area temperatures between 50 and 100 degrees over the full range of external temperature. In response to an event, some of the equipment is deployed outdoors and would be subjected to environmental temperature extremes. The equipment is capable of operating outdoors in the expected conditions. Heat tracing and freeze protection is not provided or required for this equipment.

The portable diesel fire pump may be staged east of the Pumphouse with suction from the circulating water pit, and discharge via hoses to the Turbine Building and Reactor Building southeast corner room. Freeze protection is inherent to operation of the pump, since constant flow prevents freeze-up. The pump is equipped with a minimum flow line that ensures constant flow, thus preventing freezing. In addition, the procedures that govern operation of the pump ensure that the pump and attached piping are drained when in standby condition.

The Reactor Building and Control Room contain substantial heat sources during ELAP conditions (Reference 64) and are not expected to experience freezing conditions during an ELAP. Temperatures in the battery and switchgear rooms are not expected to be sensitive to extreme cold conditions due to their location in the Control Building, the concrete walls isolating the rooms from the outdoors, and lack of forced outdoor air ventilation during early phases of the ELAP event.

Battery sizing calculations assume a minimum battery temperature of 65°F to determine DC system performance. Accordingly, FLEX procedures include requirements to monitor and maintain the battery and switchgear rooms above 65°F for the duration of the ELAP event (Reference 130).

3.9.3 Personnel Habitability

In addition to installed plant equipment being affected by temperature changes occurring as a result of the ELAP, some areas of the plant require personnel access for successful implementation of the FLEX strategies. Attachment H to this plan describes the key areas and expected plant conditions.

It is recognized that conditions in the outside yard area as well as inside the plant may be challenging including low or high temperatures, darkness, etc. Toolbox options such as portable lighting, personal protective equipment, stay times, drinking water, and ventilation/heating options are made available for operators to manage these conditions to the extent practical (Reference 130). The control room lighting includes Lighting Uninterruptable Power Supplies (LUPS) for 8 hours of operation following an ELAP event. After depletion of the LUPS, portable lighting will be available (Reference 130). Additionally procedures (Reference 127) provide direction that allow restoration of the power supply to some normal control room lighting by re-energizing the 480VAC MCC 1B32 which feeds an essential lighting panel supplying the control room lights.

An engineering evaluation (Reference 90) was developed to determine the effects of SFP boiling on personnel access to the Reactor Building. The evaluation conservatively determined area temperatures at various Reactor Building elevations and identified the areas that personnel needed to access to perform FLEX actions. The evaluation concludes that the Reactor Building refuel floor will not be accessible once the pool is boiling. The actions required to stage equipment for pool makeup (nozzle, hose) will need to be performed prior to pool boil. Analysis is performed each operating cycle to provide operators with cycle specific information on the time available prior to the spent fuel pool temperature reaching 200° F using the actual spent fuel present during the cycle. This cycle specific information is included in plant procedures (Reference 114) and allows operators to appropriately prioritize actions associated with the spent fuel pool. All other elevations in the Reactor Building will be accessible. All the systems required for FLEX response strategies will remain available and functional.

Engineering evaluations of potential temperature conditions in the Control Building have confirmed the control building remains habitable for personnel (Reference 79) with procedural controls for managing adverse conditions (Reference 130) as discussed in Section 3.9.1 above.

Procedures for deployment of FLEX equipment (Reference 128) ensure the staging location for portable equipment addresses adequate ventilation of engine exhausts.

3.9.4 Conclusions

Based on the evaluation above DAEC has developed guidance that should maintain or restore equipment and personnel habitability conditions following a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01 and adequately addresses the requirements of the Order.

3.10 Water Sources

Attachment G to this plan tabulates the available water inventory sources and their associated quality. Higher quality sources would be used first if available.

3.10.1 Phase 1 Water Sources

During Phase 1 the credited water source for Reactor Core Cooling is the safety related Suppression Pool. RCIC and HPCI are capable of taking suction from the suppression pool. If the Condensate Storage Tanks are available they would be the preferred source due to high quality and low temperature, however they are not fully protected from tornado missiles therefore, the suppression pool is the credited source.

3.10.2 Phase 2 Water Sources

During Phase 2 for ELAP conditions without external river flood events, FLEX strategies rely on raw water pumped from the circulating pit and injected through a flow path via RHR and recirculation system into the reactor vessel from outside the shroud. This water may be carrying with it a certain amount of debris that could potentially clog or block the core inlet, fuel filter or bypass flow leakage holes. Boiling Water Reactor Owners Group (BWROG) report TP-14-006 (Reference 48) was written to address this issue. It provides the basis for addressing the concern of fuel overheating from potential fuel inlet flow blockage from debris when injecting raw water. The report describes BWR core cooling capabilities with the fuel inlet fully blocked, primarily by assuring that injected coolant reaches the inside shroud region and enters the fuel through the top of the channel. The fuel then can be adequately cooled in this manner when the inside shroud is flooded by either injecting make-up coolant inside the shroud or by maintaining the water level above the steam separator return elevation if injecting make-up in the downcomer. The DAEC Emergency Operating Procedures (Reference 108) have been revised to maintain a higher water level to enhance core cooling if using raw water injection. The EOPs allow raising RPV level to a level just below the main steam line above the top of the steam separators to ensure core coverage by reverse core cooling (annulus back over top of steam separator) regardless of potential fuel inlet blockage. BWROG-TP-15-007 (Reference 49) was developed to provide additional guidance for the use of raw water sources with respect to degraded heat transfer. Specifically, the evaluation provides reasonable justification for the use of raw water sources and addresses the concern of fuel overheating from deposition of solids and debris inside the core region and on the fuel cladding. The BWROG document provides the evaluation and basis for use of raw water sources for RPV makeup. The evaluation concludes that there is no expectation for a loss of core cooling capability resulting from the use of raw water injection for BDBEE conditions. DAEC is bounded by this generic evaluation. Analysis has shown that heat transfer capability will not be degraded in the first 120 hours following an ELAP and as such sufficient time is available for the emergency response organization to establish long-term alternate core cooling using off site resources.

The circulating water storage pit is a concrete structure built to robust seismic standards (Reference 100). Circulating Water piping connected to the circulating water storage pit was evaluated and confirmed to be seismically robust in Reference 106. The pit is located below grade and is thus protected from high wind events.

For river flooding hazards, warning time is available and the main condenser hotwell is the credited alternate source of high quality water.

3.10.3 Phase 3 Water Sources

As noted in Section 3.2.4.7 for core cooling and 3.3.3 for spent fuel pool cooling, during Phase 3, water inventories must be replenished to allow indefinite coping with an ELAP and loss of normal access to the ultimate heat sink. Guidance for replenishing water inventory using off site resources is addressed in SAMP 728 (Reference 132). Raw water from the Cedar River would be used to replenish the water inventories after 24 hours. This would be accomplished using a Phase 3 low pressure high flow pump supplied by the Regional Response Center. This pump has multiple suction connections. A suction strainer that would be used with raw water is a floating self-leveling design. A beyond design basis event could potentially introduce significant debris into the Cedar River, so it would be expected that the raw water pump suction strainer could clog after a period of use. To allow an uninterrupted replenishment flow it is planned to have two independent suction hoses with a strainer on each. One suction hose would be in service initially, allowing the second to be placed in service if the first starts to clog. Then the clogged strainer could be removed from service and cleaned or flushed. This process would allow a continuous supply of replenishment water. The capacity of the regional response center pump substantially exceeds the water consumption rates of the FLEX strategies considering river water elevation, staging location, suction and discharge hose routing and required NPSH for the pump (Reference 54 Attachment 5.6). Given the capacity margin, intermittent use of the pump for replenishment would be acceptable.

Consistent with NEI 12-06 Section 3.2.2.5 robust water sources have been identified in plant procedures and prioritized by water quality.

3.11 Shutdown and Refueling Analyses

This order requires that licensees must be capable of implementing the mitigation strategies in all modes. In general, the discussion above focuses on a BDBEE occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When 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 (RCIC or HPCI) to provide the water initially needed for decay heat removal. During shutdown and refueling typically one of three general plant configurations exist:

1) Plant is shutdown with the reactor and steam system intact-from this configuration the plant response would be similar to power operation except that it would progress much slower as reactor decay heat is much lower and significant time would be required for the reactor to heat up to the point where pressure reduction via SRVs would be required and still longer before RCIC would need to operate to maintain water level. No change in mitigating strategies is needed for this condition.

2) Plant is in cold shutdown with reactor and steam system disassembled with the reactor cavity not flooded and not connected to the fuel pool-this configuration would likely be the most limiting of the shutdown and refueling configurations, but is still expected to be less challenging than power operation. Decay heat in the reactor would be substantially lower than during power operation. If an ELAP event occurred from this configuration, the reactor water temperature would slowly increase until significant evaporation and boiling commenced. At that point water level in the reactor would slowly decrease. Many hours would be available for operators to respond to this condition with FLEX equipment to restore water level. During refueling activities substantial staffing is always available to assist in plant activities.

