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10 CFR 50.4

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

Duke Energy Carolina, LLC (Duke Energy)
Oconee Nuclear Station (ONS), Units 1, 2, and 3
Docket Numbers 50-269, 50-270, 50-287
Renewed License Numbers DPR-38, DPR-47, and DPR-55

Subject: Notification of Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" for Oconee Nuclear Station, Unit 1 and FLEX Final Integrated Plan (FIP) for Oconee Nuclear Station, Units 1, 2, and 3.

References:

1. Nuclear Regulatory Commission (NRC) Order Number EA-12-049, *Order Modifying Licensees With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, dated March 12, 2012 (Accession No. ML12054A735).
2. Oconee Nuclear Station's *Overall Integrated Plan in Response to March 12, 2012, Commission Order to Modify Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order EA-12-049)*, dated February 28, 2013 (Accession No. ML13063A065).
3. Oconee Nuclear Station, Units 1, 2, and 3 - Report for the Onsite Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Instrumentation Related to Orders EA-12-049 And EA-12-051 (TAC NOS. MF0782, 0783, 0784, 0785, 0786, AND 0787), dated October 6, 2015 (Accession No. ML15259A387).
4. Oconee Nuclear Station, Unit 2 - Notification of Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" for Oconee Nuclear Station, Unit 2 (Accession No. ML16028A194).
5. Oconee Nuclear Station, Unit 3 - Notification of Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" for Oconee Nuclear Station, Unit 3 (Accession No. ML16200A315).

Ladies and Gentlemen

This letter provides notification that Unit 1 at Oconee Nuclear Station (ONS) is in full compliance with the NRC's Order regarding mitigation strategies for beyond design-basis events. Unit 1 compliance constitutes the final unit of ONS's three units.

A151
NRR

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design-Basis External Events" (Reference 1). The Order required 10 CFR 50 license holders to submit an Overall Integrated Plan (OIP) describing how compliance with the Order would be achieved. The Oconee Nuclear Station OIP for Order EA-12-049 was submitted by letter dated February 28, 2013 (Reference 2).

Section IV.A.2 of Order EA-12-049 requires full implementation of the Order to be completed no later than two (2) refueling cycles after submittal of the overall integrated plan, or December 31, 2016, whichever comes first. Thus for ONS Unit 1, full implementation was required prior to restart from the End-of-Cycle 28 (EOC29) refueling outage.

Unit 1 established full compliance with Order EA-12-049 upon entering Mode 2 (Startup) following EOC29 on November 26, 2016. As demonstrated by this submittal, and other docketed correspondence concerning this Order, ONS Unit 1 is in full compliance with Order EA-12-049.

Section IV.C.3 of Order EA-12-049 requires Licensees to notify the NRC after full compliance is achieved. Attachment 1 provides a brief summary of the key elements associated with Unit 1 compliance. The NRC Audit Report (Reference 3) open and pending items are provided in Attachment 2 along with a summary response that addresses each item. As such, Duke Energy considers these items complete, pending NRC closure. In support of the ongoing NRC Audit process, Duke Energy will continue to work with the NRC staff for issuance of a combined Safety Evaluation (SE) for the Mitigation Strategies Order. Attachment 3 is the FLEX Final Integrated Plan (FIP) for Order EA-12-049. The FIP includes a summary of the FLEX strategies and a description of equipment, applicable hazards, etc.

This letter contains no new or revised Regulatory Commitments.

Should you have any questions regarding this submittal, please contact Laura Todd with Oconee Regulatory Affairs, at (864) 873-6774.

I declare under penalty of perjury that the foregoing is true and correct. Executed on January 26, 2017.

Sincerely,

Thomas D. Ray

Thomas D. Ray
Vice President
Oconee Nuclear Station

Attachments:

1. Oconee Nuclear Station, Unit 1 - Summary of Compliance Elements for Order EA-12-049
2. Oconee Nuclear Station, Unit 1 - NRC Audit Report Open and Pending Items
3. Oconee Nuclear Station, Units 1, 2, and 3 - FLEX Final Integrated Plan

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ATTACHMENT 1

OCONEE NUCLEAR STATION, UNIT 1 - SUMMARY OF COMPLIANCE ELEMENTS FOR ORDER EA-12-049

The elements identified below, along with the Overall Integrated Plan (OIP) (Reference A2), the 6-Month Status Reports (References A4 thru A10) and additional docketed correspondence demonstrates Oconee Nuclear Station (ONS) Unit 1 compliance with Order EA-12-049 (Reference A1).

STRATEGIES - COMPLETE

ONS Unit 1 strategies are in compliance with Order EA-12-049. All strategy related Open Items, Confirmatory Items or Audit Questions/Audit Report Open Items have been addressed and are considered complete pending NRC closure.

MODIFICATIONS - COMPLETE

The modifications required to support the FLEX strategies for ONS Unit 1 have been fully implemented in accordance with the station design control process.

EQUIPMENT – PROCURED AND MAINTENANCE & TESTING - COMPLETE

The equipment required to implement the Mitigation Strategies has been procured and is ready for use at ONS Unit 1. Testing and maintenance processes have been established through the use of industry endorsed Electric Power Research Institute (EPRI) guidelines and the ONS Preventative Maintenance program such that FLEX equipment reliability is achieved.

PROTECTED STORAGE - COMPLETE

The storage facility required to implement the FLEX strategies for ONS Unit 1 has been completed and provides protection from the applicable site hazards. The equipment required to implement the FLEX strategies for ONS Unit 1 is stored in its protected configuration and is ready for use.

PROCEDURES - COMPLETE

FLEX Guidelines (FGs) for ONS Unit 1 have been developed in accordance with NEI 12-06, Revision 0, Section 3.2.2 (Reference A13). The FGs and affected existing procedures have been verified and are available for use in accordance with the site procedure control program.

TRAINING - COMPLETE

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

STAFFING - COMPLETE

The staffing study for ONS has been completed in accordance with NEI 12-01, Revision 0 (Reference A14) and Recommendation 9.3 of the 10 CFR 50.54(f) letter, "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," (Reference A11) and confirmed that ONS has adequate staffing to perform the actions to mitigate beyond design basis events. The ONS study is documented by letter dated June 17, 2015 (Reference A12).

Attachment 1

Oconee Nuclear Station, Unit 1 - Summary of Compliance Elements for Order EA-12-049

National SAFER Response Centers - Complete

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

Validation - Complete

Duke Energy has performed a validation in accordance with industry developed guidance which assures that required tasks, manual actions and decisions for FLEX strategies are feasible and can be executed.

FLEX Program Document - Established

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

References

A1. Nuclear Regulatory Commission Order Number EA-12-049, Order Modifying Licensees With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, Revision 0, dated March 12, 2012, ADAMS Accession No. ML12054A735.

A2. Oconee Nuclear Station's *Overall Integrated Plan in Response to March 12, 2012, Commission Order to Modify Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order EA-12-049)*, dated February 28, 2013 (Accession No. ML13063A065).

A3. Oconee Nuclear Station, Units 1, 2, and 3, Interim Staff Evaluation Regarding Overall Integrated Plan in Response to Order EA-12-049, dated February 10, 2014 (Accession No. ML13365A258).

A4. Oconee Nuclear Station First Six Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 29, 2013 (Accession No. ML13246A009).

A5. Oconee Nuclear Station Second Six Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 28, 2014 (Accession No. ML14064A197).

A6. Oconee Nuclear Station Third Six Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 27, 2014 (Accession No. ML14245A019).

A7. Oconee Nuclear Station Fourth Six Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 27, 2015 (Accession No. ML 15063A027).

A8. Oconee Nuclear Station Fifth Six Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 26, 2015 (Accession No. ML15247A068).

A9. Oconee Nuclear Station Sixth Six Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 29, 2016 (Accession No. ML16064A091).

A10. Oconee Nuclear Station Seventh Six Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 26, 2016 (Accession No. ML16250A019)

A11. 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, (Accession No. ML12053A340).

A12. Oconee Nuclear Station NEI 12-01 Phase 2 Staffing Assessment Report in Response to March 12, 2012, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendation of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, Enclosure 5, Recommendation 9.3, Emergency Preparedness - Staffing, Requested Information Items 1, 2 and 6 -Phase 2 Staffing Assessment, dated June 17, 2015 (Accession No. ML15176A343).

A13. NEI 12-06, Revision 0 "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide."

A14. NEI 12-01, Revision 0 "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities."

A15. Oconee Nuclear Station, Unit 2 - Notification of Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" for Oconee Nuclear Station, Unit 2 (Accession No. ML16028A194).

A16. Oconee Nuclear Station, Unit 3 - Notification of Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events" for Oconee Nuclear Station, Unit 3 (Accession No. ML16200A315).

ATTACHMENT 2
OCONEE NUCLEAR STATION, UNIT 1 - NRC AUDIT REPORT OPEN AND PENDING ITEMS

Duke Energy considers ONS Unit 1 to be in full compliance with Order EA-12-049 as demonstrated by the docketed correspondence concerning this order. Briefly, the Interim Staff Evaluation (ISE) Open and Confirmatory Items are complete pending NRC closure; ONS FLEX OIP Open Items are complete pending NRC Closure; ONS FLEX Audit Questions are complete pending NRC closure; ONS FLEX NRC Audit Report Open Items are complete pending NRC closure.

The following provides a summary response for the Audit Report Open and Pending Items and Duke Energy considers these items to be complete with respect to establishing compliance for ONS Unit 1:

Item	Description	Summary Response
ISE OI 3.2.1.1.A	Provide a description and justification for the specific evaluation model(s) used in the ELAP analyses for Oconee.	A response for this tracker item is included in a station calculation (Section 8.5.2, 10937-03). The response provided in Section 8.5.2 provides a description for the specific evaluation models used in the Oconee ELAP analyses. Also included are references for the associated Duke Energy topical reports covering the methodology used, and references for the SERs [Safety Evaluation Reports] associated with these methodology reports.

Item	Description	Summary Response
ISE OI 3.2.1.6.C	When further analyses are completed, the licensee should provide additional information that either supports a conclusion that pressurizer relief or safety valves do not lift during the ELAP event or that lifting of the valve(s), if it occurs, is acceptable.	Section 8.5.2 of station calculation 10937-03 explains that the pressurizer PORV (or safety valves) are expected to lift during the initial 20 minutes of an ELAP event beginning from full power conditions. Once steam generator feed flow is established from the SSF, additional valve lifts are not anticipated. These pressurizer relief valve lifts occur while the pressurizer responds to design basis accident conditions, and is well within the design of the equipment. The initial transient evolution to an ELAP event mitigated by the SSF is consistent with other existing design basis analyses. The Oconee DBDs do not include information that indicates the PORV is rated for two-phase flow. The Oconee PORVs, 2.5" Dresser model 31533VX-30 Electromatic Relief Valves, were included in the EPRI safety valve testing program, and subjected to subcooled liquid relief. The associated EPRI report indicates the Oconee PORV did close under two-phase conditions, and subsequent evaluation showed the valve was not damaged. The Oconee mitigating strategy does not use the PORV for event mitigation, after the initial transient response before steam generator cooling is established. During the initial period where PORV cycling can be postulated, steam relief at normal operating conditions is anticipated. Liquid relief is not expected during this time frame. Reactor Coolant Pump (RCP) Seals are evaluated in attachment 19 of station calculation 11383-00, the Flowserve White Paper (ADAMS Accession No. ML15310A094) which provides an evaluation of the loss of seal cooling for ONS Unit 1 RCPs, and station calculation 11611-00 which includes an evaluation of the loss of seal cooling for ONS Units 2 and 3 RCPs.
ISE OI 3.2.1.6.D	Provide additional information demonstrating successful mitigation of an ELAP event involving an uncontrolled cooldown resulting from consequential damage to the main steam system due to the severe natural hazard that initiates the ELAP event.	The Duke response to this SE tracker item, which is a follow up to RAI 50 (Section 8.5.2 of 10937-03), is included in station calculation 10937-03. The base case for a FLEX main steam line break at Oconee is considered to be a single main steam line break [MSLB] without credit for AFIS actuation; as demonstrated by Case 5f. Additional MSLB scenarios have also been evaluated successfully as part of the FLEX analyses and are included in station calculation 10937-03. The sensitivity runs include scenarios that result in initial overcooling, which has been demonstrated to be mitigated by use of the SSF and the guidance contained in Abnormal Procedure 25 (AP/25).

Item	Description	Summary Response
ISE CI 3.2.1.1.B	Confirm that the final ELAP computer code analyses for core cooling, reactor coolant system inventory, shutdown margin, and containment integrity have acceptable methodology and assumptions and support the sequence of events timeline.	A response for this tracker item is included in a station calculation (Section 8.5.3, 10937-03). This response reviews the computer codes and methodologies used for the NSSS and containment response separately, and provides references for the associated Duke Energy topical reports covering the methodology used, and references for the SERs [Safety Evaluation Reports] associated with these methodology reports. The timelines for the seismic response [T=0 no warning event] scenario and the flood response [warning time event] scenario are identified and included as part of a station calculation (Attachment 7, 10937-03). These timelines are reviewed and compared to the cases performed in station calculation 10937-03.

Item	Description	Summary Response
ISE CI 3.2.1.2.B	Confirm that RCP seal temperature would be maintained at an acceptably low value by establishing injection flow to the RCP seals via the SSF RCMU pump within 20 minutes of event initiation.	Attachment 19 to station calculation 11383-00, specifically addresses this concern. An excerpt from the conclusion portion of the attachment is provided below: "Oconee Design Basis Events documentation (Appendix C of 0254.00-00-4005) and the SSF RC Makeup System documentation (Section 2.2.2, of 0254.00-00-1004) establishes 20 minutes as the time to establish SSF RC Make Up to the RCP seals in order to limit seal heat-up and prevent seal damage or failure. In addition to reestablishing seal cooling flow, these documents establish 15 minutes as the time to isolate Unit 1 RCP seal return flow and 20 minutes for Units 2&3. For Events with no warning (T=0) SSF RC Makeup is started from the SSF per Abnormal Procedure 25 (AP/25). Input 5.34 from Station Calculation 5372 provides much of the technical basis. For the Advanced Warning Time event (Jocassee Dam failure), Case 3, provides a methodology in which substantial unit shutdown and cooldown to less than 350F is accomplished prior to the ELAP condition. In this case the primary system is cooled down using normal station equipment on all three units to preclude seal damage. There is no requirement to establish SSF RCMU to provide seal protection." Station procedures have required isolation of seal return flow within 15 minutes on all three units for consistency. An engineering change package (406431) was recently completed to revise the basis documents to 15 minutes on units 2 and 3. The restoration of RCP seal cooling is credited in all FLEX/ELAP events. Reactor Coolant Pump (RCP) Seals are also evaluated in the Flowserve White Paper (ADAMS Accession No. ML15310A094) which provides an evaluation of the loss of seal cooling for ONS Unit 1 RCPs and station calculation 11611-00 which includes an evaluation of the loss of seal cooling for ONS Units 2 and 3 RCPs.