3) Plant is in cold shutdown with reactor and steam system disassembled with the reactor cavity flooded and connected to the fuel pool or fuel entirely moved to fuel pool-this configuration is substantially less challenging than the previous configuration or power operation as substantial water inventory is present and therefore response time is not as challenging. A full core off load is the most challenging configuration for the spent fuel pool. If all of the fuel has been placed in the SFP, there may be a shorter timeline to implement the makeup of water to the SFP. However, this is balanced by the fact that no cooling is required for the reactor vessel, the operators can concentrate on providing makeup to the SFP. As noted in UFSAR Section 9.1.2.3.2 (Reference 103), for the design bases full core offload to the SFP, about 45 hours are available to implement makeup before boil-off results in the water level in the SFP dropping far enough to uncover fuel assemblies following a loss of cooling. The analysis supporting this conservatively assumes the maximum fuel storage allowed by the license; even though substantially less rack space is currently installed (Reference 67). Operators can readily implement makeup to the SFP well within 45 hours.

On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown/Refueling Modes" (Reference 42), which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 (Reference 12), the NRC staff endorsed this position paper as a means of meeting the requirements of the order.

The position paper describes how licensees will maintain FLEX equipment either available for deployment in shutdown and refueling modes, or pre-stage certain equipment. Those plant procedures that are used to respond to loss of cooling in these modes will incorporate FLEX equipment where appropriate. The NRC Staff concluded that the position paper provides an acceptable approach for demonstrating that licensees are capable of implementing mitigating strategies in shutdown and refueling modes of operation. In the six month update letter dated February 24, 2014 (Reference 11), DAEC informed the NRC Staff of its plans to follow the guidance in this position paper. The NextEra Fleet procedure for Shutdown Risk Management, OM-AA-101-1000 (Reference 143) reflects this industry guidance.

3.12 Programmatic Elements

3.12.1 Procedures

Operators will initially respond to a loss of AC power using AOP 301.1 (Reference 111). Loss of normal access to the ultimate heat sink without a loss of AC power is addressed in AOP 410 (Reference 113). The site Emergency Management Guideline (Reference 107) provides the emergency coordinator a broad overview of various procedures that may be needed. Emergency Operating Procedures cover key plant safety response actions (Reference 108, 109, and 110). Response to external events is described in abnormal operating procedures for Earthquake, Flooding and Adverse Weather events (References 115, 116, and 117). FLEX Support Guidelines (FSGs) detailing how to use portable equipment to support the higher tier procedures discussed above are implemented at DAEC via an existing category of procedures called Severe Accident Management Procedures (SAMPs). SAMPs can be used at any time when directed by the Emergency Coordinator when the design bases of the plant are challenged due to external events.

The FLEX procedures (SAMPs) were designed with regard to off-normal conditions such as reduced instrumentation, loss of normal lighting, lack of normal ventilation and hampered communications. These issues were taken into account during the procedure development process and enhancements were made to the procedures during the validation and verification process to ensure FLEX strategies will be able to be implemented with minimal potential for personnel error. The skill-set needed to implement FLEX strategies are at the employee worker level. Tasks require coordination between individuals or teams for completion of a task or subtask. The method of communication for coordination of an action via redundant means (radio, face-to-face, use of messengers, satellite phones) provides increased confidence that coordination efforts will be successful. Validation of the ability to communicate was also performed. Procedures exist for each FLEX strategy. The procedures include directions for what to monitor, specific cues or indications for decision making are identified and are readily available to the user. The procedures contain drawings or pictures where appropriate. The procedures and/or attachments are written at a sufficient level of detail for the user and will be readily understood in the circumstances where they are expected to be used. The procedures and attachments were validated as part of the plant's normal procedure development process. During a BDBEE condition there will be an expected impact due to the pressure and stress of the event. Provisions are built into the overall preparation of the FLEX response strategies (as detailed in in NEI 12-06), where considerations in the design inputs of the modification processes, equipment selection, audit process, training, standardized connections, labeling and placards provide a sound foundation for limiting any additional stress on the individuals performance. The use of special equipment in the FLEX strategies is minimal. Equipment operating instructions are printed on weather-proof placards with a standardized font for ease of readability.

Environmental factors and conditions such as inclement weather and darkness were considered for the deployment and operation of FLEX equipment. The environmental impact of darkness, wind, and rain is addressed by personal protective equipment, hand-held flashlights, portable lighting, and lighting on the deployment equipment and the FLEX portable equipment (Reference 130). Safe Shutdown Lights, where needed, will remain functional. In addition, human factor aids (labeling, color coding, placarding, etc.) limit the impact of darkness. Sufficient margin is available in each of the strategies to account for adverse conditions.

The FLEX strategies consider environmental conditions expected to result from an ELAP and ensure that required areas are accessible. These strategies were tested and timed, where applicable, during the Duane Arnold Energy Center validation and verification process (Reference 148).

3.12.2 Staffing

DAEC performed an assessment of the capability of the Duane Arnold Energy Center (DAEC) minimum on-shift staff and augmented Emergency Response Organization (ERO) to respond to a beyond design basis external event (BDBEE) in response to the NRC request for information under NTTF Recommendation 9.3 (Reference 6).
The assumptions for the staffing study are based on accepted industry guidance (Reference 37) and postulate that the BDBEE involves a large-scale external natural event that results in:

A. An extended loss of AC power (ELAP)
B. An extended loss of the ultimate heat sink (LUHS)
C. Unit in operation at the time of the event
D. Impeded access to the unit by off-site responders as follows:
   - 0 to 6 hours post event – No site access. (Initial Phase)
   - 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). (Transition Phase)
   - 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. (Final Phase)

The on-shift staffing analysis concluded that there were no task overlaps for the activities that were assigned to the on-shift personnel. No additional shift staffing is necessary to implement the mitigating strategies for DAEC. The evaluation utilized the minimum E-plan on-shift staff from Operations, Radiation Protection, Chemistry, Fire Brigade and Security to accomplish all applicable event response tasks. The results of the staffing study were submitted to the NRC under Reference 34.

3.12.3 Training

DAEC training program was revised to assure personnel proficiency in the mitigation of BDBEEs is adequate and maintained. These programs and controls were developed and have been implemented in accordance with the Systematic Approach to Training (SAT) process.

Initial training has been provided and periodic training will be provided to site emergency response leaders on 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, instructions, and mitigating strategy time constraints (Reference 145).

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 have been similarly weighted. Response personnel's training includes familiarity with equipment from the NSRC.

"ANSI/ANS 3.5, Nuclear Power Plant Simulators for use in Operator Training" certification of simulator fidelity is considered to be sufficient for the initial stages of the BDBEE scenario until the current capability of the simulator model is exceeded. Full scope simulator models will not be upgraded to accommodate FLEX training or drills.

Where appropriate, integrated FLEX drills will be organized on a team or crew basis and conducted periodically; with all time-sensitive actions to be evaluated over a period of not more than eight years. It is not required to connect/operate permanently installed equipment during these drills (Reference 139).

3.12.4 Equipment Maintenance and Testing

DAEC will maintain the onsite FLEX equipment with preventive maintenance and testing based on generic EPRI industry program for maintenance and testing of FLEX equipment (Reference 52) as described in NEI 12-06 Section 11.5. The generic guidance has been incorporated in NextEra fleet procedures (Reference 138) and site specific preventive maintenance tasks are specified consistent with this guidance (Reference 139)

3.12.5 Administrative Controls

DAEC has established an overall FLEX program document (Reference 139) that contains a historical record of the strategies, basis for changes, and a basis for preventive maintenance and testing performed on FLEX equipment. Administrative controls have been established to control the out of service time allowed for FLEX equipment (Reference 140). The design modification control process has been revised to include screening all modifications for potential impact on FLEX strategies (Reference 144).

3.13 Communications

NRC NTTF Recommendation 9.3 (Reference 6) requested power reactor licensees to evaluate potential improvements to power communications equipment during a prolonged SBO. By letter dated October 31, 2012 (Reference 15) DAEC submitted an evaluation of the DAEC communications capabilities and identified opportunities for enhancements. By letter dated June 6, 2013 (Reference 18) the NRC staff accepted the DAEC assessment. The DAEC FLEX strategies do not rely on continuous communications.

Consistent with the DAEC Communications Assessment, the following enhancements have been completed for DAEC site emergency communications:

- 24 two way radios have been purchased and are kept in the Control Room with their chargers. These radios have capability of transmitting and receiving with or without a repeater to provide communication for plant operations.
- Portable satellite phones have been purchased for emergency off site communications. Two portable satellite phones and spare batteries are stored in the Control Room. Six additional portable satellite phones are stored in the Technical Support Center/Operational Support Center Emergency Facility.
- The satellite system using desk phones has been upgraded with a 24 hour UPS to allow them to operate for 24 hours after the loss of AC power.
- Government Emergency Telecommunications Service (GETS) and Wireless Priority Service (WPS) cards have been obtained for critical wired and wireless communication links.
- FLEX 6KW Portable Generators have been purchased and are stored in the Emergency Response Buildings. There are 3 generators stored in each building, one of which can be used to provide power for recharging the two way radio and portable satellite phone batteries (Reference 112).