Item	Description	Summary Response
ISE CI 3.2.1.2.C	Confirm there is justification for the assumed seal leakage rates for the Bingham RCPs with Sulzer seal assemblies.	Attachment 19 of station calculation 11383-00 specifically addresses this concern. An excerpt from the conclusion portion of the attachment is provided below: "Based on the ONS FLEX strategies there is no expectation of increased Sulzer RCP seal leakage due to the early event response. Additional review of testing and correspondence with Sulzer provides additional confirmation that the Unit 2&3 seals are tolerant of the short duration temperature excursion. The modeled leakage rates are arbitrary, with the 2 gpm per seal selected from WCAP-17601-P section 4.4.3 as values used in Generic B&W calculations as "normal leakage for seals that have not experienced overheating", and the 21 gpm per seal selected as representative of a large seal leak, also selected based on documentation from the same WCAP. Based on the credible failure mode (elastomers exposed to high temperatures) and the mechanism of temperature to time exposure, there is adequate justification for leakage values selected for the base case and the high leakage sensitivity case." Reactor Coolant Pump (RCP) Seals are evaluated in attachment 19 of station calculation 11383-00, the Flowserve White Paper (ADAMS Accession No. ML15310A094) which provides an evaluation of the loss of seal cooling for ONS Unit 1 RCPs, and station calculation 11611-00 which includes an evaluation of the loss of seal cooling for ONS Units 2 and 3 RCPs.

ATTACHMENT 2
OCONEE NUCLEAR STATION, UNIT 1 - NRC AUDIT REPORT OPEN AND PENDING ITEMS

Item	Description	Summary Response
ISE CI 3.2.1.2.D	Confirm there is justification for the assumed seal leakage rates for the Westinghouse 93-A RCPs with Flowserve N-9000 seals with the Abeyance feature.	Attachment 19 of station calculation 11383-00 specifically addresses this concern. An excerpt from the conclusion portion of the attachment is provided below: "Based on the ONS FLEX strategies there is no expectation of increased Flowserve RCP seal leakage due to the early event response. Additional review of the Flowserve White Paper provides additional confirmation that the Unit 1 seals are tolerant of the short duration temperature excursion. The modeled leakage rates are arbitrary, with the 2 gpm per seal selected from WCAP-17601-P section 4.4.3 as values used in Generic B&W calculations as "normal leakage for seals that have not experienced overheating", and the 21 gpm per seal selected as representative of a large seal leak, also selected based on documentation from the same WCAP. Based on the credible failure mode (elastomers exposed to high temperatures) and the mechanism of temperature to time exposure, there is adequate justification for leakage values selected for the base case and the high leakage sensitivity case (Note: ONS Unit 1 RCP seals have the Generation 1 Abeyance Feature)." Additionally, the NRC endorsed the Flowserve Corporation report entitled "White Paper on the Response of the N-Seal Reactor Coolant Pump (RCP) Seal Package to Extended Loss of All Power (ELAP)," Revision A (ML 15222A356) on November 12, 2015. ONS has considered the stated limitations and conditions documented in NRC endorsement letter (ref. Adams Accession No. ML15222A356 or ML 15222A357) and finds no issue.
ISE CI 3.2.1.6.E	When evaluations are completed, confirm that the survivability and performance of the atmospheric dump valves is adequate to support Oconee's mitigation strategy.	Refer to Attachments 9 and 10 of station calculation 11383-00 for conclusion of survival and accessibility for implementation of FLEX strategies.

Item	Description	Summary Response
SE 20-E	Please (1) state the ambient conditions (temperature, pressure, humidity) under which the SSF RCMU pumps are qualified or otherwise expected to function and provide a basis, (2) state the expected conditions in containment during the period when the functionality of the SSF RCMU pumps is credited and provide a basis, and (3) confirm that the credit taken for the SSF RCMU pumps under ELAP conditions is justified.	(1) In accordance with the Oconee SSF RCSMU Design Basis Document and Oconee Environmental Qualification Calculation, the RCMU Pumps will operate in ambient conditions of 267 degrees F, 41.8 psig, and 0-100% humidity. (2) In accordance with the Oconee ELAP Containment Response Calculation, each of the FLEX cases which utilize RCMU pump strategy exhibits a similar trend in the containment response with each case reaching 100% humidity, a temperature of 170 – 185 deg. F, and a pressure response of 18 to 21 psig at the end of the simulation. The simulation was for 72 hours. It is expected that the containment pressure and temperature trends will stabilize shortly after the conclusion of the 72 hour simulation. Oconee expects to be capable of transitioning to Phase 2 RCS Makeup (with portable diesel pump) well in advance of 72 hours. (3) By comparison, the peak conditions expected during the ELAP event remain below or equal to the pump's design basis conditions. The SSF RCMUPs are located in the Reactor Building (RB) in containment.

NRC Order EA-12-049

FLEX FINAL INTEGRATED PLAN

Oconee Nuclear Station, Units 1, 2, & 3

January 2017

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ATTACHMENT 3

OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3 - FLEX FINAL INTEGRATED PLAN

1. Background

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

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

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

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

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

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

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

Duke Energy (Duke) declared that the three Units at Oconee Nuclear Station (ONS) are in compliance with Order EA-12-049. Duke previously submitted compliance letters to the NRC for Units 2 and 3, on January 21, 2016 and July 11, 2016, respectively (References 3 and 4). This Final Integrated Plan (FIP) is submitted as an attachment to the compliance letter for Unit 1. This timeline resulted in compliance to Order EA-12-049 within two refueling cycles of the OIP submittal for each Unit.

The Nuclear Energy Institute (NEI) developed NEI 12-06 (Reference 6), which provides guidelines for nuclear stations to assess extreme external event hazards and implement the mitigation strategies specified in NRC Order EA-12-049. The NRC issued Interim Staff Guidance JLD-ISG-2012-01 (Reference 7), dated August 29, 2012, which endorsed NEI 12-06 with clarifications on determining baseline coping capability and equipment quality. ONS developed and implemented FLEX strategies using the guidance[1] from NEI 12-06, Revision 0 (Reference 6).

NRC Order EA-12-051 (Reference 8) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level. This order was prompted by NTTF Recommendation 7.1 (Reference 1).

Duke declared that the three Units at ONS are in compliance with Order EA-12-051. Duke previously submitted a compliance letter for Units 1 and 2 (which share a common SFP) on January 20, 2016 (Reference 9) and for Unit 3 on February 29, 2016 (Reference 10). This timeline resulted in compliance to Order EA-12-051 within two refueling cycles of the OIP submittal for each Unit.

NEI 12-02 (Reference 11) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in JLD-ISG-2012-03 (Reference 12), conformance with the guidance in NEI 12-02 is an acceptable method for satisfying the requirements in Order EA-12-051. ONS developed and implemented the reliable SFP level instrumentation in accordance with NEI 12-02, Revision 1 (Reference 11).

2. Order Implementation

2.1 General Elements

This section includes the assumptions used for the evaluations of an ELAP/Loss of Ultimate Heat Sink (LUHS) event and the development of FLEX strategies.

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

- The reactor is initially operating at power, unless there are procedural requirements to shut down due to the impending event. Prior to the event, the reactor is assumed to have been operating at 100% power for the past 100 days.

[1] Two alternatives to the guidance of NEI 12-06, Revision 0, were incorporated into the ONS FLEX strategy, as discussed in Section 2.1 and elsewhere in the Final Integrated Plan.

- The reactor is successfully shut down when required (i.e., all rods inserted, no Anticipated Transient Without Scram (ATWS)).
- On-site staff is at site administrative minimum shift staffing levels.
- All personnel on-site are available to support site response.
- The reactor and supporting plant equipment are either operating within normal ranges for pressure, temperature and water level, or available to operate, at the time of the event consistent with the design and licensing basis.
- Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to the applicable hazards are available. Permanent plant equipment that is contained in structures with designs that are robust with respect to the applicable hazards is available.

  The ONS FLEX strategy relies on the Atmospheric Dump Valves (ADVs) which are located in a structure (i.e., the Turbine Building) that is not protected from all applicable hazards. This approach was therefore considered to be an alternative to NEI 12-06. ONS performed a technical evaluation that verified the robustness of the ADVs and downstream piping for the applicable hazards. See Section 2.3.4.3 of this Final Integrated Plan (FIP).
- Normal access to the ultimate heat sink (UHS) is lost. Specifically, the motive force for UHS flow (i.e., pumps) is assumed to be lost with no prospect for recovery. However, robust piping connecting the UHS to plant systems remains intact.
- Fuel for FLEX equipment stored in structures with designs that are robust with respect to the applicable hazards, remains available.
- Installed electrical distribution systems, including inverters and battery chargers, remain available provided they are protected from the applicable hazards.
- No additional accidents, events, or failures are assumed to occur immediately prior to or during the event, including security events.
- Reactor coolant inventory loss consists of unidentified leakage at the upper limit of Technical Specifications, reactor coolant letdown flow (until isolated), and reactor coolant pump seal leak-off at normal maximum rate.
- For the SFP, all boundaries (e.g., liner, gates) and the SFP cooling system are assumed to be intact. The SFP heat load is assumed to be the maximum design basis heat load. In addition, inventory loss from sloshing during a seismic event does not preclude access to the pool area.

ONS uses an alternative to the assumption in NEI 12-06 that the initial condition is assumed to be a loss of off-site power (LOOP) with installed sources of emergency on-site AC power and station blackout (SBO) alternate AC power sources unavailable with no prospect for recovery. As discussed in the OIP (Reference 22), ONS credits the Standby Shutdown Facility (SSF) diesel generator (DG), which is an installed source of emergency on-site AC power. The SSF DG is provided solely for operation of SSF equipment and is disconnected from the normal and emergency electrical distribution system (similar to a diesel driven pump).

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

- Additional deployment resources are assumed to begin arriving at 6 hours and the site Emergency Response Organization (ERO) will be fully staffed at 24 hours after the event.
- The plant Technical Specifications contain the limiting conditions for normal unit operations to ensure that design safety features are available to respond to a design basis accident and direct the required actions to be taken when the limiting conditions are not met. The result of the BDBEE may place the plant in a condition where it cannot comply with certain Technical Specifications and/or with its Security Plan, and, as such, may warrant invocation of 10 Code of Federal Regulations (CFR) 50.54(x) and/or 10 CFR 73.55(p). (Reference 13)

2.2 Strategies

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

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

This indefinite coping capability will address an ELAP with a simultaneous LUHS. This condition could arise following external events that are within the existing design basis with additional failures and conditions that could arise from a BDBEE.

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

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

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

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

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

ONS developed FLEX strategies that address all applicable hazards specified in NEI 12-06, based on response that begins following the event (i.e., the T=0 strategy). ONS also developed a FLEX strategy for an external flood hazard that is not part of the plant's design basis and therefore beyond the requirements of NEI 12-06 (See Section 2.6.2). The strategy for response to an external flood (i.e., the Warning Time strategy) relies on actions taken during the warning time prior to site inundation.

Section 2 of this FIP includes the T=0 strategy and supporting information that describe the ONS FLEX strategies and how they comply with NRC Order EA-12-049 and conform to NEI 12-06 (with the noted alternatives) for all applicable hazards. The Warning Time strategy for response to an external flood is included in Section 3 but is not required for compliance with NRC Order EA-12-049.

2.3 Reactor Core Cooling Strategy

2.3.1 Phase 1: Core Cooling

After the event occurs and power is lost, the reactors will trip. Operators will attempt to restore power. During Phase 1, ONS will rely on the Safe Shutdown Facility (SSF) to ensure adequate core cooling. As discussed in Section 2.1, this approach is an alternative to NEI 12-06. The SSF provides an independent source of electrical power for SSF system loads, a pump for Steam Generator (SG) makeup water, pumps for Reactor Coolant System (RCS) makeup, and instrumentation for monitoring key parameters.

An operator will align SSF Auxiliary Service Water (ASW) flow from the SSF within 14 minutes. The SSF ASW pump will take suction from the Condenser Circulating Water (CCW) intake crossover line and discharge to both SGs on each Unit. ONS will use the SSF to stabilize the plant at RCS pressure and temperature of 1950 - 2250 psig and 550 - 555°F. Cooldown to 325 - 350°F will be accomplished using the SGs as a heat sink by steaming and discharging through the plant atmospheric dump valves (ADVs). The ADVs are manual valves that will be operated locally. Natural circulation will drive flow through the RCS. ONS will limit cool down to a rate of ≤ 50°F per hour, maintain pressurizer level –above 85 inches, and maintain RCS pressure of 1950 - 2250 psig.

The operator at the SSF will also align the SSF Reactor Coolant Makeup (RCMU) pump to supply Reactor Coolant Pump (RCP) seal injection within 20 minutes, so that the RCP seal function can be maintained. The SSF RCMU pump takes suction from the SFP and discharges to the RCP seal injection lines, which provides both boration of the RCS along with RCS makeup and RCP seal cooling.

The SSF is designed to operate for 72 hours, and ONS would use the SSF for as long as it remains viable. However, ONS will deploy portable equipment (Phase 2) early in the event to establish a backup to the SSF. This approach provides prompt redundant capabilities to installed systems and is consistent with the intent of Order EA-12-049 and NEI 12-06.

The SSF provides dedicated instrumentation with indications located in the SSF control room for all parameters required to support the FLEX strategy. Additional instrument indications are available in the Main Control Room (MCR) from battery-backed vital panelboards. The battery-backed MCR instrumentation and indications will be available until manual isolation at approximately three hours into the event. The batteries have a capacity of four hours, but will be isolated as soon as the SSF is in service and instrument monitoring has been established (i.e., prior to four hours) to prevent full discharge. Breakers at the vital inverters will also be opened to eliminate the potential for tripping the input breaker and/or blowing the input fuses as DC voltage decreases. This action is taken to prevent any potential damage to the batteries that could challenge their recovery when recharging using the FLEX primary repower strategy (in Phase 2).

The turbine-driven emergency feedwater (TDEFW) pump is not credited as part of the FLEX strategy because it is not located in a hardened structure and its suction sources are not missile protected. However, if the pump and its suction sources survive, the TDEFW pump could be running following a BDBEE. If the TDEFW pump is causing excessive cooling of the RCS, ONS will trip the pump and rely exclusively on the SSF ASW pump.

2.3.2 Phase 2: Core Cooling

The SSF will be used to supply SG feedwater for as long as it is available. However, ONS will promptly deploy a Phase 2 strategy using portable pumps and hoses to provide SG feedwater, in case the SSF becomes unavailable. The Phase 2 core cooling strategy continues to use the SGs as the heat sink. ONS will deploy a portable high-capacity pump (FLEX Mitigating Strategies Pump) and associated hoses and fittings. The portable pump will draw suction from the Intake Canal. The primary strategy is to connect to a SG fill line in the Protected Service Water (PSW) system that can distribute water to both SGs in all three Units. The alternate strategy connects to three SSF ASW emergency connections (one for each affected Unit).

RCS boration and makeup will be accomplished for each Unit using a portable, high-pressure injection pump that draws suction from the Borated Water Storage Tank (BWST) and discharges into selected connection points to the RCS. The primary connection is a set of four connection points that are in the Auxiliary Building East Penetration Room. The connections are vent and drain lines on the High Pressure Injection (HPI) header and Seal Injection lines. The alternate connection is a comparable set of connection points in the Auxiliary Building West Penetration Room. The East Penetration Room is more accessible than the West Penetration Room, and is therefore the preferred connection. ONS will establish RCS makeup at a flow rate of approximately 48 gpm.

The Phase 2 FLEX strategy relies on continued availability of the monitored parameters from Phase 1 and additional instrumentation and components. A portable power distribution system will be deployed to repower essential instrumentation and equipment using portable DGs, transformers, cable splitter boxes, and cables. Permanent connections are installed to provide power to existing station components from the portable power distribution equipment (e.g., Motor Control Center (MCC) or power panel feed receptacles, transfer switches, or terminal blocks).

The primary FLEX repower strategy includes one 600 VAC/500 kW DG, 600 VAC/208-120v transformer, and cable splitter per Unit (i.e., three of each component if all Units are affected) and one 120 VAC/6 kW DG for the site.

- The 500 kW DG, transformer, cable splitter, and associated cabling will be deployed to create an electrical distribution system that will repower selected MCCs that support essential electrical loads. This approach will recharge the vital batteries and ultimately repower the vital 120 VAC panel boards via the vital inverters. Parameters and equipment that are not fed from the vital panelboards will be repowered directly from the portable power distribution system. A portable power distribution system will be set up for each affected Unit.
- The 6 kW DG and associated cabling will be used to repower the RCS cold leg temperature indications available in the SSF control room. The connection for this strategy is located in the SSF equipment room.

The alternate repower strategy uses one 600 VAC/500 kW DG, one 120/240 VAC portable DG (approximately 10 kW), one 600/208-120V transformer, and three cable splitter boxes per Unit.

- The 10 kW DG, cable splitter boxes, and associated cabling will restore power to instrument panels directly from the generator (rather than going through the battery charger, like the primary strategy) and provide 120 VAC feeds to the control room and cable room.
- The 500 kW DG, transformer, and associated cabling will restore power to selected MCCs using different connections than the primary strategy.

FLEX procedures ensure that electrical isolation is maintained while the DGs are being connected (e.g., by opening all breakers on MCCs being repowered prior to connecting the DGs). Proper phase rotation was verified based on post-modification testing of permanently installed connections, factory acceptance testing of the diesel generators, and the use of color-coded connections and cables. FLEX procedures specify connections by color coding.

The Core Flood Tank (CFT) isolation valves will be repowered using the strategy described above and closed to prevent the pressurized nitrogen gas from entering the RCS during depressurization. As an alternative, the CFT vent valves may be repowered and opened to vent the pressurized nitrogen gas. The primary repowering strategy supports closing the CFT isolation valves; the alternate repowering strategy supports opening the CFT vent valves. RCS pressure will be maintained greater than 650 psig until the CFTs are vented or isolated. After the CFTs are vented or isolated, ONS will continue cooldown to 240°F to 250°F and 300 psig to 350 psig using SSF ASW flow or ADVs.

2.3.3 Phase 3: Core Cooling

The Phase 3 core cooling strategy continues the Phase 2 approach of using SGs as the heat sink and the ADVs for steam discharge. A National SAFER Response Center (NSRC) will deliver water filtration and demineralization equipment to provide clean water for long-term makeup. The water treatment components will be connected upstream of the high-capacity pump. The NSRC equipment will establish logistics for delivery and purification of water with the capacity for 720,000 gallons per day within 5 days. The NSRC will also provide replacement pumps, in case the Phase 2 equipment becomes unavailable.

For RCS inventory control during Phase 3, mobile boration units from the NSRC can be used to provide additional borated water to the RCS. The NSRC mobile boration system consists of a 1000-gallon mixing tank, a transfer pump, and associated connections. ONS will provide water to the mixing tank from the Intake Canal. Connections to plant systems are the same as the Phase 2 strategy. The NSRC will provide replacement high-pressure pumps, in case the Phase 2 equipment becomes unavailable.

The Phase 3 strategy with respect to electrical power consists of sustaining Phase 2 capabilities with redundant and replacement equipment from the NSRC. It is noted that the replacement DGs from the NSRC are 480 VAC (rather than the 600 VAC DGs at ONS), so the NSRC is supplying a step-up transformer and associated cabling to connect to the output of the NSRC DG. ONS has adapter cables stored in the FLEX Support Building (FSB) that will enable connection to the FLEX power distribution system.

2.3.4 Availability of Systems, Structures, and Components

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

2.3.4.1 Structures

The FLEX strategy relies on site structures to provide protection for components, fluid and electrical connections, and deployment paths from applicable extreme external hazards.

- The Reactor Buildings, Auxiliary Building, and BWST Enclosures are seismically robust structures that are also designed to provide protection from the design basis hazards. Each of the strategies involve connection points that allow access from an outside staging area either directly into the Auxiliary Building or through the BWST Enclosures.
- The SSF is a seismically robust structure that is also designed to provide protection from the design basis hazards.
- The Turbine Building is a seismically robust structure, but does not provide protection from tornado missiles. ONS evaluations determined that piping and

components within the Turbine Building credited for the FLEX strategy would not be damaged or become inaccessible due to debris from internal non-seismic walls, tornado loads, or tornado missiles such that the FLEX mission could not be achieved.

- The FLEX Support Building is designed to be robust to the applicable hazards and is specifically addressed in Section 2.7.

2.3.4.2 Systems

The FLEX strategy relies on installed piping from various plant systems to deliver water for core cooling. Primarily, ONS relies on piping and components from the RCS and other plant systems including Spent Fuel Pool Cooling (SF), High Pressure Injection (HPI), Low Pressure Injection (LP), Feedwater (FDW), Core Flood (CF), Main Steam (MS), CCW, and PSW. Credited portions of these systems were either designed for safety-related service or evaluated to survive the applicable hazards, and will therefore be available following the applicable extreme external hazards.

The FLEX strategy also relies on SSF systems and components. Credited portions of these systems were either designed for safety-related service or evaluated to survive the applicable hazards, and will therefore be available following the applicable extreme external hazards.

2.3.4.3 Atmospheric Dump Valves (ADVs)

The ONS FLEX strategy relies on the ADVs to discharge steam during cool down of the RCS. As discussed in an update to the FLEX strategy submitted by ONS (Reference 23), use of the ADVs is considered to be an alternative to NEI 12-06, because they are located in a structure (i.e., the Turbine Building) that is not protected from all applicable hazards. ONS performed a technical evaluation that verified the robustness of the ADVs and downstream piping for the applicable hazards. This evaluation also concluded that an earthquake or a tornado would not result in damage to the building that would preclude accessibility to the ADVs. ONS concluded that the ADVs will be available to support the FLEX strategy following the applicable extreme external hazards.

2.3.4.4 SSF Auxiliary Service Water (ASW) Pump

The ONS FLEX strategy relies on the SSF ASW pump to provide feedwater for the SG during Phase 1 of the FLEX strategy. The SSF ASW pump is designed for the applicable design basis hazards. The SSF ASW pump will therefore be available to support the FLEX strategy following the applicable extreme external hazards.

2.3.4.5 SSF Reactor Coolant Makeup (RCMU) Pump

The ONS FLEX strategy relies on the SSF RCMU pump to provide makeup water from the Spent Fuel Pool for the RCS during Phase 1 of the FLEX strategy. The SSF RCMU pump and its flow control valves are designed for the applicable design basis hazards. The SSF RCMU pump will therefore be available to support the FLEX strategy following the applicable extreme external hazards.

2.3.4.6 Electrical Distribution System

ONS uses selected plant electrical distribution equipment to repower installed components credited for the FLEX response strategy. Credited electrical distribution equipment is located in the Auxiliary Building, the Reactor Building, and the SSF. The Auxiliary Building, Reactor Buildings, and SSF are seismically robust structures that will provide protection from applicable design basis hazards and will therefore provide protection for electrical distribution equipment. Therefore, the credited portions of the installed electrical distribution system will be available to support the FLEX strategy following the applicable extreme external hazards.

2.3.4.7 Electrical Components

ONS uses many installed electrical components to support the FLEX strategies. ONS has performed evaluations of non-safety related electrical components to validate that they will be available to support the FLEX strategy following a BDBEE. Such components include pressurizer heaters and RCS cold leg temperature instrumentation. The ONS evaluation concluded that these components would be available as necessary to support the FLEX strategy following the applicable extreme external hazards.

2.3.4.8 Intake Canal

The Intake Canal is the water source for SG makeup. The Intake Canal Dike is a Class 2 structure that has been qualified for the same seismic loading as nuclear safety related structures. It provides access to water from the UHS and is an essentially infinite source of water for the FLEX strategy.

2.3.4.9 Borated Water Storage Tank (BWST)

The BWSTs are the credited source of borated water for RCS make-up during Phase 2 of the FLEX strategy. The BWSTs are nuclear safety related structures that are protected from all design basis hazards. Analysis of potential tornado missile hazards concluded that the BWST will be available to perform its design function following a tornado missile impact on the BWST, the tank vent, or any of the BWST structural supports, pipe supports, ladders, and platforms.

The nominal inventory in each BWST is 350,000 gallons. However, the hydraulic evaluation of the Phase 2 FLEX strategy identified that a water level of at least 20 feet is required to provide adequate Net Positive Suction Head to the portable pump, so the useable volume is 198,000 gallons. Accounting for shrinkage and RCS leakage, this volume of water will support RCS inventory control for 13.6 days. The NSRC mobile boration unit will be available after 1 day, so the BWST inventory is sufficient.

2.3.5 FLEX Connections

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

2.3.5.1 Primary SG Feedwater Connection

The primary Phase 2 SG feedwater strategy uses a connection in the PSW piping that can distribute water to both SGs in all three Units. The piping supplies feedwater to both SGs in each Unit, thereby allowing symmetric cooldown. The connection is at a valve in the PSW system, which is located inside the Auxiliary Building, and is therefore protected from all the applicable extreme external hazards.

2.3.5.2 Alternate SG Feedwater Connections

The alternate SG feedwater strategy uses three individual Unit connections in the CCW system. The connection points provide feedwater to the B SG in each Unit, and therefore results in asymmetric cooldown. As discussed in Section 2.3.7, ONS has evaluated use of asymmetric cool down and determined that it is satisfactory. The connections are located in the Cask Decontamination Rooms for each Unit, which are part of the Auxiliary Building and therefore protected from all the applicable extreme external hazards.

2.3.5.3 Primary Connections for Reactor Coolant Inventory

The primary connection points for RCS makeup include a set of four connection points that are in the Auxiliary Building East Penetration Room. The connections are vent and drain lines on the HPI header and Seal Injection lines. Because these locations are located inside a safety-related structure, they are protected from all design basis hazards. Therefore, the primary connections for RCS makeup are protected from the applicable extreme external hazards.

2.3.5.4 Alternate Connections for Reactor Coolant Inventory

The alternate connection points for RCS makeup include a set of four connection points in the Auxiliary Building West Penetration Room. The connections are vent and drain lines on the HPI header and Seal Injection lines. Because these locations are located inside a safety-related structure, they are protected from all design basis hazards. Therefore, the alternate connections for RCS makeup are protected from the applicable extreme external hazards.

2.3.5.5 Electrical Connections

The ONS FLEX strategy relies on FLEX power to charge batteries, maintain vital instrumentation, and repower plant equipment. Several different permanently installed connection points are used for the primary and alternate electrical repower strategies.

For the primary repower strategy, connection points are located in the Auxiliary Building at a designated FLEX docking station, selected MCCs, and transfer switches. The connection point for the 6 kW DG is at a 120 VAC power panel board in the SSF. Because the Auxiliary Building and the SSF are protected from all design basis hazards, the primary electrical connections are protected from the applicable extreme external hazards.

For the alternate repower strategy, connection points are located in the Auxiliary Building at selected MCCs, transfer switches, and terminal blocks located within electrical cabinets. Accordingly, the alternate electrical connections are protected from the applicable extreme external hazards.

2.3.6 Plant Instrumentation

ONS will monitor selected plant parameters to support deployment of the FLEX core cooling strategy.

All required parameters may be monitored from the SSF and may be initially powered from the SSF diesel generator, as follows:

- RCS Pressure
- RCS Hot Leg Temperature
- RCS Cold Leg Temperature
- Pressurizer Level
- SG Level
- Core Exit Thermocouples

In addition to these parameters, ONS will also monitor ASW flow rate from the SSF, although this indication is not essential for executing the FLEX strategy.

During Phase 1 (up to approximately T+3 hours), ONS will be able to monitor plant parameters from the Main Control Room (MCR) that are powered by station control batteries. This function is not essential for Phase 1, as all required indications are available in the SSF. During Phase 2, the electrical repower strategies (primary or alternate) will restore the following instrument indications in the MCR:

- RCS Hot Leg Temperature
- RCS Wide Range Pressure
- SG Pressure
- Reactor Vessel Level
- Excore Nuclear Instrumentation (NI), Channels 1 & 2
- Reactor Building Normal Sump Level
- Reactor Building Emergency Sump Level
- Pressurizer Level
- SG Level
- Core Exit Thermocouples

During Phase 2, instrument indications for RCS Cold Leg Temperature will be restored in the SSF (primary strategy) or the MCR (alternate strategy).

It is noted that SG pressure is listed by NEI 12-06 as a typical key parameter, but the SG pressure indication is not required for the ONS FLEX strategy. RCS heat removal can be directly monitored by RCS parameters and controlled by SG level without the SG pressure indication.

Procedural guidance on how to obtain local instrument readings was developed and included in an FG. SG level, RCS pressure, Pressurizer level, and RCS temperature (via Core Exit Thermocouples) can be monitored at electrical penetrations using Fluke Temperature calibrators. This method can also be used to monitor SG pressure, RCS Hot Leg temperature, RCS Cold Leg temperature and Reactor Vessel level (shutdown modes only).

2.3.7 Thermal-Hydraulic Analysis

ONS developed a RELAP model to evaluate delivery of cooling water to plant systems during execution of FLEX strategies. The analysis demonstrated that the FLEX strategies were sufficient to keep the core covered, cooled, and subcritical.

- The analysis of the FLEX strategy evaluated feeding and steaming both loops while the SSF is available, and feeding either one or both loops using a portable pump after the SSF stops functioning. Results demonstrate that single phase natural circulation is maintained, ensuring that the core remains covered and heat is adequately transferred to the UHS. The calculation shows that approximately 240 gpm peak flow is needed from the FLEX Mitigating Strategies Pump in Phase 2 for each Unit, which is well below the pump capacity.
- The RELAP analysis results demonstrate that the core is adequately borated while the SSF RCMU pump is operating.
- The RELAP analysis results demonstrate that the FLEX strategy ensures the core remains covered and cooled by continuous natural circulation flow for a double-ended main-steam line break event with or without auxiliary feedwater isolation system actuation and results in an asymmetric cooldown.
- Sensitivity analyses were performed to examine opening the ADV block valves while the SSF is operating, feeding the RCS loop with or without pressurizer, increased RC makeup flow and delayed FLEX RC makeup coincident with larger seal leaks. All of these sensitivity cases met the acceptance criteria.
- The alternate connection strategy for SG makeup only provides cooling water to one of the two SGs and therefore results in asymmetric cooling. The RELAP analysis determined that this single loop cooling approach is satisfactory.

ONS also performed an analysis to determine the potential effect of using raw water for SG feedwater (e.g., from the Intake Canal) on SG cooling capability. This evaluation considered SG fouling and potential for corrosion due to impurities in the water sources. The limiting case concluded that ONS could use the available water sources for 138 hours (5.75 days) prior to affecting heat transfer capability. This duration is acceptable, because the Phase 3 equipment for water purification will arrive from an NSRC after 24 hours.

ONS performed a hydraulic evaluation of the Portable RCS Makeup Pump and the associated flow path through hoses and installed systems. This evaluation concluded that there is adequate Net Positive Suction Head and that the discharge pressure at the required flow rate does not exceed the pump's capacity.

2.3.8 Reactor Coolant Pump Seal Leakage (ELAP)

ONS Unit 1 has Westinghouse RCPs with Flowserve N9000 mechanical seals with the 1st generation abeyance feature. ONS Units 2 and 3 have Bingham RCPs with Sulzer Mechanical Seals.