3.14 Conclusions for Order EA-12-049

Based on the evaluations above DAEC has developed guidance to maintain or restore core cooling, SFP cooling, and containment following a BDBEE which will adequately address the requirements of Order EA-12-049. The DAEC program is consistent with NEI 12-06 with no required alternatives to this guideline.

4.0 Technical Evaluation of Order EA-12-051 for Reliable Spent Fuel Pool Instrumentation

4.1 Levels of Required Monitoring

Three Spent Fuel Pool levels were identified in the Overall Integrated Plan for reliable spent fuel pool instrumentation (Reference 17) as the required measurement range for indication. These consist of the level required for normal Spent Fuel Pool cooling function (Elevation 853' 8"), the level required to provide approximately 10 feet of water shielding above the spent fuel (Elevation 841'5") and the level where fuel remains covered (Elevation 832' 7 ⅜"). For human factors purposes the control room display of the level instruments are scaled with reference to the bottom of the spent fuel pool rather than by elevation for consistency with existing narrow range spent fuel pool instruments and associated existing Technical Specification requirements for maintaining normal spent fuel pool level.

4.2 Design Features of Spent Fuel Pool Instrumentation

4.2.1 Instruments

The new spent fuel pool level indication consists of two independent channels of guided wave radar probes that are permanently installed to detect the water level inferred from the reflection of the electromagnetic energy (Reference 57). Instrument design and installation implements guidance provided in NRC and NEI guidance (References 9 and 38).

4.2.2 Arrangement

The spent fuel pool level instruments are located at opposite corners of the spent fuel pool and cable routes have been kept independent and separated by at least the shortest length of the spent fuel pool (20 feet) per NEI 12-02 guidance (Reference 38). Detector elevation encompasses the range of water level in the pool required to be monitored. Power supplies and transmitter electronics are located remotely to minimize exposure to radiation, moisture and high temperature conditions expected near the spent fuel pool.

4.2.3 Mounting

The spent fuel pool level instrument mounting brackets were evaluated by the vendor in accordance with requirements that bound the DAEC design bases earthquake (Reference 77) and hydrodynamic loads associated with pool sloshing (Reference 78). A Duane Arnold site specific calculation (Reference 71) established mounting bracket anchorage requirements.

4.2.4 Qualification

The spent fuel pool level instrumentation quality and expected reliability has been demonstrated by design, analysis, operating experience and testing with environmental conditions bounding the DAEC spent fuel pool area following an extended loss of all AC power with the concurrent loss of spent fuel pool cooling and loss of normal ventilation (Reference 57).

4.2.5 Independence

The spent fuel pool level instrument primary channel components have been constructed and arranged to be redundant and independent of the backup channel through separation of sensors, power supplies and cabling (Reference 57).

4.2.6 Power Supplies

Two independent power sources are used for powering the new SFP instrumentation system. Existing branch circuits in panel 1Y11 and 1Y21 are used to power the level instruments. Panels 1Y11 and 1Y21 are alternate divisions of the Instrument AC power supply and the loss of one of these distribution panels will not result in the loss of both channels. During a BDBEE, each channel has an independent battery system which will supply the level instrument channel with at least three (3) days of power. Repowering of 1Y11 and 1Y21 via portable diesel generators are included in the FLEX coping strategies (References 126 and 129).

4.2.7 Accuracy

The spent fuel pool level instruments have a specified accuracy of +/- 3 inches of level (Reference 57) and will maintain that accuracy following an AC power interruption without recalibration. Operating procedures direct operator actions consistent with the specified accuracy of the indication (References 110 and 114).

4.2.8 Testing

Factory Acceptance Testing and on-site Modification Acceptance Testing were performed for function and calibration of the new spent fuel pool instruments (Reference 57). Periodic functional and calibration surveillance procedures have been established (References 146 and 147).

4.2.9 Display

The primary and backup level instrument displays are located in the the Control Room. The Control Room is in a structure protected from the defined external hazards for Duane Arnold. Personnel will be stationed in the Control Room during a BDBEE such that the displays are in a habitable environment, will be readily accessible and will be monitored periodically.

4.3 Programmatic Controls for Spent Fuel Pool Instrumentation

4.3.1 Training

The training impact of the new spent fuel pool instruments was reviewed in accordance with the systematic approach to training for station personnel. Training program changes were implemented consistent with these impact reviews. Personnel were trained on provisions for providing alternate power to the spent fuel pool instruments (Reference 145).

4.3.2 Procedures

Maintenance and testing procedures (Reference 146 and 147) have been established for the new spent fuel pool instruments. Emergency Operating Procedures (Reference 110) and Abnormal Operating Procedures (Reference 114) have been established to give guidance on operational response to changes in spent fuel pool level indicated on the new spent fuel pool instruments. FLEX procedures have been established for repowering the instruments within 72 hours

(References 126 and 129). Changes to these procedures are controlled under the site procedure control program.

4.3.3 Administrative Controls

Site processes have been established to ensure instruments are maintained at their design accuracy. Administrative controls have been established to control the out of service time allowed for spent fuel pool instruments (Reference 140). The design modification control process has been revised to include screening all modifications for potential impact on FLEX strategies (Reference 144).

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Attachment A-Installed Plant Equipment Credited For FLEX

System	Function	Robustness and Availability
Reactor Core Isolation Cooling (RCIC)	Provides the primary means for reactor vessel inventory control during Phase 1. In the event RCIC is unavailable, HPCI can be used as an alternate.	RCIC is a seismically qualified system (Reference 75) housed in a Class 1 structure (Reactor Building). The normal water source is the Condensate Storage Tanks (CSTs). The CSTs are not protected from tornado missiles and therefore may not be available for that extreme external event. Equipment required for transfer of the suction path from the CSTs to the Suppression Pool is protected from external hazards. The suppression pool provides an alternate water source to the RCIC system. Suppression pool temperatures will rise above the normal operating design temperature for RCIC suction as a result of the ELAP and as the suppression pool temperatures rise reliability of RCIC is expected to decrease. While operating experience (Reference 47) indicates RCIC may operate with suppression pool temperatures as high as 300 degrees Fahrenheit, above 250° F the operating conditions are considered sufficiently challenging that for purpose of this analysis RCIC is assumed to fail. Room temperatures in the RCIC room during ELAP have been evaluated and found to be acceptable for the equipment in the area (Reference 64). Room temperatures will remain below 125° F and the RCIC system is rated to ambient conditions of 148°. No operator actions are required in the RCIC room. The RCIC system relies on 125 VDC for control power which remains available throughout the ELAP event as discussed below.

System	Function	Robustness and Availability
High Pressure Coolant Injection (HPCI)	Assists RCIC in initial recovery of reactor vessel inventory following the initial loss of AC power. Acts as a backup to RCIC in the event RCIC is unavailable at any time during the ELAP response.	HPCI is a safety related system designed for the assumed external hazards. The normal water source is the Condensate Storage Tanks (CSTs). The CSTs are not protected from tornado missiles and therefore may not be available for that extreme external event. The suppression pool provides an alternate water source to the HPCI system. Suppression pool temperatures will rise above the normal operating design temperature for HPCI suction as a result of the ELAP and as the suppression pool temperatures rise reliability of HPCI is expected to decrease. When RCIC is available HPCI would not be used beyond the initial inventory recovery as HPCI is oversized for the makeup requirements expected. Operators would secure HPCI unless it was needed. From the standby condition, it is not anticipated that increasing suppression pool temperatures would degrade HPCI reliability. If RCIC fails due to elevated suppression pool temperatures, it is expected that HPCI would reliably operate at least initially with the elevated temperatures from the standby condition. Given the relatively large size of HPCI (3000 GPM) vessel level recovery could be achieved with only a few minutes of operation at the elevated suppression pool temperatures but subsequently HPCI would be subject to similar failure mechanism as RCIC. For purposes of the FLEX timeline, no credit is taken for use of HPCI after failure of RCIC due to high suppression pool temperature. Room temperatures in the HPCI room during ELAP have been evaluated and found to be acceptable for the equipment in the area (Reference 64). The HPCI system relies on 250 VDC for control power and availability of that system is discussed below. The independence of control power between HPCI and RCIC adds additional overall reliability.
125 VDC	Provides power to RCIC, Safety Relief Valves (SRVs) and key instrumentation used for decision making.	125 VDC Batteries are safety related, housed in a Class 1 Structure and as such are protected from applicable external hazards. The design bases for 125 VDC is to provide a minimum of 4 hours of battery capacity. Under ELAP conditions this time can be extended using aggressive load shedding (Reference 111). With the expected load shedding the batteries have been shown to be capable of powering key equipment for a minimum of 8 hours on 1D1 and 10 hours on 1D2 (Reference 59).
250 VDC	Provides power to HPCI and motive	250 VDC Batteries are safety related, housed in a Class 1 Structure and as such are protected from