The SSF RCMU pump will take suction from the SFP and discharge to the RCP seal injection lines to provide seal cooling. An RCP Seal leakage of 8 gpm per Unit (2 gpm per RCP) was included in the cooldown analysis, which is consistent with WCAP-17601, Section 4.4.3 for RCP seals in B&W plants that do not experience overheating. ONS analysis of RCS temperatures during the response to a FLEX event concluded that the temperature of water in the pump seals would remain within the seal limitations. Specifically, both the Flowserve N9000 seals and the Sulzer seals require restoration of seal injection flow within 20 minutes. The ONS FLEX response using the SSF satisfies this criterion. (This was specifically noted in Reference 27, the Flowserve White Paper on the Response of the N-Seal Reactor Coolant Pump Seal Package to Extended Loss of All Power.) Therefore, no damage to the RCP seals is expected, and the assumption of 8 gpm per Unit (2 gpm per RCP) is appropriate.

2.3.9 Shutdown Reactivity Analysis

The ONS strategy to use the SSF for FLEX Phase 1 response enables boration of the RCS to commence shortly after event initiation. Cooldown of the RCS will commence approximately 2 hours into the event. Highly borated water from the SFP or the BWST will be injected into the RCS to offset leakage and shrinkage. The boron in this makeup water will provide negative reactivity to keep the plant shut down.

In all the asymmetric scenarios, recovering flow to an idle loop is not procedurally attempted in Phases 1 through 3.

ONS performed RELAP analyses to justify that adequate shutdown margin exists during execution of the FLEX strategy. Equilibrium xenon reactivity can be credited for the first 20 hours after the event due to the assumed initial core power level and prior operating history. The RELAP evaluation concluded that adequate shutdown margin exists at 200°F without credit for xenon when borated water from the SFP or BWST has been injected to make up for shrinkage due to cooldown at 364°F. Therefore, the ONS strategy to complete RCS boration and reduce temperature to below 350°F by approximately 18 hours into the event is satisfactory. This calculation includes several conservatisms, including the fact that it does not account for RCS injection to replace coolant lost due to RCP seal leakage.

The boron mixing model assumes perfect mixing in the RCS, since single phase conditions are expected.

2.3.10 FLEX Pumps

2.3.10.1 FLEX Mitigation Strategies Pumps (Low Pressure)

If the SSF is no longer available, the ONS FLEX response strategies rely on a portable, low-pressure pump (FLEX Mitigating Strategies Pump) to provide cooling water from the Intake Canal to plant systems for core cooling and SFP makeup. The FLEX Mitigation Strategies Pump is designed to supply flow of 3,000 gpm.

The ONS FLEX strategy requires one FLEX Mitigation Strategies Pump for the site. The ONS inventory of two pumps, both stored in the FSB, satisfies the N+1 requirement for equipment redundancy.

The credited water supply for the FLEX Mitigation Strategies Pump is the Intake Canal.

The maximum flow demand from the high-capacity pump used for SG makeup in the ONS thermal-hydraulic analyses was 817 gpm. The capacity of the FLEX Mitigation Strategies Pump is sufficient for this demand.

2.3.10.2 FLEX Portable RCS Makeup Pumps (High Pressure)

For an ELAP/LUHS initiating in Mode 1 - 4, the ONS FLEX response strategy relies on a Portable RCS Makeup Pump to provide boration and inventory make-up. The FLEX Portable RCS Makeup Pumps deliver a design flow of 48 gpm at 2,500 psig discharge pressure, which is adequate to support the boration and RCS inventory control requirements for the FLEX response strategy.

The ONS FLEX strategy requires one FLEX Portable RCS Makeup Pump per Unit. ONS has four FLEX Portable RCS Makeup Pumps, all stored in the FSB, which satisfies the N+1 requirement for equipment redundancy.

The credited water supply for the FLEX Portable RCS Makeup Pumps is the BWST.

The maximum flow demand from the high-head pump used for RCS makeup in the ONS thermal-hydraulic analyses was 40 gpm. The capacity of the FLEX Mitigation Strategies Pump is sufficient for this demand.

2.3.11 Electrical Analysis

2.3.11.1 Battery Load Shedding

During Phase 1, the ONS FLEX strategy relies on power from the SSF DG. Battery load shedding actions beyond those described in station emergency procedures is not required to support the FLEX strategies. Therefore, a battery load shedding analysis was not required for the ONS FLEX strategies.

However, as part of the FLEX strategy, ONS does isolate all DC loads to the batteries prior to battery coping time limit (four hours) to prevent full discharge. The batteries have a capacity of four hours, but will be isolated as soon as the SSF is in service and instrument monitoring has been established (i.e., prior to four hours) to prevent full discharge. Breakers at the vital inverters will also be opened to eliminate the potential for tripping the input breaker and/or blowing the input fuses as DC voltage decreases. This action is taken to prevent any potential damage to the batteries that could challenge their recovery when recharging using the FLEX primary repower strategy (in Phase 2).

2.3.11.2 FLEX Diesel Generators

The ONS FLEX strategy relies on portable FLEX DGs (Phase 2) to repower equipment needed to support the FLEX strategies.

The ONS primary and alternate repowering strategies require a set of DGs with a range of capacities. The primary strategy for each Unit requires a 600 VAC, 500 kW DG and a 120 VAC, 6 kW DG. The alternate strategy for each Unit uses the same 600 VAC, 500 kW DG and a 120/240 VAC, 10 kW DG.

ONS has four 600 VAC, 500 kW DGs, four 120 VAC, 6 kW DGs, and four 120/240 VAC, 10 kW DGs, all stored in the FSB, which satisfies the N+1 requirement for equipment redundancy.

ONS performed an ETAP analysis to evaluate the primary and alternate electrical repower strategies, considering all loads to be repowered and the deployed cable configuration. This analysis concluded that all electrical buses and equipment are acceptable for the limiting voltage, loading, and short circuit requirements, with adequate margin. Additionally, the analysis concluded that all newly installed cables are acceptable for limiting loading and short circuit requirements. Adequate voltage was verified for associated buses.

2.3.11.3 Lighting

ONS performed an evaluation to determine lighting requirements for the FLEX strategies that included all activities associated with the FLEX strategies, the type and amount of lighting equipment required, the duration of the lighting need, and the lighting staging location.

Types of lighting used in the FLEX strategy include hard hat lights, portable tripod flood lights, portable lanterns, and equipment mounted lights. Portable lighting is stored in the FSB.

NFPA 805 lighting is available in many areas where manual actions (e.g., connecting hoses, power cables, or operating pumps) are necessary. The NFPA 805 lights have self-contained batteries with an 8-hour life.

Hard hat LED lights will be used to ensure operators can safely move through the plant during an ELAP. Additional portable lighting will be used to provide lighting in the yard to replace some of the emergency lighting once it is depleted, and to enhance lighting in other areas of the plant as deemed necessary.

The NSRC will provide nine diesel-powered mobile lighting towers during Phase 3.

2.4 SFP Cooling/Inventory Strategy

2.4.1 Phase 1: SFP Cooling

Time to boil is estimated at 6.1 hours for the Unit 3 SFP and 6.9 hours for the Unit 1 & 2 SFP (which is a shared SFP that is used for fuel storage from both Units 1 and 2). These values are based on a full core offload for each pool. Sufficient time exists to establish inventory makeup in Phase 2 prior to fuel damage. SFP level will be at least 10 feet above the top of the fuel racks after 24 hours, whereas only 8 feet of water is necessary to provide adequate shielding. Actions during Phase 1 include monitoring SFP water level using reliable SFP level instrumentation installed per Order EA-12-051 and ventilation of the SFP areas by opening doors.

2.4.2 Phase 2: SFP Cooling

The ONS SFP makeup strategy consists of using a high-capacity pump at the Intake Canal. This pump is the same pump that is deployed for the core cooling strategy (i.e., the FLEX Mitigating Strategies Pump), and will already be in place when SFP makeup is required. Normal makeup flow to each SFP is approximately 100 gpm. High flow using the portable spray nozzle (Boggs Box) is 400 gpm for the Unit 1 & 2 SFP and 200 gpm for the Unit 3 SFP which meets the flow criteria for spray nozzles with no overspray.

Hose will be routed from the discharge of the pump, through a Duplex filter, to a gated wye that distributes flow to the two SFPs. Connections to deliver SFP makeup are as follows:

- The primary connection strategy uses hoses connected to permanently installed SFP fill lines located in the Unit 1 Cask Decontamination Room and Unit 3 Fuel Receiving Bay stairwell.
- The alternate connection strategy uses flexible hose pulled from the Boggs Box at the pool deck. ONS will deploy the Boggs Box regardless of availability of the primary connection point, in case the SFP becomes inaccessible. The Boggs Box will be attached to the rail on the side of the SFP with a tie-down strap.

High flow (> 400 gpm) makeup for the Unit 1 & 2 SFP using the Boggs Boxes does not utilize the Duplex Filter. ONS will install a wye upstream of the Duplex Filter to bypass flow around the filter if necessary. Use of the Duplex Filter is preferred, but is not credited, for the SFP makeup strategy.

It is noted that the core cooling FLEX strategy uses the SSF RCMU pump, which draws suction from the SFP. To avoid dilution of the boron concentration in the SFP water that is used for RCS makeup, SFP makeup will not occur simultaneously with operation of the SSF RCMU pump (unless engineering analysis is completed to allow raw water makeup). The SSF RCMU pump is expected to operate for some period of time (approximately 18 hours) while the Phase 2 RCS Makeup strategy is deployed. The portable FLEX RCS Makeup Pump will then be placed in service and the SSF RCMU pump will be secured. The FLEX RCS Makeup Pump draws suction from the BWST, and the SFP will no longer be the credited source for RCS makeup. At some time later (expected around 24 hours), the FLEX SFP makeup strategy will be placed in service. SFP makeup water will be borated to avoid dilution (unless engineering analysis is completed to allow raw water makeup). If SFP makeup is required before borated makeup is available, ONS will only add water to replace boiloff.

2.4.3 Phase 3: SFP Cooling

ONS will receive water purification and boration equipment from the NSRC to provide the capability for an indefinite supply of borated makeup water. ONS will preferentially use borated water, rather than non-borated water directly from the Intake Canal.

Additionally, the NSRC will provide booster pumps to support water purification and boration packages.

2.4.4 Availability of Structures, Systems, and Components

2.4.4.1 Buildings

The FLEX response strategy relies on site structures to provide protection for components, fluid and electrical connections, and deployment paths from applicable extreme external hazards. Specifically, the FLEX strategy for SFP cooling relies on the Reactor Building and the Auxiliary Building, which are both seismically robust structures that are designed to provide protection from the design basis hazards.

2.4.4.2 Systems

The FLEX strategy relies on installed piping in the SF system to deliver makeup water for SFP cooling. Credited portions of the SF system were designed for safety-related service, and will therefore provide protection from the applicable extreme external hazards.

2.4.4.3 Primary Connection for SFP Makeup

The primary connection strategy for SFP makeup uses permanently installed SFP fill lines located in the Unit 1 Cask Decontamination Room and Unit 3 Fuel Receiving Bay stairwell. These rooms are located in the Auxiliary Building, which provide protection from the applicable extreme external hazards.

2.4.4.4 Alternate Connection for SFP Makeup

The alternate connection strategy for SFP makeup uses flexible hose pulled from the Boggs Box deployed at the pool deck. The Boggs Box will be attached to the rail on the side of the SFP with a tie-down strap. The Boggs Boxes are stored in the SFP Change Rooms, which are in the Auxiliary Building. Therefore, the alternate connection strategy is protected from the applicable extreme external hazards.

2.4.4.5 Ventilation

ONS will establish ventilation of the SFP areas by opening doors from the SFP into the Purge Inlet rooms, and opening doors from those rooms to the atmosphere. ONS will also open the SFP truck receiving bay roll-up doors.

2.4.5 Plant Instrumentation

The key parameter for the SFP cooling/inventory function is Wide Range SFP level. ONS has two independent channels of SFP level instruments per pool.

The reliable SFP level transmitters, installed per NRC Order EA-12-051, are capable of measuring SFP level from approximately the top of the fuel racks to a level above normal SFP water level.

The instruments are arranged on opposite ends of the SFP to provide reasonable protection against missiles. The SFP level instruments are mounted to retain design configuration during and following a seismic event, and will be reliable at expected environmental and radiological conditions including extended periods when the SFP is at saturation. The instruments are independent of each other and have separate and diverse power supplies.

Each level channel consists of a guided wave radar horn assembly and waveguide piping located at opposite ends of each SFP. Each channel contains a level sensor or transmitter, a power control panel that includes battery back-up capability, and a local display all located on the 838 ft elevation of the Auxiliary Building in separate rooms. Each channel provides level indication on independent indicators located in the MCR. The SFPLI is normally provided non-safety related AC power. If AC power is lost, the battery backup can provide power for 14 days. At very low temperatures (i.e., -22°F, which is below the design basis for FLEX), batteries can support operation for 5 days. ONS will replace batteries as necessary to ensure that SFPLI remain powered.

2.4.6 Thermal-Hydraulic Analysis

Time to boil is estimated at 6.1 hours for the Unit 3 SFP and 6.9 hours for the Unit 1 & 2 SFP. These values are based on a full core offload for each pool.

Using a decrease in volume of 32 gpm per Unit due to SSF RCMU pump suction and 70 gpm from boil-off, ONS calculated that the level in each SFP is reduced to approximately 10 feet above the fuel at approximately 24 hours. This calculation uses several conservative assumptions, as follows:

- The calculation uses the RCMU flow rate for an operational Unit (i.e., fuel is in core) and the boil-off rate for a full core offload (i.e., fuel is in SFP). Realistically, the fuel can only be in one place.
- The calculation assumes full RCMU flow rate through 25 hours, but the effect of RCS cooldown/shrinkage is expected to complete at approximately 18 hours. Additional SSF RCMU operation beyond 18 hours is expected to be for RCS leakage only.
- The calculation uses boiloff rates starting immediately rather than the time to boil.
- Per ONS analysis, time to fuel uncovery is in excess of 72 hours. This value considers a full core offload and simultaneous SSF RCMU demand for the Unit 1 and 2 SFP.

ONS performed a FATHOM analysis to evaluate the capacity of the FLEX Mitigating Strategies Pump and the hosing configuration to simultaneously provide SG makeup and

SFP makeup. The greatest total flow rate required from the pump is 1,162 gpm for the scenario where unthrottled flow is provided to both SFPs and all Units' SGs. The analysis confirmed that the FLEX Mitigating Strategies Pump has sufficient capacity for this demand.

The ONS SFP makeup strategy has the capability to provide a spray flow of 200 gpm spray flow per unit. This capability bounds the maximum boil-off rate of 70 gpm per pool (140 gpm total). NEI 12-06 specifies a minimum of 200 gpm per unit to the SFP or 250 gpm per unit if overspray occurs. The overspray provision does not apply because the Boggs Box is located next to the SFP and will be deployed in time to permit any adjustments to prevent overspray prior to SFP boiling.

The ONS SSF RCMU pump for each Unit takes suction from its associated SFP and provides flow at 32 gpm. As such, the Unit 1 & 2 SFP is depleted at a rate of 64 gpm and the Unit 3 SFP is depleted at a rate of 32 gpm. These depletion rates are in addition to boil-off volume losses which are 70 gpm per pool. Therefore, the total depletion rate from the Unit 1 & 2 SFP could be 134 gpm and the total depletion rate from the Unit 3 SFP could be 102 gpm. The spray capabilities provided by the FLEX SFP makeup strategy bounds the total volume of water leaving each pool.

2.4.7 FLEX Mitigating Strategies Pump and Water Supplies

The ONS FLEX response strategy relies on a FLEX Mitigating Strategies Pump to supply water from the Intake Canal.

As discussed in Section 2.3.10.1, the FLEX Mitigation Strategies Pumps are rated for 3,000 gpm flow. As discussed in Section 2.4.6, the flow rate from one of these pumps exceeds the requirements for SFP makeup and SG feedwater.

2.4.8 Electrical Analysis

SFP level will be monitored during an ELAP event by the instrumentation installed to satisfy Order EA-12-051. The level instrumentation system has replaceable batteries with sufficient capacity to maintain the level indication function for at least 5 days. If necessary, ONS will replace the batteries in the SFPLI.

2.5 Containment Function Strategy

ONS has a large, dry containment structure that does not rely on an ice condenser. ONS performed an evaluation to determine containment pressure and temperature during the postulated event. This evaluation calculated that conditions will remain well below Containment design limits. Pressure and temperature will stabilize shortly after 72 hours following an ELAP.

2.5.1 Phase 1: Containment

ONS will establish Containment closure by isolating all penetrations. No other actions are required.

2.5.2 Phase 2: Containment

Deployment of the FLEX electrical repowering strategy will restore power to the Reactor Building Wide Range Pressure indications. As an alternative, ONS may use a pressure gauge in the West Penetration Room to monitor this parameter. No other Phase 2 actions are required to ensure Containment integrity.

2.5.3 Phase 3: Containment

The NSRC will provide backup DGs to ensure continued functionality of the FLEX electrical repowering strategy. No other Phase 3 actions are required to ensure Containment integrity.

2.5.4 Availability of Structures, Systems, Components

2.5.4.1 Structures

The FLEX strategy for maintaining Containment integrity relies on the Reactor Building/Containment Vessel, along with instrumentation connections located in the Auxiliary Building. The Reactor Buildings/Containment Vessels and Auxiliary Building are seismically robust structures that are designed to provide protection from the design basis hazards.

2.5.4.2 Spray Strategy

Containment spray functionality is not required to support the ONS FLEX strategy.

2.5.5 Plant Instrumentation

The key parameter for the Containment integrity function is Reactor Building Wide Range pressure, which can be monitored from the control room. ONS does not plan to monitor Reactor Building pressure until the Phase 2 electric repower strategy is deployed. This approach is acceptable, because of the slow buildup of pressure and temperature identified by analysis (see Section 2.5.6) and the large margin to design limits. As an alternative, ONS may use a pressure gauge in the West Penetration Room to monitor Reactor Building pressure.

2.5.6 Thermal-Hydraulic Analysis

ONS performed a GOTHIC evaluation to determine the containment pressure and temperature response during an ELAP for the first 72 hours. For an ELAP/LUHS where the FLEX strategy is executed, the analysis demonstrates that after 72 hours, pressure increases to 18 psia and temperature increases to 170°F.

The simulation results show that the temperature and pressure trends are leveling off at 72 hours. ONS expects that the containment pressure and temperature trends would stabilize shortly after 72 hours due to continued reduction in RCS temperature and pressure, long-term site recover actions, and natural reduction in core decay heat. Over an extended period, further reduction in decay heat levels and continued passive heat conduction through the RB walls to the outside environment will keep temperature and pressure well below Containment design limits of 59 psig (74 psia) and 286°F.

2.5.7 Electrical Analysis

ONS will repower instrumentation for Reactor Building Wide Range pressure as part of the Phase 2 FLEX strategy.

As discussed in Section 2.3.11, ONS performed an ETAP analysis to evaluate the primary and alternate electrical repower strategies, considering all loads to be repowered. This analysis included the Reactor Building Wide Range pressure transmitters. This analysis concluded that all electrical buses and equipment are acceptable for the worst-case voltage, loading, and short circuit requirements, with adequate margin. Additionally, the analysis concluded that all newly installed cables are acceptable for worst-case loading and short circuit requirements. Adequate voltage was verified at associated buses.

2.6 Characterization of External Hazards

2.6.1 Seismic Events

The seismic hazard is applicable for ONS. Per NEI 12-06, Revision 0, Table 4-2, all sites will consider seismic events.

The seismic criteria for ONS includes a Maximum Hypothetical Earthquake (MHE), which is also referred to as the Safe Shutdown Earthquake (SSE). The Peak Ground Acceleration (PGA) for the MHE is 0.10g for structures founded on rock. For structures founded on overburden, the PGA for the MHE for Class 1 structures is 0.15g.

In response to the 50.54(f) letter requesting additional information on the seismic hazard at all plants, Duke performed the Expedited Seismic Evaluation Process (ESEP) for ONS and submitted the results to the NRC. Through the implementation of the ESEP guidance, Duke identified and evaluated the seismic capacity of certain key installed mitigating strategies equipment that is used for core cooling and containment functions to cope with scenarios that involve an ELAP and an LUHS to withstand a seismic event two times the ONS SSE. The NRC concluded that this assessment provides additional assurance that supports continued plant safety while the longer-term seismic evaluation is completed to support regulatory decision making. It is noted that the ESEP does not modify any requirements for FLEX implementation and was not intended to influence implementation methodologies or schedules for compliance to Order EA-12-049.

2.6.2 External Flooding

The external flooding hazard is not applicable for ONS to comply with the requirements of NEI 12-06, Revision 0. ONS does not have any external flooding hazards as part of the design basis.

The ONS Updated Final Safety Analysis Report (UFSAR) reflects that the Jocassee Dam was constructed with sufficient seismic margin and overtopping margin such that these failure modes are not postulated within the ONS licensing or design basis. Hence, Jocassee Dam Failure (JDF) is not part of the ONS design basis or current licensing basis.

Although consideration of the external flooding hazard is not required for ONS compliance to Order EA-12-049, ONS decided to design an enhancement to its FLEX strategy that provides protection against the external flooding hazard. This strategy is discussed in Section 3 of this FIP.

2.6.3 Storms such as Hurricanes, High Winds, and Tornadoes

The high wind hazard is applicable for ONS.

Using Figure 7-2 from NEI 12-06, the location of ONS has a recommended tornado design wind speed of 179 mph. Based on the potential for winds in excess of 130 mph, the ONS site is susceptible to damage from severe winds from a hurricane or tornado.

2.6.4 Extreme Snow, Ice and Cold

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

ONS is located above the 35th parallel and is therefore subject to snowfall accumulation and extreme low temperatures per NEI 12-06. Based on NEI 12-06, the ONS site is also subject to catastrophic destruction of power lines and/or existence of extreme amounts of ice.

2.6.5 Extreme Heat

The extreme heat hazard is applicable for ONS.

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

2.7 Planned Protection of FLEX Equipment

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

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

ONS has one structure, the FLEX Support Building (FSB), for storing FLEX equipment that is located on-site and protects FLEX equipment from all applicable hazards. Selected equipment used to support the FLEX strategy is stored in other protected locations. ONS has sufficient protected equipment to satisfy the redundancy requirements of NEI 12-06, Revision 0 for reliability and availability.

2.7.1 FLEX Support Building

The FSB is a single, large building located in the northwest area of the plant. The FSB is a reinforced concrete dome structure with an outside diameter of 144 feet and a height of 43 feet. It has two equipment doors and two personnel doors. The FSB design specification required that it satisfy the requirements of NEI 12-06 for providing reasonable protection from BDBEEs.

Structural design loadings were determined in accordance with the requirements of ASCE 7-10. The building was designed for dead loads, operating and temporary loads (including snow and ice), construction loads, hurricane and tornado wind loads, tornado missile loads, seismic loads, and applicable load combinations.

In addition, for seismic loading, the building has been evaluated such that a catastrophic collapse will not occur for an earthquake in excess of two times SSE.

The FSB includes an HVAC system that will maintain the internal temperature between 40°F and 110°F and relative humidity of 70% or less.

Doors to the FSB can be manually operated in the event of a loss of power.

Equipment on trailers or beds are either seismically insensitive, secured rigidly to the trailer such that it moves with the trailer frames to prevent amplified movement, or positioned such that it will not move excessively or topple over on other equipment on the trailer nor topple out of the trailer. All wheeled equipment is chocked to prevent rolling. ONS performed an evaluation on this equipment and concluded that equipment has significant margin with respect to seismically-induced overturning, and that mobile equipment does not need to be seismically restrained. ONS also concluded that there is sufficient space between equipment to alleviate concerns due to seismic interaction from sliding or rocking.

FLEX equipment stored in the FSB includes FLEX Mitigation Strategies Pumps, FLEX Portable RCS Makeup Pumps, FLEX Submersible Pumps, FLEX Shutdown Modes Pumps, FLEX Diesel Generators, the CAT 924K loader, the truck for towing equipment, and other miscellaneous equipment (e.g., tools, lighting).

2.7.2 Other Storage Locations

Selected equipment for the FLEX strategies is stored in locations other than the FSB, as follows:

- The Boggs Boxes that provide spray makeup capability for the SFPs and associated hoses are stored in the SFP Change Rooms, which are inside the Auxiliary Building, and are therefore protected from the applicable hazards
- Hoses for the portable SG Makeup connection strategy are stored in a box near 2PSW-29, which is inside the Auxiliary Building, and therefore protected from the applicable hazards.

- The Duplex Filter used for SFP makeup is stored in the SSF, which is protected from all applicable hazards.
- Fluke Temperature Calibrators that are used for alternate instrumentation monitoring are stored in a cabinet in the Auxiliary Building 5th floor elevator lobby, which is protected from the applicable hazards. Replacement batteries for the WR SFP level channels installed per NRC Order EA-12-051 are also stored in this cabinet.

2.8 Planned Deployment of Flex Equipment

2.8.1 Haul Paths and Accessibility

The ONS FLEX response strategies include deployment of pumps, DGs, and other equipment from the FSB to locations at the power block to support the various FLEX capabilities.

ONS has a Caterpillar 924K loader for clearing debris on the deployment path and a Dodge 5500 truck with 27,000 lb towing capacity for towing of FLEX equipment. The 924K loader and the truck are both stored in the FSB and will therefore be protected from the applicable extreme external hazards.

ONS performed an evaluation of the primary and alternate deployment paths, which considered the likely potential debris. This evaluation confirmed that pathway diversity and debris cleaning/towing capabilities are expected to be adequate to support timely deployment of FLEX strategies following a BDBEE.

ONS evaluated deployment paths for seismic stability and confirmed that they are acceptable. The evaluation considered beyond design basis seismic loading with a PGA equal to 2.23 times the SSE. The only area susceptible to liquefaction is over an original drainage feature in the Construction Yard. The primary and alternative deployment paths do not enter this area and therefore are not susceptible to seismic liquefaction. ONS has supplemental (i.e., non-credited) deployment paths that enter the susceptible area and are potentially affected by seismic liquefaction. Such impediments to deployment would be identified as part of the initial post-event assessment and affected deployment paths would not be used.

2.8.2 Deployment of Strategies

At the beginning of the event, ONS will perform a strategy implementation assessment to confirm that there is no damage to equipment required for the FLEX strategy.

All FLEX equipment was procured/designed for routine outdoor commercial use in extreme ambient temperatures and harsh conditions. FLEX equipment engines are supplied with integral air cooled systems for use in high ambient temperatures and block heaters for use in freezing conditions. ONS strategies utilize FLEX equipment outdoors.

2.8.2.1 Raw Water Distribution

ONS will use a FLEX Mitigating Strategies Pump (high-capacity pump) to provide water for SG feedwater and SFP makeup. ONS will transport the FLEX Mitigating Strategies

Pump from the FSB to the Intake Canal via a ramp to the water's edge. Suction hoses with strainers will be attached to the pump and placed into the Intake Canal. Water temperature in the Intake Canal will not decrease to the point where access will be challenged due to ice formation.

2.8.2.2 Core Cooling Strategy

The FLEX Mitigating Strategies Pump will be staged at the Intake Canal. A discharge hose will be routed from the pump to the staging area in the yard on the west side of the Auxiliary Building.

Hose routing from the staging area on the west side of the Auxiliary Building to the connection to plant systems will be one of the following:

- The primary strategy routes hose into the Unit 2 Auxiliary Building rollup door, down the spiral stairs to elevation 783'-9", east down the Auxiliary Building second floor hallway, into the Component Cooling (CC) system cooler room area, and connects to a valve in the PSW system.
- The alternate strategy routes hose into a portable feed manifold that distributes flow to each of the affected Units via three discharge couplings. ONS will deploy hoses from the manifold to each Unit's Cask Decontamination Room and connect to three valves in the CCW system (one for each Unit).

2.8.2.3 Reactor Coolant Boration and Make-up Strategy

The FLEX strategy for RCS boration and inventory control requires a FLEX RCS Makeup Pump for each affected Unit.

The FLEX Portable RCS Makeup Pump(s) with hoses and adapters will be deployed from the FSB to the west side of the Auxiliary Building near the BWST for each affected Unit. A suction hose will be deployed to connect the BWST to the portable pump. Discharge hoses will be connected from the portable pump and to a set of connections points on the HPI lines and seal injection lines in the Auxiliary Building. The deployment path from each pump discharge depends on selection of the primary or alternate connection points:

- For the primary strategy, hose will be routed from the pump, into the East Penetration room through the flood dropout panel, and into a distribution manifold that divides flow into four paths. Four additional hoses will be routed from the four manifold outlets to a vent valve and a drain valve on the HPI lines and two HPI seal injection drain valves.
- For the alternate strategy, hose will be routed from the pump, into the West Penetration room via the stairwell adjacent to the Cask Decontamination Room, and into a distribution manifold that divides flow into four paths. Four additional hoses will be routed from the four manifold outlets to a vent valve and drain valve on the HPI lines and two HPI seal injection drain valves.

2.8.2.4 Electrical Strategy

For the primary electrical strategy, the 600 VAC/500 kW DG and the FLEX primary power trailer are positioned at the Auxiliary Building roll-up door. The transformer and the splitter box are initially staged in the West Yard at each Unit's Auxiliary Building rollup door. Cabling will then be routed from the 500 kW DG to several locations in the Auxiliary Building, where selected MCCs and panel boards will be repowered. The 6kW generator will be placed just outside the entrance to the SSF. Cabling will then be routed into the SSF and down the stairs to a selected panel board.

For the alternate electrical strategy, the 600 VAC/500 kW DG is positioned at the Auxiliary Building roll-up door. The 120/240 VAC DG, the transformer, and the three cable splitter boxes are deployed to the Turbine Building ground floor for each affected Unit. Cabling will be routed from the 120/240 VAC 10 kW generator to selected electrical cabinets, and transfer switches in several locations in the Auxiliary Building. Cabling will be routed from the 600 VAC/500 kW DG to selected MCCs in the Auxiliary Building.

2.8.2.5 SFP Makeup

The ONS SFP makeup strategy relies on a FLEX Mitigating Strategies Pump at the Intake Canal. The Mitigating Strategies Pump that is used for SG feedwater will also be used for SFP makeup, and will already be in place when SFP makeup is required. However, a different discharge hose will be used from the FLEX pump for SFP makeup.