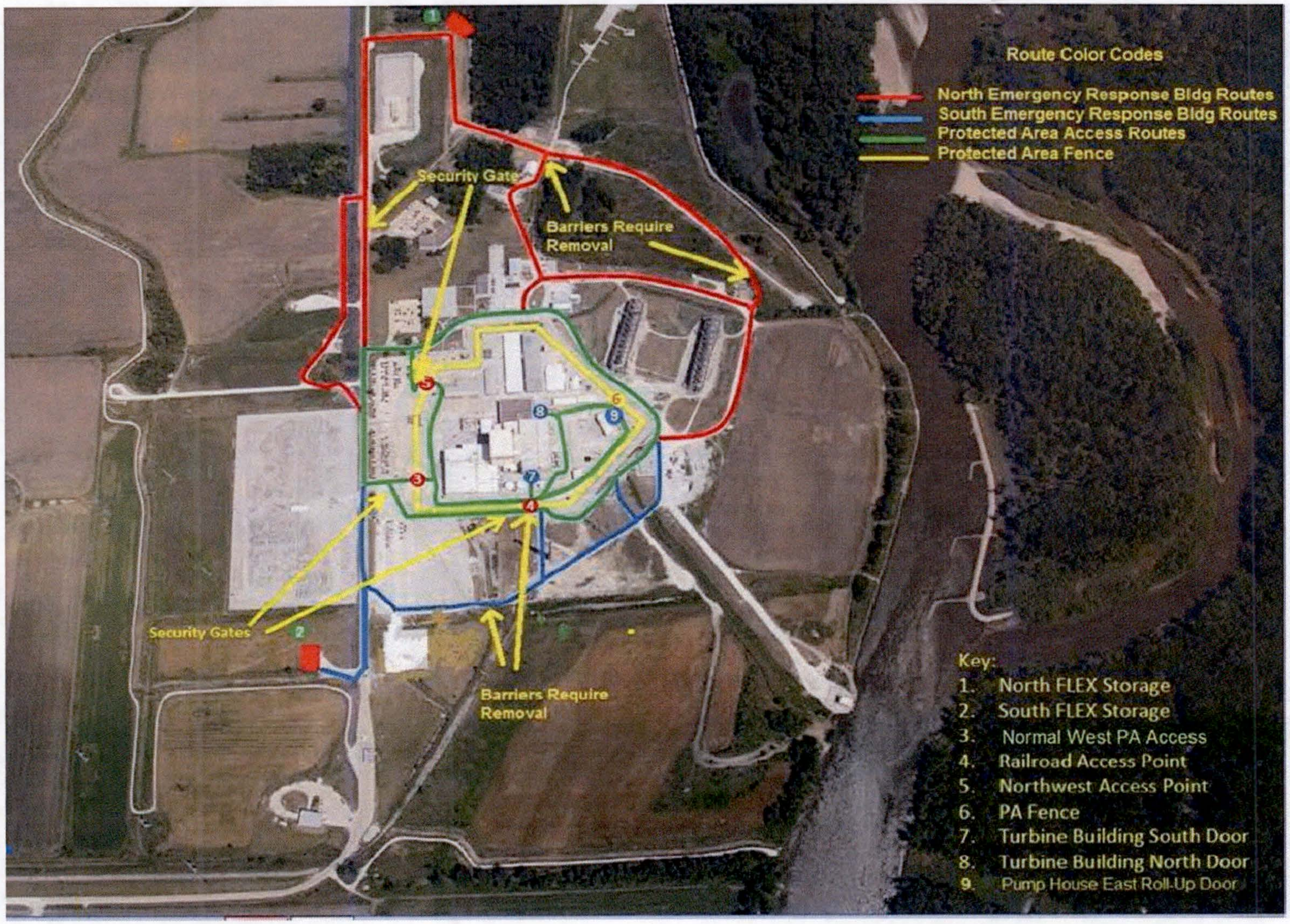
System	Function	Robustness and Availability
	power to some containment isolation valves.	applicable external hazards. The design bases for 250 VDC is to provide a minimum of 4 hours of battery capacity. Under ELAP conditions this time can be extended using aggressive load shedding (Reference 111). With the expected load shedding the batteries have been shown to be capable of powering key equipment for a minimum of 10 hours (Reference 59).
Safety Relief Valves (SRV) including nitrogen accumulators	Controls reactor pressure within specified limits during initial response to a loss of AC power. SRV functionality is required to allow the transition to Phase 2 of core cooling as the reactor must be sufficiently depressurized to allow portable low-head pumps to inject water to the RPV.	The SRVs are safety related equipment housed in a Class 1 Structure (Drywell) and as such are protected from applicable external hazards. SRVs are powered by 125 VDC discussed above. Pneumatic supplies for the SRVs include four 200 gallon safety related accumulators that are substantially oversized (Reference 65) for the FLEX use such that pneumatic supplies do not restrict SRV use under the FLEX strategies. SRV solenoids were tested for environmental conditions significantly hotter than are projected in the Drywell during an ELAP (Reference 82). After the initial pressure response, only one SRV would be required to allow control of the RPV or to allow the transition to Phase 2 use of portable pumps. The six installed SRVs with four independent pneumatic accumulators provide redundancy and a high reliability for this function. Each pneumatic accumulator is nominally sized at 200 gallons (757,000 cubic centimeters). Cycling an SRV requires approximately 492 cubic centimeters of gas, therefore, pneumatic supply does not restrict planned use of the SRVs for FLEX strategies.
Low-Low Set Logic (LLS)	Controls safety relief valves in initial response to reactor pressure vessel isolation to limit stresses on SRV tail pipes. Shortly after initial operation the LLS logic will not be needed for the FLEX strategies.	The LLS logic is safety related and housed in a Class 1 structure and as such is protected from applicable external hazards.
Control Rod Drive (CRD) System and Hydraulic Control Units (HCU)	Ensures reactor is shutdown as an immediate response to loss of AC power. Once shutdown, the reactor will remain shutdown regardless of the status of AC power.	The CRD system is safety related and housed in a Class 1 structure and as such is protected from applicable external hazards.

System	Function	Robustness and Availability
Reactor Protection System (RPS)	Ensures reactor is shutdown as an immediate response to loss of AC power. Once shutdown, the reactor will remain shutdown regardless of the status of AC power. RPS power also supplies instrumentation in portions of the containment isolation logic. However, these instruments trip (i.e. fail safe) on loss of RPS power.	The RPS system is safety related and housed in a Class 1 structure and as such is protected from applicable external hazards.
Condensate Storage Tanks (CST)	Provides the preferred initial water inventory for RCIC and HPCI make-up to the RPV.	CSTs are not fully protected from external hazards such as tornado missiles. If the CSTs are unavailable, the suppression pool will be the credited source of water inventory. The instrumentation, logic, and associated motor operated valves to switch the source of pump suction from the condensate storage tanks to the suppression pool are powered by station batteries and are protected from external hazards.
Torus (Suppression Pool) and Containment Structure	Provides protected source of water inventory for RCIC and HPCI in the event the CSTs are not available. Provides a suppression pool for SRV discharge. Provides the primary containment function.	The Torus and Containment Structure are safety related and are protected from applicable external hazards. Modifications to the venting capability for the Torus under Order EA-13-109 (Reference 7) ensure the torus and containment structure remain functional during an ELAP.
Nuclear Boiler and Main Steam	Provide a source of steam to the HPCI and RCIC turbines and maintains the floodable volume for core cooling. The nuclear boiler and main steam system do not limit the coping duration for core cooling under the FLEX strategies.	The Nuclear Boiler and Main Steam are safety related and housed in a Class 1 structure and as such are protected from applicable external hazards.
Nuclear Steam Supply	Isolates the primary reactor coolant system as an	The NSSS and PCIS systems are safety related and housed in a Class 1 structure and as such are protected from applicable external hazards.

System	Function	Robustness and Availability
Shutoff (NSSS) and Primary Containment Isolation Systems (PCIS)	immediate response to the loss of AC power. Once isolations are complete no further action is required by the NSSS or PCIS system and the NSSS system will not affect the core cooling coping time.	
Main Steam Isolation Valves (MSIV)	Isolates the main steam lines as an immediate response to the loss of AC power. Once isolations are complete no further action is required by the MSIVs and the system will not affect the core cooling coping time.	The MSIVs are safety related and housed in a Class 1 structure and as such are protected from applicable external hazards.
Residual Heat Removal (RHR)	Provides primary and alternate connection points for FLEX portable pumps to provide water to either the Reactor or the Spent Fuel Pool during Phase 2 of FLEX strategies.	The RHR system is safety related and housed in a Class 1 structure and as such is protected from applicable external hazards. For FLEX Phase 2 functions, operators will need to be able to access the connection points in either the South East corner room or the torus area and manually open applicable injection valves in the RHR valve room (References 120 and 123).
River Water Supply (RWS)	Provides normal access to the Ultimate Heat Sink (Cedar River). During an ELAP/LUHS the installed pumps are not available. During Phase 3 the RWS piping provides one flow path for NSRC portable equipment to replenish water inventories (Reference 132).	The River Water Supply system is safety related and housed in a Class 1 structure and as such is protected from applicable external hazards. Piping connecting the RWS pumps to the pump house is also safety related and buried underground.