Hose will be routed from the discharge of the pump to the west side of the Auxiliary Building and connected to a filter that is stored and deployed from in the SSF. Additional hose will deliver water to the SFPs by one of the following strategies:

- The primary strategy is to route hose through a portable splitter allowing hoses to be run to permanently installed SFP fill lines located in the Unit 1 Cask Decontamination Room and the Unit 3 Fuel Receiving Bay stairwell.
- The alternate strategy is to route hoses from the Boggs Box in Unit 1 & 2 SFP, through the Purge Equipment Room, and down the Caged ladder to the portable splitter. Similarly, the hoses are routed from the Boggs Box in Unit 3 SFP, through the Purge Equipment Room, and down the Caged ladder to the portable splitter.

2.8.3 Fueling of Equipment

Portable FLEX pumps and DGs have fuel tanks that are sized to support up to 12 hours of operation at the equipment's rated capacity. These fuel tanks will be maintained near full capacity while in the FSB. Additionally, a portable 1,240-gallon trailer-mounted refueling tank is maintained near full and stored in the FSB. This trailer will be used to service the deployed portable pumps, generators, and other diesel-operated FLEX equipment as needed. Once the initial volumes of diesel fuel oil (DFO) have been depleted, ONS has identified strategies to obtain additional DFO.

2.8.3.1 Credited Fuel Sources

DFO for SSF equipment and FLEX equipment will be obtained from the safety-related, underground SSF DG fuel oil storage tank. This tank is safety-related and underground, so it is protected from all design basis hazards. The SSF DG fuel oil storage tank has a 50,000 gallon capacity and is maintained with no less than 25,000 gallons of fuel, which is sufficient for full load SSF DG operation in excess of 72 hours.

For refueling FLEX equipment, DFO may be pumped out of the underground tank from a pipe located under the day tank that connects to the underground tank. The fuel will be transferred to a FLEX portable refueling trailer using a diesel-driven portable transfer pump. The portable refueling trailer will be towed by the FLEX Pickup Truck to the various site locations for refueling FLEX Diesel Engines.

The SSF DG fuel oil storage tank currently has a sulfur concentration in the range of 170 ppm and is replenished with ultra-low sulfur fuel oil, which has a sulfur concentration of less than 15 ppm. Therefore, the concentration of sulfur continues to be reduced by dilution. The portable refueling trailer and truck tanks contain ultra-low sulfur fuel oil. All ONS FLEX equipment that includes diesel engines is compatible with fuel containing sulfur levels of 170 ppm or less.

ONS performed a fuel consumption evaluation and determined that there is sufficient fuel on-site for operation in excess of 72 hours without an external source of fuel. If the SSF DG stops operating, the Phase 2 FLEX strategies are placed in operation for all three Units. With all Phase 2 equipment operating continuously and at capacity, fuel consumption would be approximately 4,300 gallons per day. Since the Phase 1 SSF DG consumption rate of 6,600 gallons per day bounds the potential Phase 2 consumption rate, the DFO in the SSF DG fuel tank is sufficient for Phase 1 and 2 through at least 72 hours. Thereafter, maximum fuel consumption would be approximately 3,500 gallons per day, provided that the ONS FLEX DGs are in use, and approximately 5,500 gallons per day if the NSRC DGs are in use.

In Phase 3, contact with fuel oil suppliers will be made to arrange delivery of additional fuel oil by trucks. In the event that roadways to the site are impassable, fuel can be provided by helicopter using NSRC airlift fuel shipping containers.

2.8.3.2 Non-credited Fuel Sources

ONS has several non-credited sources of DFO that are not robust to the applicable hazards, but could be used if available, as follows:

- Underground DFO Tank at Duke Energy fleet services garage - A 10,000 gallon tank that is not designed to be robust, but is underground and expected to survive all applicable external events.
- ONS Auxiliary Steam Boiler DFO Tanks - Two tanks totaling 75,000 gallons of capacity that are above ground and not designed to survive the external events.

2.9 Sequence of Events and Staffing

2.9.1 Sequence of Events

The table below presents a Sequence of Events (SOE) timeline for the ONS FLEX strategy. Validation of each of the FLEX time constraint actions was completed in accordance with the FLEX Validation Process document issued by NEI and includes consideration for staffing. Times listed are approximate. Actions identified in the SOE timeline may not require the full duration listed. ONS provided conservatism for elapsed time for each action.

Sequence of Events Timeline			
Action	Start Time	Completion Time	Remarks / Applicability
Event Starts	0	NA	Plant @100% power
Implement Blackout EOP	0	1 min	Design Basis for SBO Event
Implement SSF EOP • Feed SG within 14 min • Supply RCP seals within 20 min • Stabilize RCS pressure at 1950 to 2250 psig	1 min	20 min	Design Basis for SBO Event.
Stabilize plant by following guidance in Blackout EOP and SSF EOP	20 min	1 hr	Design Basis for SBO Event ONS may control RCS temperature and pressure using Turbine Bypass Valves or ADVs. RCS temperature to be ≥ 550°F and pressure to be 1950 to 2250 psig
Monitor SFP level	20 min	2 hr	Design Basis for SBO Event
Crew determines event is ELAP and enters ELAP section of Blackout tab	45 min	2 hr	Time constraint Predecessor activity for entry into FGs
Remove Control Batteries from service	2 hr	4 hr	Time constraint This step is to be completed prior to battery depletion (nominal capacity of 4 hr). Estimated duration of this step is 30 minutes. Allotting 2 hours in the timeline is conservative.
Perform damage assessment after entry into FGs	2 hr	6 hr	

Sequence of Events Timeline			
Action	**Start Time**	**Completion Time**	**Remarks / Applicability**
Perform cool down of RCS using SSF ASW and/or ADVs	2 hr	24 hr	Time constraint On-going action for cooldown and decay heat removal; operations personnel remain stationed locally Cool down is limited by ability to maintain pressurizer level RCS temperature to be ≤ 350°F by 18 hours.
Augmented staff arrive onsite	6 hr	N/A	Per NEI 12-01
Deploy FLEX SG makeup strategy (e.g., FLEX Mitigating Strategies Pump and hoses)	6 hr	24 hr	Time constraint
Deploy FLEX RCS Makeup strategy (e.g., FLEX RCS Makeup Pump and hoses).	6 hr	24 hr	Time constraint 14 hours is the early estimate to reach cooldown hold temperature of < 350°F
Deploy FLEX repower strategy (e.g., portable generators and cables)	6 hr	24 hr	Time constraint
Deploy FLEX SFP makeup strategy (e.g., Boggs Boxes and hoses connecting to FLEX Mitigating Strategies Pump)	6 hr	24 hr	Time constraint
Initiate and complete Auxiliary Building ventilation actions	6 hr	24 hr	Time constraint Natural circulation of the Unit 1 Auxiliary Building should be completed prior to 12 hours after event initiation.
Borate RCS using either SSF RCMU pump taking suction from SFP or FLEX RCMU pump taking suction from BWST	14 hr	18 hr	Accomplished via FLEX Phase 1 & 2 strategies. This step ensures that the core is subcritical without xenon.
Cool down RCS to 325-350°F and hold	14 hr	18 hr	Accomplished via FLEX Phase 1 & 2 strategies

Sequence of Events Timeline			
Action	Start Time	Completion Time	Remarks / Applicability
Begin RCS depressurization	14 hr	18 hr	Precursors for this step include: FLEX Portable RCS Makeup Pump aligned and operating, SSF RCMU pump secured, SSF Pressurizer Heaters secured
With pressurizer heaters secured, allow RCS pressure to decrease to 650-700 psig	24 hr	44 hr	Cycle pressurizer heaters as necessary to maintain RCS pressure above 650 psig.
Vent or isolate CFTs	24 hr	44 hr	Perform after repower strategy is aligned
Maintain level in SFPs	24 hr	> 72 hr	Perform using raw water from FLEX Mitigating Strategies Pump, as necessary
As necessary, provide SG feedwater with FLEX Mitigating Strategies pump and reduce SG pressure using ADVs	24 hr	> 72 hr	
Utilize instruments repowered from FLEX generators	24 hr	> 72 hr	
Reduce RCS pressure and temperature to 300-350 psig and 240-250°F	44 hr	> 72 hr	Perform with CFTs vented or isolated
Align SGs for asymmetric feed	44 hr	> 72 hr	After RCS cooldown complete

2.9.2 Staffing

Using the methodology of NEI 12-01, Revision 0 *Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities* (Reference 14), an assessment of the capability of the on-shift staff and augmented Emergency Response Organization (ERO) to respond to a BDBEE was performed.

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

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

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

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

To conduct the assessment, a team of subject matter experts from Operations, Maintenance, Radiation Protection, Chemistry, Security, Emergency Preparedness, and industry consultants conducted tabletop evaluations. The participants reviewed the assumptions and existing procedural guidance, including applicable draft FLEX Support Guidelines (FGs) for coping with a BDBEE using minimum on-shift staffing. Particular attention was given to the sequence and timing of each procedural step, its duration, and the on-shift individual performing the step to account for both the task and time motion analyses of NEI 10-05, Revision 0, *Assessment of On-Shift Emergency Response Organization Staffing and Capabilities* (Reference 15).

2.10 Offsite Resources

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

ONS relies on equipment stored off-site for Phase 3 of the FLEX response strategy. In the event of an ELAP/LUHS, ONS will notify the NSRC that Phase 3 equipment is needed.

The NRC letter dated September 26, 2014 (ADAMS Accession No. ML14265A107) titled "Staff Assessment of National SAFER Response Centers Established in Response to Order EA-12-049" (Reference 16) endorsed NEI's White Paper titled "National SAFER Response Centers" (Reference 17). NRC concluded that SAFER procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI 12-06, Revision 0 guidance and the SAFER Response Plan to meet Phase 3 requirements of Order EA-12-049.

2.10.1 National SAFER Response Center (NSRC)

The SAFER Response Plan for ONS (Reference 18) contains (1) SAFER control center procedures, (2) NSRC procedures, (3) logistics and transportation procedures, (4) staging area procedures, which includes travel routes between staging areas to the site, (5) guidance for site interface procedure development, and (6) a listing of site-specific equipment (generic and non-generic) to be deployed for FLEX Phase 3.

Two NSRCs are strategically located across the country in Memphis, Tennessee and Phoenix, Arizona. Equipment can be provided to ONS from either NSRC.

If possible, NSRC equipment will be delivered to Staging Area C, which is the Anderson Regional Airport. When ONS is ready, NSRC equipment will then be delivered to Staging Area B, which is a softball field at the ONS site. ONS identified primary and alternate driving routes from Staging Area C to Staging Area B. ONS will coordinate with the state of South Carolina to determine the condition of bridges along the travel path. If road travel from Staging Area C to Staging Area B cannot be accomplished, then Staging Area B will receive SAFER equipment directly via helicopter airlift. Staging Area B is across Rochester Highway from the protected area. There are two access points from Rochester Highway into the site providing a primary and alternate access routes.

The SAFER Response Plan for ONS also includes a Staging Area D, which is the Oconee County Regional Airport, and is an alternate to Staging Area C. ONS identified primary and alternate driving routes from Staging Area D to Staging Area B, and will coordinate with the state of South Carolina to determine the condition of bridges along the travel path. If road travel from Staging Area D to Staging Area B cannot be accomplished, then Staging Area B will receive SAFER equipment directly via helicopter airlift.

2.10.2 Equipment

The NSRC will provide the equipment listed in the SAFER Response Plan (Reference 18). ONS identified the highest priority equipment, which will be delivered within 24 hours from initial contact. Such priority equipment includes a water treatment system with filtration and reverse osmosis, water storage containers, a mobile boration system, and diesel fuel transfer equipment (airlift container, pumps, etc.). All other equipment from the NSRC will arrive within 72 hours from initial contact, and includes redundant equipment that is a backup for Phase 2 equipment. Lower-priority equipment provided by the NSRC includes DGs (both 4160 VAC / 1 MW and 480 VAC / 1000 KW) with associated cables and connections, pumps (high-pressure, makeup, and low pressure) with associated hoses and connections, and other support equipment, such as lighting towers.

NSRC equipment connections to applicable hoses and/or plant equipment are compatible or necessary adapters are available (e.g., transformers for DGs that provide power at a different voltage).

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

2.11 Habitability and Operations

2.11.1 Equipment Cooling and Personnel Habitability

ONS performed an analysis using GOTHIC software to determine the heat loading in pertinent locations for the FLEX response to a BDBEE. This evaluation considered several actions to ensure that temperature does not exceed 110°F in the control room or 130°F in other areas for at least 4 days and steam from the SFPs does not transport to undesired areas of the Auxiliary Building. The temperature limit of the battery room is 140°F and is bounded by the 130°F maximum.

ONS will take actions in various plant buildings to ensure that temperatures remain within acceptable limits for equipment and personnel occupancy, in support of the FLEX strategies.

Actions in the Auxiliary Building to support equipment cooling and personnel habitability include the following:

- Open SFP truck bay doors and Purge Inlet Equipment Room doors before the time to boil to prevent pressurization of the fuel handling areas or steaming/exhausting into undesired areas of Auxiliary building.
- Open doors to Operator Aid Computer (OAC) rooms at event initiation.
- Complete SBO load shed within 30 minutes, which will reduce the heat load.

- To limit additional heat load, perform breaker manipulations prior to repowering (at approximately 18 hours) so that only the credited equipment for ONS FLEX strategies is restored.
- Establish natural circulation of the Auxiliary Building within 12 hours by blocking open specific doors throughout the building.
- Apply forced cooling via spot coolers to vital ELAP areas when required. Such cooling will not be required until at least 4 days into the event.

In the Turbine Building, ONS will open or verify open the TB roll-up doors and louvers/dampers (East side ground floor).

No actions are required for ventilation in the SSF or the Reactor Building. SSF ventilation is available during SSF operations.

No actions are planned for loss of heating as equipment temperature is not expected to decrease below minimum temperature specifications. During Phase 1, the SSF ventilation system is available. During Phase 2, the majority of portable equipment operates outdoors. Temperatures in locations containing permanently installed equipment that is relied on for Phase 2 are not expected to decrease below minimum temperature specifications based on the expected impact from heat loads within the Reactor Building and Spent Fuel Pools. Also, with respect to Phase 2 repower, the alternate repower strategy relies on a minimum set of permanently installed equipment.

2.11.2 Freeze Protection

If necessary, ONS will take action to provide freeze protection for components utilized for the FLEX strategy. Specifically, ONS will periodically start diesel-driven pumps, establish trickle flow while pumps are running or using gravity drains, as applicable.

2.11.3 Hydrogen Ventilation

By approximately 18 hours into the ELAP, it is expected that the 125V control batteries on all three units will be placed on a float charge by the primary repower strategy. As a result, hydrogen gas will be generated in each Unit's battery room.

The minimum concentration of hydrogen gas to result in an explosive mixture is 4%. A conservative ONS analysis determined that the hydrogen concentration will be maintained in the battery rooms at or below 0.37%.

2.12 Water Sources

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

2.12.1 SG Make-up

For SG make-up, ONS will provide water from one of the following sources:

- CCW Intake Crossover Line (via SSF)

- Intake Canal

The CCW Intake Crossover Line (which feeds the SSF ASW pump) and the Intake Canal are protected from all design basis hazards and will therefore be available following any of the applicable hazards.

ONS has an alternative strategy for providing SG makeup water from Chemical Treatment Pond (CTP)-1, and supplementing the CTP-1 inventory with water from embedded CCW piping. This strategy would be used for an external flood (see Section 3), and is not credited for the T=0 strategy.