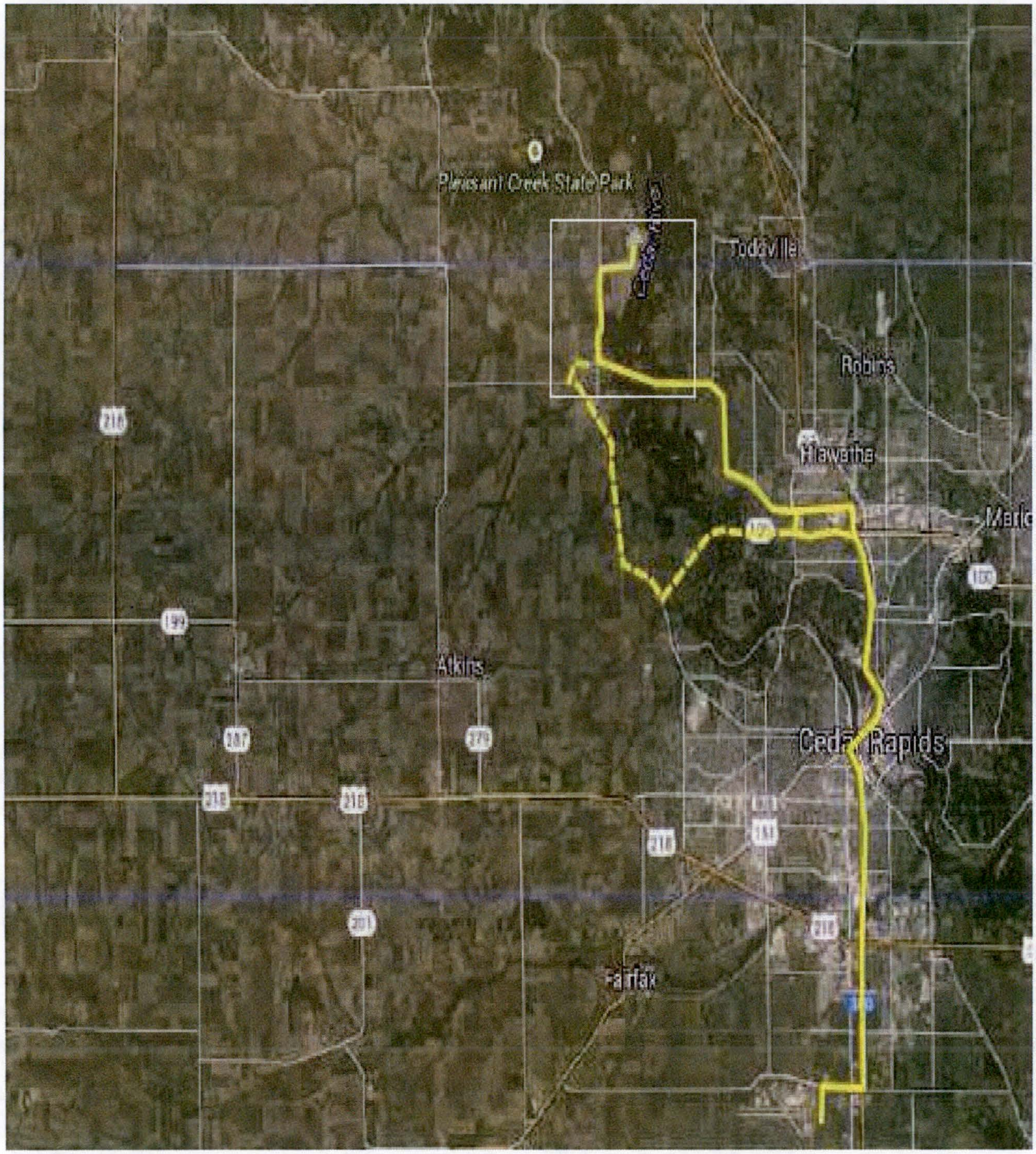
System	Function	Robustness and Availability
Circulating Water Storage Pit	Provides a raw water inventory for FLEX portable pumps during Phase 2 of FLEX strategies and a basin for Phase 3 strategies to replenish water inventories.	The circulating water storage pit is a concrete structure built to robust seismic standards (Reference 100). The circulating water storage pit is robustly designed for seismic conditions as discussed in UFSAR section 3.8.4.3.3 as it shares common construction with the adjacent safety related essential service water storage pit. Circulating Water piping connected to the circulating water storage pit was evaluated and confirmed to be seismically robust in Reference 106. The pit is located below grade and is thus protected from high wind events and combined with its large thermal mass is protected from high and low temperature conditions. When the inventory is depleted, equipment from the Regional Response Center can replenish the water inventory as needed (Reference 132).
Main Condenser Hotwell	Provides a water inventory for FLEX portable pump during flood conditions. Pump is staged in south Turbine Building rail bay.	The main condenser is located in the lower level of the Turbine Building. A connection point for portable pump suction from the Hotwell is located inside the Turbine Building and accessible throughout an external flood event. As described in UFSAR Section 3.8.4.3.3, the Turbine Building is robustly designed. Although the Turbine Building, with the exception of that portion which houses the emergency diesel generators, is classified as Non-seismic, the criteria for Seismic Category I structures were used for the structural design of the entire building. A complete dynamic analysis has been conducted for the Turbine Building to ensure the integrity of Seismic Category I equipment within the building and Seismic Category I equipment and structures adjacent to it. The condenser hotwell is located below grade, and within substantial concrete shield walls (heater bay walls); this provides significant protection from high winds and wind generated missiles. Also, based on the location within the Turbine Building, the condenser would not be adversely affected by high and low temperature conditions. When inventory is depleted, water can be replenished from the CSTs, circulating water pit, or river (Reference 132).

Attachment B-FLEX Storage and Deployment Routes

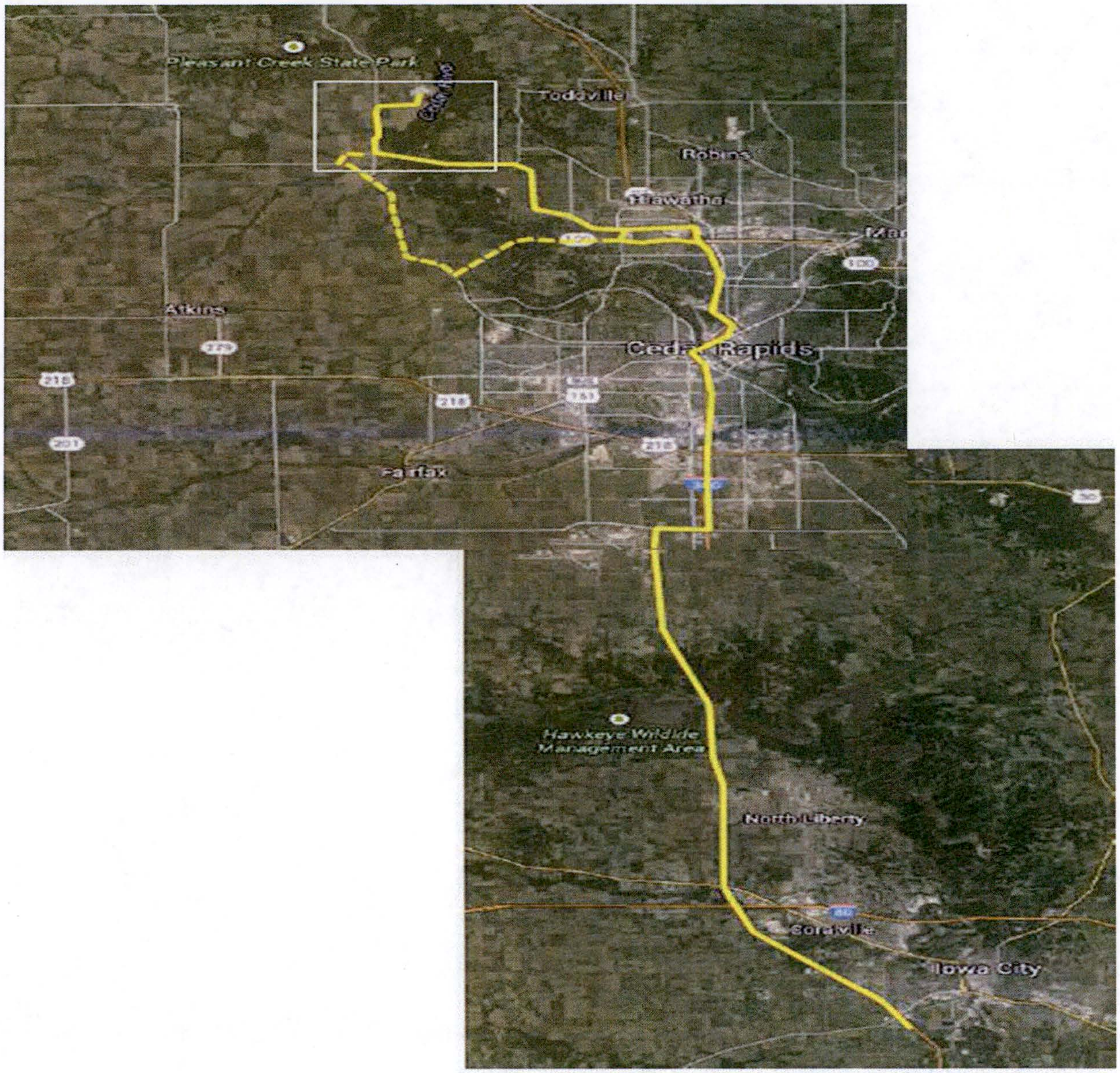


Attachment C-Regional Response Center Staging Areas

Primary Offsite Stating Area-Cedar Rapids Airport



Alternate Offsite Staging Area-Iowa City Airport



Attachment D-On Site Portable Equipment for Primary FLEX Strategies

Equipment*	Nominal Capacity	Quantity	Comments
Diesel Driven Pump	1000 GPM @ 400 foot head	2	Portable pumps used for water supply to reactor vessel and spent fuel pool. One stored in each Emergency Response Storage Building.
480 Volt Diesel Generator	405 KW	2	480 Volt generators for charging 125 VDC batteries. Can be used for charging 250 VDC batteries or other 480 Volt uses. One stored in each Emergency Response Storage Building.
120 Volt / 240 Volt Diesel Generator	6 KW	6	Portable generators for charging communications equipment, backup instrument power or other 120 volt / 240 volt uses. Three in each building.
Tow Vehicle	Ford F-550	2	One stored in each Emergency Response Storage Building for transport of FLEX equipment.
Backhoe	Case 580N (6800 LBS. Lift)	2	One stored in each Emergency Response Storage Building for debris removal.
Fuel Oil Transport Trailer	900 Gallons	2	One stored in each Emergency Response Storage Building for refueling portable equipment.

*Additional equipment including hose trailers, electrical cables, connections and tools are stored in each Emergency Response Building sufficient to allow connection of portable equipment to plant connection points and to provide defense in depth options to the primary FLEX strategies.

Attachment E-Regional Response Center Equipment

Equipment/Function	Nominal Capacity
4160 Volt Generators	2@1 MW
480 Volt Generator	1000 kW
Medium Flow Pump	2500 GPM @ 300 PSI
High Flow Pump	5000 GPM @ 150 PSI
RPV Makeup Pump	500 GPM @ 500 PSI
High Pressure Injection Pump	60 GPM @ 2000 PSI
Lighting Towers	440,000 Lumens
Diesel Fuel Transfer (Air Lift)	500 Gallon
Diesel Fuel Transfer Tank Trailer	264 Gallons
Portable Fuel Transfer Pump	60 GPM
Electrical Distribution System	4160 V, 250 MVA, 1200 A

Attachment F-Timeline for FLEX Strategies

Table F-1 FLEX Response Times from 100% Power			
Elapsed Time	**Action**	**Time Sensitive Operator Action**	**Remarks / Applicability**
0	Event Starts. All off site AC power and installed diesel generators fail.	N	Plant @100% power
0-2 min	Automatic Plant Response	N	Consistent with UFSAR 15.3.2 (Reference 104) Reactor scrams, primary containment isolation Groups 1-5 occur, Safety Relief Valves (SRVs) and Low-low set control reactor pressure, RCIC and HPCI initiate to control reactor water level. Following initial reactor vessel level recovery HPCI is secured and RCIC is the preferred make up system.
30 min	Controlled Reactor Depressurization	N	Operators initiate a controlled reactor depressurization using SRVs. Sufficient pressure is maintained for steam driven systems (RCIC/HPCI) to operate (Reference 111).
60 min	Open required cabinets and doors in control building.	Y	Opening cabinets and doors to maintain adequate area cooling to ensure necessary equipment is maintained functional (Reference 111).
2 hours	Operators complete load shedding of non-critical loads on station batteries.	Y	Removing non-critical loads extends battery availability beyond 8 hours (Reference 111)
2 hours	Fire Brigade performs damage assessment and determines preferred portable equipment deployment route. Debris removal activities as needed on the selected route are expected to be performed subsequent to the damage assessment (Approximately two additional hours).	N	Timing of this activity is to support later time sensitive actions and may vary based on nature of possible external event (Reference 128).

Table F-1 FLEX Response Times from 100% Power			
Elapsed Time	**Action**	**Time Sensitive Operator Action**	**Remarks / Applicability**
7.5 hours	Prior to the loss of all steam driven reactor vessel make up, align a portable diesel driven pump to inject water to the reactor.	Y	Steam driven systems may be available for substantially longer periods of time, however if suction source is the suppression pool, increasing temperatures reduces system reliability and for analysis purposes this evaluation assumes they become unavailable for extended operation at 250 degrees (Reference 120).
7.5 hours	Manually depressurize the reactor using SRVs to allow low pressure injection.	N	Depressurizing the reactor sufficiently to allow low pressure injection can be completed by simple opening of a single SRV from the control room. Actual timing of this action will be determined by the operator when transition to portable pumps of Phase 2 is desired (Reference 108).
8 hours	Prior to depletion of station safety related batteries use a portable diesel generator to supply power to station battery chargers. Division 1 (1D1) of 125 VDC supplies power to RCIC and may be depleted shortly after 8 hours. Division 2 of 125 VDC (1D2) and the 250VDC battery (1D4) are expected to last at least 10 hours. The HPCI system control power is from 1D2, and motive power is from 1D4; HPCI provides a backup to the RCIC system. SRVs can be operated from either division of 125 VDC.	Y	Ensures control power is available to RCIC, HPCI, and SRVs (Reference 126).
4-72 hours	Prior to significant accumulation of moisture on the refuel floor due to increasing fuel pool temperature and	N	Actual timing of this will vary with fuel loading in the pool and time since discharge. The vent control is accessible

Table F-1 FLEX Response Times from 100% Power			
Elapsed Time	**Action**	**Time Sensitive Operator Action**	**Remarks / Applicability**
	evaporation, open refuel floor vent and establish reactor building ventilation.		outside the fuel pool area. The more rapid scenarios for fuel pool temperature rise are associated with full core off loads where no fuel is in the vessel and previously listed actions for the reactor would not be applicable (Reference 133).
16- 24 hours	Prior to portable equipment fuel depletion initiate re-fueling.	Y	Actual timing of refueling will vary with timing of use of portable equipment and how heavily loaded but based on typical consumption rates of portable equipment refueling is not expected to be required in the first 16 hours (Reference 124).
4-13 hours	Prior to exceeding containment limits, vent the containment through hardened suppression pool vent.	Y	The primary containment can be preserved by venting the containment within approximately 13 hours. Margins to containment limits and challenges to RCIC and HPCI are improved by use of anticipatory venting earlier in the event as directed by EOPs (Reference 109 and 136)
16 hours	Establish charging capability for batteries in portable communications equipment.	N	DAEC FLEX strategies do not rely on continuous communications, however, during the DAEC assessment of communications under NRC recommendation 9.3, it was identified that portable communication equipment could be enhanced by establishing a method to recharge batteries (Reference 112).
45+ hours	Prior to spent fuel pool water level decreasing to the top of spent fuel, initiate make-up to the pool using a portable diesel driven pump.	Y	Existing analysis of loss of spent fuel pool cooling under conservative assumptions indicates that a minimum of 45 hours is available prior to water

Table F-1 FLEX Response Times from 100% Power			
Elapsed Time	**Action**	**Time Sensitive Operator Action**	**Remarks / Applicability**
			level decreasing to the top of stored fuel. Cycle specific evaluations of heat loads are performed and incorporated in operating procedures that provide operators specific guidance on available response time (References 110, 114, 121 and 123).
24-72	Supplement on site equipment with equipment from the Regional Response Center (NSRC).	N	An extended loss of AC power can be mitigated using a combination of installed equipment and portable equipment that will be stored on site. The NSRC equipment provides a reliable back up to this on site equipment for extended operation. This will provide added assurance that consumables are replenished including fuel oil and water inventories (Reference 135).