2.12.2 Reactor Coolant System Make-up

During Phase 1, ONS will provide borated water from the SFP using the SSF RCMU Pump.

For RCS boration during Phase 2, ONS will provide borated water from the BWST. During Phase 3, the NSRC will provide additional boration equipment that can be used to provide high quality, borated makeup. See Section 2.3.3.

2.12.3 SFP Inventory Control

For inventory control of the SFPs, the ONS FLEX strategy credits use of water from the Intake Canal to provide any necessary makeup. The same water source and pump is used for Phase 2 SFP makeup as for Phase 2 SG Makeup (see Section 2.12.1). ONS will only provide raw water makeup to the SFPs if necessary. ONS will preferentially supply demineralized, borated water for makeup using equipment from the NSRC, if possible. See Section 2.4.2.

2.13 Shutdown and Refueling Analysis

Order EA-12-049 requires that licensees must be capable of implementing the FLEX response strategies in all Modes. In general, the previous Sections focus on a BDBEE occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year.

On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown Refueling Modes" (Reference 19), which described methods to ensure plant safety in shutdown modes. By letter dated September 30, 2013 (Reference 20), the NRC staff endorsed this position paper as a means of meeting the requirements of the Order. In the third six-month update (Reference 21) dated August 27, 2014, ONS stated its intent to follow the guidance in this position paper. The final strategies incorporate this guidance to the extent practical.

2.13.1 Core Cooling

The ONS FLEX response strategy for core cooling from Modes 5 and 6 involves supplying water from the BWST to the RCS using a FLEX Shutdown Modes Pump, which can deliver 150 gpm to 200 gpm of flow at 100 psig. The primary RCS injection path is through an existing Reactor Building Spray (BS) piping connection in the East Penetration Room that is aligned to Low Pressure Injection (LP) piping. The alternate connection point utilizes disassembly of an existing mechanical joint in the SFP purification system piping, and aligning valves to direct flow to the LP piping.

ONS performed a FATHOM analysis to evaluate this FLEX strategy. The analysis concluded that the required pump capacity is 110 gpm at 77 psid. The FLEX Shutdown Modes Pump provides sufficient pressure and flow to meet the required demand. The analysis also concluded that feeding the pump from the BWST will satisfy the pump suction requirements. Additionally, the calculation conservatively estimated that the BWST inventory would last for at least 41.5 hours, which is sufficient for Phase 3 resources to arrive.

The ONS FLEX strategy requires one FLEX Shutdown Modes Pump per Unit. ONS has three FLEX Shutdown Modes Pumps stored in the FSB. It is very unlikely that all three Units would be simultaneously shut down; however, in this case, and if one of the FLEX Shutdown Modes Pumps were unavailable, ONS could use a FLEX Mitigating Strategies Pump instead. Therefore, the N+1 requirement for equipment redundancy is satisfied.

The credited water supply for the FLEX Shutdown Modes Pumps is the BWST.

2.13.2 SFP Cooling

The FLEX SFP makeup strategy with full core offloaded is the same as during operating modes. (See Section 2.4.)

2.13.3 Containment Integrity

If the event occurs while the reactor is shut down and the RCS is open to containment, containment pressure will increase as the RCS inventory boils. ONS will open a vent flow path to the outside atmosphere, if a vent path has not already been established. ONS GOTHIC analysis calculated that containment pressure will continue to increase until eventually stabilizing at 52.2 psia, at which point the rate of steam leaving the vent path plus the rate of condensation starts to exceed the boil-off rate. The vapor calculated temperature in the Reactor Building at the end of the transient is 284°F. These calculations are conservative, as they do not include RCS subcooling from makeup flow, which would absorb some of the energy in the RCS by heating. Based on the results of this case and the inherent conservatism in the analysis, ONS concluded that the long-term pressure and temperature response will not exceed the Containment design limits of 59 psig (74 psia) and 286°F.

2.14 Procedures and Training

2.14.1 Procedural Guidance

The inability to predict actual plant conditions that require the use of BDBEE equipment makes it impossible to provide specific procedural guidance. As such, the FGs provide guidance that can be employed for a variety of conditions. FGs, to the extent possible, provide pre-planned FLEX response strategies for accomplishing specific tasks in support of

EOPs and Abnormal Operating Procedures (APs). FGs are used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

2.14.2 Training

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

Initial training was provided for Auxiliary Operators, Licensed Operators and shift maintenance technicians in August and September 2015, prior to implementation of FLEX on ONS Unit 2 (i.e., the first Unit to implement FLEX). Recurring training is on the Non-Licensed Operator Requalification and Licensed Operator Requalification schedule and maintenance continuing training schedule.

A basic ERO Computer Based Training (CBT) module and an ONS Site Specific CBT module were developed and delivered to all ERO members. An Advanced CBT for ERO Decision makers was developed and delivered to all ERO Decision makers.

Periodic training will be provided to emergency response leaders and personnel assigned to direct the execution of the FLEX strategies.

FLEX drills will be planned and conducted to demonstrate site readiness, consistent with industry guidance.

2.15 Maintenance and Testing

ONS has implemented maintenance and testing of FLEX equipment that conforms to the requirements of NEI 12-06, Revision 0, Section 11.5. ONS has adopted EPRI Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment," to the extent possible.

3. Warning Time Strategy

This section of the FIP discusses a FLEX strategy to address an external flood. The ONS design basis does not include an external flooding hazard, so this strategy is not required for compliance with NRC Order EA-12-049 or conformance to the guidelines of NEI 12-06, Revision 0. ONS prepared this enhancement to its FLEX strategy because of a previous commitment to the NRC to maintain plans and procedures to address mitigation of postulated external floods (Reference 24). This previous commitment is independent of NRC Order EA-12-049 and NEI 12-06. The strategy discussed in this section relies on actions taken during the warning time prior to the flood affecting the site (i.e., the Warning Time strategy). The Warning Time strategy conforms to the guidelines of NEI 12-06.

Section 2 of this FIP describes the T=0 strategy and the features of that strategy that establish compliance with NRC Order EA-12-049 and conformance to the guidelines of NEI 12-06, Revision 0, with noted alternative approaches. Much of the content from Section 2 of the FIP is applicable to the Warning Time strategy. The discussion below focuses on differences between the T=0 strategy and the Warning Time strategy.

3.1 Reactor Core Cooling Strategy

3.1.1 Phase 1: Core Cooling

The Warning Time strategy will be initiated upon receipt of notification of imminent or potential failure of the Jocassee main dam. Jocassee Hydro personnel are trained and authorized to make this notification in accordance with the Emergency Action Plan for the Jocassee Hydro Station.

ONS will enter the procedure for flood mitigation, and all three Units will begin shutdown. Notification of external flooding will be provided approximately 7 hours before potential loss of the SSF by flood waters in the ONS yard overtopping the SSF flood wall.

During the warning time period, ONS will increase water levels in the pressurizer and SGs and begin cool down to 240-250°F. Cooldown rate is limited to 50°F per half-hour when RCS temperature exceeds 270°F, and 25°F per half-hour when RCS temperature is less than 270°F. ONS will decrease RCS pressure to 290 - 300 psig. ONS will deploy a SG makeup strategy from a portable pump (Phase 2) prior to site inundation.

ONS will borate the RCS to cold shutdown conditions using normal plant equipment during the warning period. As discussed in the previous paragraph, ONS will perform RCS injection to increase pressurizer level during the warning period. Therefore, actions to address RCS boration and inventory will be complete prior to loss of any installed components or power sources from the flood.

Prior to RCS depressurization below 800 psig and loss of power, ONS will close CFT isolation valves.

Normal plant instrumentation will be available to support Phase 1 coping prior to site flooding. ONS can monitor key parameters from selected electrical penetrations using portable instruments, if necessary.

3.1.2 Phase 2: Core Cooling

The Phase 2 Warning Time strategy for supplying makeup is identical to the T=0 strategy, except that the portable pump will draw suction from Chemical Treatment Pond 1 (CTP-1), because it is protected from external flooding and the FLEX Mitigating Strategies Pump and hoses will be deployed prior to site inundation.

ONS will use the water volume retained by the embedded CCW piping to sustain core cooling beyond the initial capacity of CTP-1. Operator action to break siphon prior to site flooding will be completed to maximize CCW water retention. CTP-1 has a minimum inventory that will support approximately 24 hours of core cooling. The CCW inventory can be accessed with a FLEX Submersible Pump and has sufficient inventory to provide makeup to CTP-1 that supports core cooling for an additional 8 days (i.e., approximately 9 days of total cooling water inventory).

RCS boration and inventory addition will be accomplished prior to site inundation. After the flood waters recede, the RCS makeup strategy discussed for the T=0 strategy may be used for further RCS makeup.

For the electrical repower strategy, the alternate repower strategy discussed for the T=0 strategy will be used rather than the primary strategy. Prior to site inundation, 10 kW DGs, splitter boxes, and cables will be staged on the 5th floor of the Turbine Building rather than on the ground floor to protect it from the flood waters. The 500 kW DGs are not required for the Warning Time strategy. In the alternate repower strategy, the only load on these DGs is the CFT vent valves. Because the CFTs will have already been isolated before site inundation, repowering the CFT vent valves is not necessary.

3.1.3 Phase 3: Core Cooling

The Phase 3 strategies to support core cooling are identical to the T=0 strategy, The NSRC equipment will establish logistics for delivery and purification of water at a rate of 720,000 gallons per day within 9 days, which is sufficient to ensure indefinite coping capability.

The NSRC will provide a mobile boration unit to prepare additional borated water for RCS makeup. For the Warning Time strategy, makeup water to support this strategy may be provided by CTP-1 (rather than the Intake Canal, which may not be available following a flood).

3.1.4 Availability of Systems, Structures, and Components

The T=0 strategy for core cooling relies on various installed systems, structures, and components (SSCs). The discussion in Section 2.3.4 for the T=0 strategy is applicable to SSCs relied upon for the Warning Time strategy. Additional discussion of SSCs used only for the Warning Time strategy is included below.

3.1.4.1 Structures

The Warning Time strategy accounts for external flooding that exceeds the ONS design basis. The Warning Time strategy relies on the Reactor Building, the Auxiliary Building, the SSF and portions of the Turbine Building prior to site inundation. Although buildings may be flooded, components are at elevations that will provide protection from flood waters.

3.1.4.2 Systems

The Warning Time strategy relies on the same installed piping from plant systems as the T=0 strategy to deliver water for core cooling. These components will not be affected by site flooding and are therefore available for the Warning Time strategy.

3.1.4.3 Chemical Treatment Pond 1 (CTP-1)

CTP-1 is the water source for SG makeup for the Warning Time strategy. CTP-1 is above the flood level, and will therefore be available to support the Warning Time strategy. The minimum volume of water in CTP-1 mandated by administrative controls is sufficient for at least 24 hours of core cooling using the SGs.

3.1.4.4 Condenser Circulating Water (CCW) Piping

ONS credits CCW piping as a source of makeup water to CTP-1. The CCW piping is underground and will not be affected by site flooding. Additionally, the CCW piping will not need to be accessed until after the flood waters have receded. Therefore, the inventory in the CCW piping will be available to support the Warning Time strategy. The captured inventory in this piping can provide approximately 8 days of SG feedwater.

3.1.5 FLEX Connections

Primary and alternate FLEX connections are installed on various plant systems to provide water and power for the T=0 strategy. These connections are also used for the Warning Time strategy. The combination of primary and alternate connections ensures that the Warning Time strategy can be deployed following an external flood as discussed below.

3.1.5.1 SG Feedwater Connections

The primary and alternate connections for Phase 2 SG feedwater strategy are the same as for the T=0 strategy. For the Warning Time strategy, the flow path will be established prior to flooding and will not be affected by the flood waters.

3.1.5.2 Reactor Coolant Inventory Connections

The primary and alternate connections for Phase 2 SG RCS inventory strategy are the same as for the T=0 strategy. RCS boration will have occurred prior to site inundation and further RCS makeup capability will not be required until after flood waters recede, thus allowing for deployment after flooding.

3.1.5.3 Electrical Connections

The T=0 strategy includes a primary and an alternate repower strategy. The Warning Time strategy relies solely on the alternate repower strategy. This approach complies with NEI 12-06, which states that both the primary and alternate connection points do not need to be available for all applicable hazards.

Connection points are located in the Auxiliary Building at selected MCCs, transfer switches, and terminal blocks located within electrical cabinets. These connection points are located in various locations. The lowest required connection points are located on the 809'-3" level of the Auxiliary Building. For the T=0 strategy, the MCC connections to repower the CFT vent valves are at a lower level, but these connections are not required for the Warning Time strategy, because the CFTs will be isolated during the warning time.

3.1.6 Plant Instrumentation

Normal plant instrumentation will be available prior to site inundation, and will support the Phase 1 Warning Time strategy. The alternate repower strategy is preemptively staged and Fluke calibrators deployed to enable indication of key instrument parameters throughout the flood event.

ONS identified alternate methods for obtaining key parameters that are protected from site inundation. The following parameters can be monitored with Fluke calibrators at panels in the East and West penetration rooms that are located above the maximum flood level.

- SG Level
- RCS Pressure
- Core Exit Thermocouples
- Pressurizer Level
- RCS Hot Leg temperature
- RCS Cold Leg temperature
- RV Level (shut down modes only)

3.1.7 Thermal-Hydraulic Analysis

As part of the RELAP analysis of the T=0 strategy, ONS included an evaluation of the Warning Time strategy. The analysis evaluated shut down of the reactor and rapid cool down of the RCS in preparation for a loss power. This scenario also included loss of the SSF coincident with the loss of power and subsequent use of a portable pump. Results demonstrate that single phase natural circulation is maintained, ensuring that the core remains covered and heat is adequately transferred to the UHS. Additionally, the results demonstrate that the core is adequately borated during the preparations for the loss of power.

3.1.8 FLEX Pumps

3.1.8.1 FLEX Mitigation Strategies Pumps (Low Pressure)

The same FLEX Mitigation Strategies Pumps are used for SG makeup as for the T=0 strategy.

The water supply for the FLEX Mitigation Strategies Pump is CTP-1 for the Warning Time strategy.

3.1.8.2 FLEX Portable RCS Makeup Pumps (High Pressure)

The same FLEX Portable RCS Makeup Pumps are used for RCS makeup as for the T=0 strategy.

The water supply for the FLEX Portable RCS Makeup Pumps is the BWST.

3.1.8.3 FLEX Submersible Pumps

CTP-1 is the water source for SG and SFP makeup using the Warning Time strategy. Because the inventory in CTP-1 may be sufficient for only 24 hours, the Warning Time strategy relies on a FLEX Submersible Pump that is placed in the CCW piping to provide makeup to CTP-1. The FLEX Submersible Pumps deliver a design flow of 650 gpm at 90 feet Total Discharge Head.

The FLEX Submersible Pump will be deployed in time to support delivery of water by the time the CTP-1 inventory is depleted, which will occur 24 hours after the event. ONS analysis determined that the SG boil-off rate would be 108 gpm at this time (i.e., 324 gpm and conservatively adding 70 gpm per SFP (i.e., 140 gpm) boil-off is less than 500 gpm total for the site). ONS performed a hydraulic analysis, which concluded that the FLEX Submersible Pump and its hose configuration would provide adequate flow for this potential demand.

The ONS Warning Time strategy requires one submersible pump. ONS has three FLEX Submersible Pumps, all stored in the FSB, which satisfies the N+1 requirement for equipment redundancy.