Table F-2 Flood Timeline			
Elapsed Time	**Action**	**Time Sensitive Operator Action**	**Remarks / Applicability**
0	Extreme Rainfall Event Occurs and Abnormal Operating Procedure for Flood (Reference 116) entered due to flash flood warnings.	N	Maximum site flooding from Flood Hazard re-evaluation report (Reference 22) is projected to occur if an extreme rainfall event occurs with an extreme snow pack present over the Cedar River basin.
3 days	FLEX Portable Equipment from South Emergency Response Building moved inside the Turbine building.	N	Equipment is staged inside Turbine building prior to closing final flood door.
3 days 16 hours	Plant is shutdown, final flood barriers installed and Turbine Building flood door closed.	Y	Time sensitivity is to ensure preparations are complete prior to water reaching plant grade and impeding work (Reference 36).
4 days 17 hours	Flood water level reaches plant grade. ELAP is assumed to occur.	N	Lower decay heat and initial reactor coolant temperature substantially slows the transient compared to ELAP from 100% power.
4 days 18 hours	Initial response to loss of power completed and reactor begins slow heat up until pressure increases sufficiently for RCIC to be used for RPV level control and inventory to be lost from SRV operation.	N	Time to reach SRV setpoint depends on initial coolant temperature and RCIC status. Flood procedure (Reference 116) directs placing plant in cold shutdown but reactor may not have fully reached cold shutdown by the time assumed for the ELAP.
5 days	FLEX injection source from the hotwell to the RPV using portable pump.	N	No time limit exists for this action. RCIC can operate indefinitely with suction from the CSTs. Use of FLEX portable pump from the hotwell provides FLEX capability accessible under flood conditions if RCIC is lost for any reason (Reference 120).
5 days 1 hour	Station battery chargers aligned to 480 volt FLEX generator.	Y	Battery chargers must be established prior to depletion 8 hours after ELAP (Reference 126).

Table F-2 Flood Timeline			
Elapsed Time	**Action**	**Time Sensitive Operator Action**	**Remarks / Applicability**
6 days 1 hour	Vent the primary containment through torus vent.	Y	Time listed is the earliest containment pressure could reach 53 PSIG if ELAP starts from hot shutdown (Reference 136).
6 days 13 hours.	Peak flood height reached.	N	Time from Flood Hazard re-evaluation report (Reference 22).
6 days 14 hours	Make up to the spent fuel pool is aligned.	Y	Limiting case for full core off load. Spent fuel pool makeup (Reference 121 and 123) must start within 45 hours after ELAP (Reference 67). Cycle specific times may allow much longer depending on spent fuel pool loading (Reference 114). Venting of the reactor building is required if pool is boiling (Reference 133).
7 days 17 hours.	Flood recedes below plant grade.	N	Access to exterior of buildings can be restored (Reference 22).

Attachment G-Water Sources

System Supplied	Source	Capacity	Quality
Condensate & Feedwater	1E007A & 1E007B (Hotwell)	544,861 gal.	Demineralized Water(2)
CRD	1T005A & 1T005B (Condensate Storage Tanks)	400,000 gal. total	Demineralized Water(2)
RCIC	1T005A & 1T005B (Condensate Storage Tanks)	400,000 gal. total	Demineralized Water(2)
	Torus	440,000 gal.	Demineralized Water(2)
HPCI	1T005A & 1T005B (Condensate Storage Tanks)	400,000 gal. total	Demineralized Water(2)
	Torus	440,000 gal.	Demineralized Water(2)
RHR	Torus	440,000 gal.	Demineralized Water(2)
Core Spray	1T005A & 1T005B (Condensate Storage Tanks)	400,000 gal. total	Demineralized Water(2)
	Torus	440,000 gal.	Demineralized Water(2)
Demineralized Water	1T-45 (Demineralized Water Tank)	50,000 gal.	Demineralized Water(2)
Condensate Service	1T005A & 1T005B (Condensate Storage Tanks)	400,000 gal. total	Demineralized Water(2)
Standby Liquid Control	1T217 (SBLC Test Tank)	210 gal.	Demineralized Water(2)
	1T218 (SBLC Storage Tank)	3270 gal.	Sodium Pentaborate(4)
Well Water	Aquifer	Unlimited	Well Water(1)
RHR Service Water	Stilling Basin / Pump House	110,400 gal.	Raw Water(3)
Emergency Service Water	Stilling Basin/ Pump House	110,400 gal.	Raw Water(3)
Fire Water System	Circulation water pit / Pump House	515,883 gal.*	Raw Water(3)
General Service Water	Circulation water pit / Pump House	515,683 gal.*	Raw Water(3)
River Water	River /Intake Structure	Unlimited	Raw Water(3)

Notes:

*The circulation water pit, cooling tower basins, condenser and associated piping all together contain 2.4E6 gallons.

(1) Well Water: A source of water that comes from an aquifer underground and is generally clean but may contain some fine particulates.

(2) Demineralized Water: A source of water that has been demineralized that has had the mineral ion impurities removed. Clean and with virtually no particulates and is the base water for all clean systems.

(3) Raw Water: A water source that enters the plant from the river. Raw water has not been demineralized or chemically treated and contains minerals, particulates, clay, silt and microbiologicals. Raw water filters larger debris through the intake structure traveling screens. Once in the circulation water pit in the Pump House, the water contains suspended solids and particulates. In addition, suction of the makeup water from the circulation water pit is taken several feet off the floor of the pit to minimize sediment.

(4) Sodium Pentaborate: Has already been previously evaluated for use in the Reactor Vessel.

Attachment H-Accessibility and Equipment Operating Conditions

Area	FLEX Function	Temp.**	Reference/Other
Main Control Room	Overall Operations, Instrumentation and Controls	110°	Reference 64 With FLEX procedural actions in References 111, 128 and 130
Battery Rooms	DC Power	>65° and <120°	Reference 64 With FLEX procedural actions in References 111, 128 and 130
Essential Switchgear Rooms	Electrical Distribution and Remote Operating Station for HCVS	120°	Reference 64 With FLEX procedural actions in References 111, 128 and 130
RCIC Room	Core cooling in Phase 1-Equipment only-no personnel access required	125°	Reference 64
HPCI Room	Alternate source of core cooling during Phase 1 Equipment only-no personnel access required	138°	Reference 64 with procedural actions in Reference 111
South East Corner Room	Primary connection point for Phase 2 portable pump	105° at 8 hours	Reference 89
Torus Area	Alternate Connection Point for Phase 2 Portable Pump	120° at 3 hours 130° at 7 hours Not Accessible later in event	Reference 89
RHR Valve Room	Injection valve location for Phase 2	105° at 8 hours	Reference 89
Drywell	Safety Relief Valves and Instrumentation Equipment only-no personnel access required	270°	Reference 79
Reactor Building Elevation 855 Refuel Floor	Area with direct access to spent fuel pool	Varies by time since fuel discharged. Inaccessible once pool reaches boiling.	Time to boil Reference 114 Area Temperatures with Pool Boiling Reference 90
Reactor Building Elevation 757	Hose routing for Phase 2 and general operations and Local Instrumentation Racks for Backup Indication	105° at 8 hours 115° at 24 hours	Reference 89

Area	FLEX Function	Temp.**	Reference/Other
Reactor Building Elevation 786	Local Instrumentation Racks for Backup Indication	110° at 24 hours	Reference 89
Reactor Building Elevation 812	Operate one RHR Valve for alternate remote spent fuel pool make up	102° at 8 hours 115° at 15 hours	Reference 89
Reactor Building Elevation 833	Remote operation of Refuel Floor Vent	113° at 8 hours 125° at 18 hours	Reference 89
Turbine Building	Primary staging area for portable equipment during a flooding event	Not Specified* Tool Box Controlled	Reference 130
Yard Area	Primary staging area for portable equipment during non-flood events	Not Specified* Tool Box Controlled	Reference 130
Pump House and Intake	Houses water sources	Not Specified* Tool Box Controlled	Reference 130

*Areas that are not subject to decay heat impacts from the reactor or are not in the control building do not have detailed temperature analysis. To manage access to these areas a tool box approach is taken where operators use options like stay time and portable tools along with observation of actual conditions or selection of alternate locations to manage accessibility (Reference 130).

**Wet bulb temperatures are used to evaluate human accessibility. Dry bulb temperatures are used to evaluate equipment impacts.