3.2 SFP Cooling/Inventory Strategy

3.2.1 Phase 1: SFP Cooling

There are no differences between the T=0 and Warning Time strategies for Phase 1.

3.2.2 Phase 2: SFP Cooling

There are no differences between the T=0 and Warning Time strategies for Phase 2, except that the FLEX Mitigating Strategies Pump draws suction from CTP-1 instead of the Intake Canal.

3.2.3 Phase 3: SFP Cooling

There are no differences between the T=0 and Warning Time strategies for Phase 3.

3.2.4 Availability of Structures, Systems, and Components

The Warning Time strategy relies on site structures to provide protection for components, fluid and electrical connections, and deployment paths from applicable extreme external hazards. Specifically, the Warning Time strategy for SFP cooling relies on selected spaces in the Auxiliary Building. The top of the SFPs is at the 844 ft elevation, which is 48 ft above site grade.

3.3 Containment Function Strategy

There are no differences between the T=0 and Warning Time strategies for the containment function.

ONS performed a GOTHIC evaluation to determine the containment pressure and temperature response during an ELAP for the first 72 hours. For an ELAP/LUHS where the Warning Time strategy is executed prior to an external flood, the analysis demonstrates that after 72 hours, pressure increases to 20 psia and temperature increases to 185°F.

The simulation results show that the temperature and pressure trends are leveling off at 72 hours. ONS expects that the containment pressure and temperature trends would stabilize shortly after 72 hours due to continued reduction in RCS temperature and pressure, long-term site recovery actions, and natural reduction in core decay heat. Over an extended period, further reduction in decay heat levels and continued passive heat conduction through the RB walls to the outside environment will keep temperature and pressure well below Containment design limits.

3.4 Characterization of External Flooding

As discussed in Section 2.6.2, external flooding is not a design basis hazard for ONS. ONS elected to design its Warning Time strategy for external flooding higher than the SSF. The postulated flood is caused by upstream dam failure. ONS determined that this scenario would provide approximately 7 hours of warning time, and that the flood water would recede to approximately 798 ft elevation (2 feet above grade) approximately 5 hours thereafter.

3.5 Planned Protection of FLEX Equipment

3.5.1 FLEX Support Building

The FSB is located at an elevated portion of the site and is well above the potential flood level at ONS. Therefore, the FSB is protected from external flooding.

3.5.2 Other Storage Locations

Selected equipment for the Warning Time strategy is stored in locations other than the FSB, as follows:

- The Boggs Boxes that provide spray makeup capability for the SFPs and associated hoses are stored in the SFP Change Rooms. ONS will pre-stage the Boggs Boxes and hoses out of the SFP area prior to site inundation.
- The Duplex Filter used for SFP makeup is stored in the SSF, which is only protected from external flooding to a limited height. For an external flooding event, ONS would deploy the Duplex Filter if available after flood waters recede.
- Fluke Temperature Calibrators that are used for alternate instrumentation monitoring are stored in a cabinet in the Auxiliary Building 5th floor elevator lobby, which is above the credible flood height.
- Hoses for the SG Makeup portable connection strategy are stored in a box near 2PSW-29, which is inside the Auxiliary Building. These hoses are deployed and 2PSW-29 positioned open prior to site inundation.

3.6 Planned Deployment of Flex Equipment

3.6.1 Haul Paths and Accessibility

For the flooding event, ONS will either deploy FLEX equipment during the Warning Time period, or deploy after the flood waters have receded. Therefore, flooding does not adversely impact deployment paths from the FSB to the power block.

3.6.1.1 Raw Water Distribution

ONS will transport the FLEX Mitigating Strategies Pump to CTP-1 at a location that allows access to the pond as a suction source. Suction hoses with strainers will be attached to the pump and placed into the pond.

3.6.1.2 Core Cooling Strategy

The FLEX Mitigating Strategies Pump will be staged at CTP-1. Discharge hoses will be routed from the pump to the EFM Hard Pipe, which heads towards the power block. Additional hose will be connected to the EFM Hard Pipe outlet and routed to the staging area in the yard on the west side of the Auxiliary Building. All hoses will be deployed prior to site inundation from the flood waters. The hoses will be secured at various points in the yard and are expected to remain in place during the time water is on-site.

Hose routing from the staging area on the west side of the Auxiliary Building is the same as the T=0 strategy.

3.6.1.3 Reactor Coolant Boration and Make-up Strategy

RCS boration will be complete prior to site inundation, so the RCS makeup strategy will be deployed after flood waters recede.

Deployment of the RCS makeup strategy is the same as for the T=0 strategy.

3.6.1.4 Electrical Strategy

The repower strategy for the Warning Time strategy is the same as the alternate repower strategy for the T=0 strategy, except that ONS will deploy the 120/240 VAC DGs, cable splitters, and cable to the 822' elevation of the Turbine Deck (instead of the ground floor) for each affected Unit. This elevation will protect the equipment from flooding. This deployment of equipment will be completed during the warning time prior to site inundation. The 600 VAC/500 kW is not required for the Warning Time Strategy as previously discussed in Section 3.1.2.

3.6.1.5 SFP Makeup

Deployment of the Warning Time strategy for SFP makeup is the same as the T=0 strategy, except for the following two differences:

- The FLEX Mitigating Strategies Pump will be deployed to CTP-1 rather than the Intake Canal.
- The Boggs Boxes will be deployed and hoses flaked out of the Spent Fuel Pool area during the warning time period, prior to site inundation.

Full strategy deployment is completed after flood waters recede.

3.6.2 Fueling of Equipment

In the Warning Time strategy, the reactor will be shut down and cool down with long term heat removal underway prior to site flooding using normal procedures and the SSF, until it is inundated. Warning Time strategies would be used thereafter, as necessary. Once the on-site water inventory has receded the FLEX portable refueling trailer will be pulled by the FLEX Pickup Truck to the various site locations for refueling portable equipment. The ONS fuel consumption study determined that the fuel stored in FLEX equipment and the additional fuel in the FLEX refueling trailer will be sufficient for the first 36 hours into the event. Thereafter, maximum fuel consumption will be approximately 1,500 gallons per day.

To provide additional fuel, site procedures will direct personnel to relocate the ONS Garage DFO refueling truck to the FSB location above the maximum flood height. This refueling truck has a 1,700 gallon capacity and will have at least 800 gallons of fuel. This inventory extends the credited on-site fuel capacity to 48 hours.

Contact with fuel oil suppliers will be made to arrange delivery of additional fuel oil prior to site inundation. This additional fuel oil will be stored at an elevation to protect the fuel oil from flooding. Additionally, as part of Phase 3, the NSRC will supply air lift fuel oil containers that will enable delivery of additional fuel by helicopter, if necessary.

3.7 Sequence of Events and Staffing

3.7.1 Sequence of Events

The table below presents the SOE timeline for the Warning Time strategy. Validation of each of the FLEX time constraint actions was completed in accordance with the FLEX Validation Process document issued by NEI and includes consideration for staffing. Times listed are approximate. Actions identified in the SOE timeline may not require the full duration listed. ONS provided conservatism for elapsed time for each action.

Sequence of Events Timeline - Warning Time Strategy			
Action	Start Time	Completion Time	Remarks / Applicability
Condition B declaration for Jocassee Dam	0	NA	Plant @100% power
Initiate External Flood Mitigation Procedure	0	1 min	
Trip Unit, borate RCS to cold shutdown conditions, close CFT isolations, increase level in pressurizer and SGs, and begin plant cooldown	1 min	6.86 hr	Control Room Supervisor takes these actions for each Unit. Sufficient concentrated boric acid will be injected into RCS prior to the ELAP to ensure core remains subcritical.
Activate Operational Support Center (OSC) and Technical Support Center (TSC), classify event, conduct site assembly, request increased staffing, and direct SFP monitoring	1 min	6.86 hr	Shift Manager takes these actions.
Dispatch operators and maintenance to align FLEX Mitigating Strategies Pump. Notify maintenance to relocate alternate repower strategy equipment to Turbine Bldg 5th floor and relocate ONS garage refueling truck to FSB area. Notify maintenance to pre-stage portable instrumentation in the Penetration Rooms and prepare to take instrument readings. Dispatch operators to open siphon break valves on CCW piping. Notify operators to prepare to operate SSF, portable diesel SG makeup pump and ADVs.	1 min	6.86 hr	Unit 1 Balance of Plant (BOP) operator and each Unit's Control Room Supervisor take these actions.
Flood crests Intake Canal Dike and begins flooding ONS yard. (Power is assumed to be lost.)	6.86 hr	N/A	
Monitor SFP conditions	6.86 hr	> 72 hr	

Sequence of Events Timeline - Warning Time Strategy			
Action	Start Time	Completion Time	Remarks / Applicability
Flood waters result in loss of SSF	7 hr	N/A	
Throttle open ADVs	7 hr	> 72 hr	Time constraint
Feed SGs with FLEX Mitigating Strategies pump taking suction from CTP-1	7 hr	> 72 hr	
Flood recedes to elevation 798'	11.86 hr	N/A	
Deploy FLEX RCS Makeup Pump and associated equipment to support Phase 2 RCS makeup strategy	12.86 hr	24 hr	Time constraint
Deploy FLEX Submersible Pump and associated equipment to provide makeup to CTP-1 via transfer from CCW	12.86 hr	24 hr	Time constraint
Deploy equipment to support Phase 2 SFP makeup strategy	12.86 hr	24 hr	Time constraint
Initiate and complete Auxiliary Building ventilation actions	12.86 hr	24 hr	Time constraint
Deploy DGs and associated equipment to support Phase 2 FLEX repower strategies	12.86 hr	24 hr	Time constraint
Initiate actions to establish an offsite makeup water transfer capability to CTP-1.	24 hr	> 72 hr	CTP-1 and CCW inventory will provide at least 5 days of water to support FLEX strategies

3.7.2 Staffing

For the Warning Time strategy, ONS will initiate plans to increase staffing prior to site flooding by activating the ERO and notifying the overtime shift to report to the site.

3.8 Water Sources

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

3.8.1 SG Make-up

For SG make-up, ONS will provide water from one of the following sources:

- CCW Intake Crossover Line
- CTP-1
- CCW Piping
- Intake Canal
- Off-site supplies (e.g., trucks)
- Lake Keowee

The CCW Intake Crossover Line feeds the SSF ASW pump and would be used as a source of water for as long as the SSF is available. However, should the SSF become inundated, ONS has prepared alternate strategies.

CTP-1 is protected from external flooding, and is the credited water source for the Warning Time strategy. ONS will deploy a FLEX Mitigating Strategies Pump to CTP-1 prior to site inundation to support the Warning Time strategy. The CTP-1 inventory may be supplemented by CCW piping inventory using a FLEX Submersible Pump.

Dam failures may result in drainage of the water that would be in the Intake Canal. Therefore, the Intake Canal is not a credited water source for the Warning Time strategy. However, if downstream dams remained intact, and water remained in the Intake Canal, ONS could deploy a FLEX Mitigating Strategies Pump to the Intake Canal to provide inventory beyond the water contained in CTP-1 and the CCW piping.

Off-site supplies of water (e.g., via trucks) are expected to be available during Phase 3 to provide indefinite coping capability. However, if necessary, ONS can deploy a FLEX Submersible Pump, a low pressure pump provided by the NSRC, and hoses to obtain residual water in Lake Keowee. A river originally ran through the area currently occupied by Lake Keowee. Construction of the downstream dam created the lake. If the downstream dam failed, the river would continue to run through the area. ONS could use this river as a water source for replenishing CTP-1, and providing a source of long term cooling water.

3.8.2 Reactor Coolant System Make-up

ONS will borate the RCS using normal plant systems using water from the Concentrated Boric Acid Storage Tank (CBAST) and BWST prior to site inundation.

Otherwise, the RCS Makeup strategy is the same as for the T=0 strategy. During Phase 2, ONS will provide borated water from the BWST for RCS inventory control. During Phase 3, the NSRC will provide additional boration equipment that can be used to provide high quality, borated makeup to the RCS.

3.8.3 SFP Inventory Control

For inventory control of the SFPs, ONS will use the same water source as for SG Makeup. The credited approach is to use CTP-1 and CCW piping. Consistent with the T=0 strategy, ONS will only provide raw water makeup to the SFPs, if necessary. ONS will preferentially supply demineralized, borated water for makeup using equipment from the NSRC, if possible.

3.9 Shutdown and Refueling Analysis

If an external flooding event occurred while one or more Units is shutdown, ONS would increase RCS levels and attempt to restore the capability of SG cooling before the flood waters arrive on site. Core cooling would then be accomplished using a FLEX Mitigating Strategies Pump drawing suction from CTP-1, in the same manner as for the core cooling plan for Units that had been operating at full power. If the Fuel Transfer Canal is filled for refueling, the shutdown mode pump would be deployed after flood waters recede.

If Fuel Transfer Canal is filled for refueling, actions would be taken to establish containment venting. After flood waters recede, the shutdown modes pump would be deployed.

4. Acronyms

ADV - Atmospheric Dump Valve
AP - Abnormal Operating Procedure
ASW - Auxiliary Service Water
ATWS - Anticipated Transient Without Scram
BDB - Beyond-Design-Basis
BDBEE - Beyond Design Basis External Event
BWST - Borated Water Storage Tank
CBAST – Concentrated Boric Acid Storage Tank
CBT - Computer Based Training
CC - Component Cooling System
CCW - Condenser Circulating Water System
CFR - Code of Federal Regulations
CFT - Core Flood Tank
CTP - Chemical Treatment Pond
DBE - Design Basis Earthquake
DG - Diesel Generator
EFM - External Flood Mitigation
ELAP - Extended Loss of AC Power
EOP - Emergency Operating Procedure
ERO - Emergency Response Organization
ESEP - Expedited Seismic Evaluation Process
FDW - Feedwater System
FHRR - Flood Hazard Re-Evaluation Report
FIP - Final Integrated Plan
FLEX - Diverse Flexible Coping Strategies
FG - FLEX Support Guideline
FSB - FLEX Support Building
HPI - High Pressure Injection
JDF - Jocassee Dam Failure
LOOP - Loss of Offsite Power
LUHS - Loss of Access to Ultimate Heat Sink
MCC - Motor Control Center
MCR - Main Control Room
MHE - Maximum Hypothetical Earthquake
MSL - Mean Sea Level
NEI - Nuclear Energy Institute
NI - Nuclear Instrument

NRC - Nuclear Regulatory Commission
NSRC - National SAFER Response Center
NTTF - Near-Term Task Force
OAC - Operator Aid Computer
OBE - Operating Basis Earthquake
ONS - Oconee Nuclear Station
PEICo - Pooled Equipment Inventory Corporation
PGA - Peak Ground Acceleration
PIM – Pooled Inventory Management
PSW - Protected Service Water
RCP - Reactor Coolant Pump
RCMU - Reactor Coolant Makeup
RCS - Reactor Coolant System
SAFER - Strategic Alliance for FLEX Emergency Response
SAT - Systematic Approach to Training
SBO - Station Blackout
SF - Spent Fuel Pool Cooling System
SFP - Spent Fuel Pool
SG - Steam Generator
SOE - Sequence of Events
SSC - System, Structure, and/or Component
SSE - Safe Shutdown Earthquake
SSF - Standby Shutdown Facility
TDEFW - Turbine-Driven Emergency Feedwater Pump
TIA - Task Interface Agreement
TS - Technical Specifications
TSC - Technical Support Center
UFSAR - Updated Final Safety Analysis Report
UHS - Ultimate Heat Sink

5. References

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