Attachment I-Critical Instruments

Plant Parameter*	Instrument	Range
Drywell Pressure	PI4396C	0-100 psig
Drywell Pressure	PI4396D	0-100 psig
Torus Pressure	PI4395A	0-100 psig
Torus Pressure	PI4395B	0-100 psig
Drywell Temperature	TR4383A	0 to 500 °F
Drywell Temperature	TR4383B	0 to 350^{0}F
Drywell Average Temp.	TIA4386	0-350 ^{0}F
Torus Water Level	LI4397A	1.5 to 16 ft
Torus Water Level	LI4397B	1.5 to 16 ft
Torus Water Temp.	TR4386A	20 to 220 ^{0}F
Torus Water Temp.	TR4386B	20 to 220 ^{0}F
Torus Average Water Temp.	TIA4325	20 to 220 ^{0}F
RPV Pressure	PI4599A	0 to 1500 Psig
RPV Pressure	PI4599B	0 to 1500 Psig
RPV LEVEL Flood Up	LI4541	158 to 458 Inches
RPV Level Fuel Zone	LI4565B	-153 to +218 Inches
RPV Level Fuel Zone	LI4565C	-153 to +218 Inches
Fuel Pool Level	LI3414	Top of Fuel Racks to Normal Spent Fuel Pool Operating Level
Fuel Pool Level	LI3415	Top of Fuel Racks to Normal Spent Fuel Pool Operating Level

*Critical Instrument Table Note: For any given parameter, a valid reading from either division provides adequate indication for operational decision making.

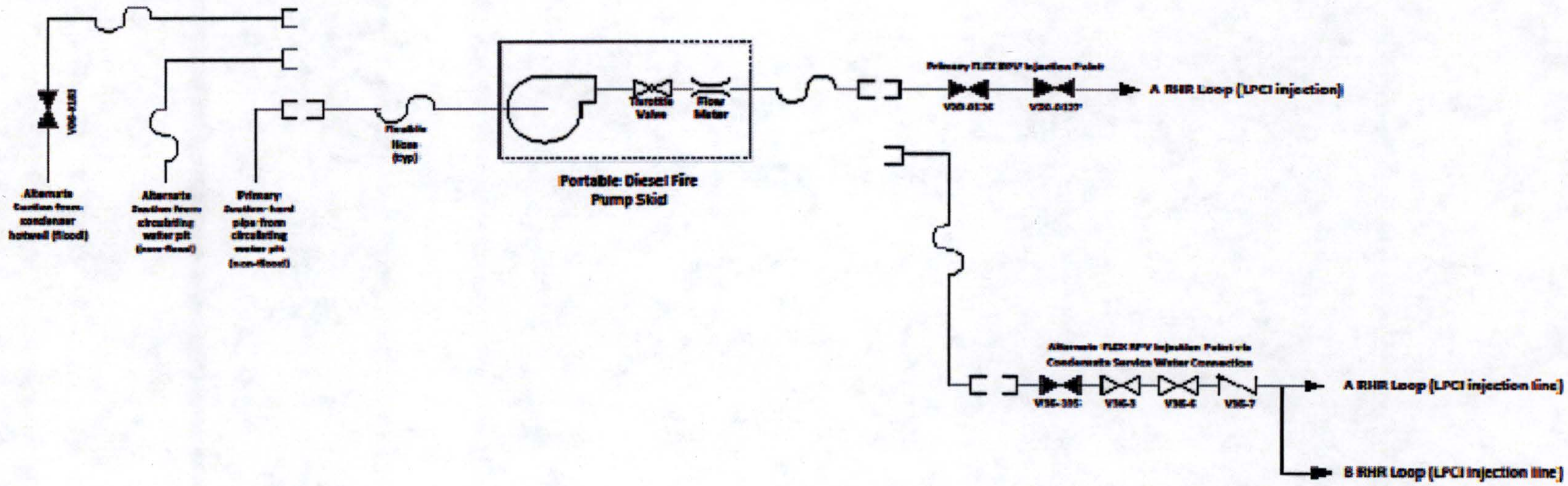
Attachment J-FLEX Portable Equipment Plant Connections

Portable Equipment	System Interface	Function	Connection Location and Routing
480 Volt Generator	125 VDC and 250 VDC Battery Chargers	Recharge Station 125 VDC Batteries	Generator is deployed in the yard area or alternatively inside the Turbine Building during a flood. Cables are routed through the Turbine Building to the Essential Switchgear Rooms in the Control Building. Connection points in the Essential Switchgear Rooms are protected from all defined external hazards and remain accessible throughout the event. (Reference 126)
	480 VAC Motor Control Center (MCC) 1B32	Provide AC power to desired loads on MCC 1B32. Loads that can be connected via MCC 1B32 provide defense in depth to the strategies but none are required for the primary FLEX strategies	Same Staging and Cable Routing (Reference 127)
	Hardened Containment Vent System (HCVS) Uninterruptable Power Supply (UPS)	Provide power to recharge HCVS prior to battery depletion	Same Staging and Cable Routing (Reference 134)
120/240 Volt Generator	Instrument AC	Provide alternate power to station instrument independent of station batteries and inverters	Generator is deployed in the yard area or alternatively on the Data Acquisition Center Roof during a flood. Cables are routed through the Turbine Building to the Essential Switchgear Rooms in the Control Building. Connection points in the Essential Switchgear Rooms are protected from all defined external hazards and remain accessible throughout the event. (Reference 129)
Portable Diesel Pump	Circulating Water	Provide primary suction source for Phase 2 portable	Portable pump would be deployed in the outdoor yard area and suction hose

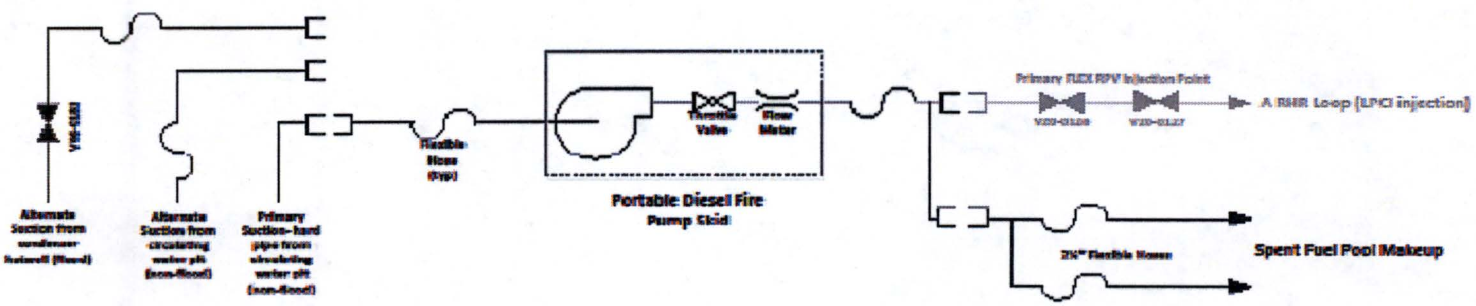
Portable Equipment	System Interface	Function	Connection Location and Routing
		pumps to provide water for Reactor Core Cooling or Spent Fuel Pool makeup	connected either to an installed suction standpipe, or alternatively directly from the circulating water system pit (Reference 122)
	Condenser Hotwell	Provide primary alternate suction source for Phase 2 portable pumps to provide water for Reactor Core Cooling or Spent Fuel Pool makeup during flood conditions	During a river flooding event the portable pump would be deployed to a flood protected area in the turbine building. (Reference 122)
	Residual Heat Removal	Provide primary injection path for portable pump to provide water for Reactor Core Cooling or an alternate injection path to the Spent Fuel Pool	Portable pump would be deployed in the yard area or alternatively in the turbine building during a flood event and discharge hoses routed through the turbine building and reactor building and connect to RHR in the Southeast Corner Room of the Reactor Building. The RHR system is a seismic Class 1 Safety Related System (Reference 120)
	Condensate Service Water	Provide alternate injection path for portable pump to provide water for Reactor Core Cooling or Spent Fuel Pool Cooling	Portable pump would be deployed in the yard area or alternatively in the turbine building during a flood event and discharge hoses routed through the turbine building and reactor building and connect to the Condensate Service Water piping in the Torus Area of the Reactor Building. (Reference 120)
	Spent Fuel Pool	Primary injection path for makeup to the Spent Fuel Pool is via hoses on the Refuel Floor	Portable pump would be deployed in the yard area or alternatively in the turbine building during a flood event and discharge hoses routed through the turbine building and reactor building to the Refuel Floor of the Reactor Building. (Reference 121)
NSRC Pumps	Circulating Water	Primary path for makeup of water inventories during	Pump would be deployed in the area adjacent to the Cedar River near the plant

Portable Equipment	System Interface	Function	Connection Location and Routing
		Phase 3 is NSRC Pump suction directly from the Cedar River and connecting via hoses to the Circulating Water system return pipe at the cooling towers	intake structure and hoses routed over ground to the cooling tower area where circulating water piping provides a flow path to the Circulating Water Pit (Reference 135)
	River Water Supply	Alternate discharge path for makeup of water inventories during Phase 3 NSRC	Pump would be deployed in the area adjacent to the Cedar River near the plant intake structure with pump suction directly from the Cedar River and connecting via hoses to the River Water Supply system piping in the safety related intake structure. The River Water Supply piping provides a flow path to the service water and circulating water pits in the Pump House (Reference 135)

Attachment K-RPV Makeup with Portable Pump



Attachment L- Spent Fuel Pool Makeup with Portable Pump



Attachment M-Use of Portable Electrical Generators